Bulletinen

Svenska Matematikersamfundets Bulletin

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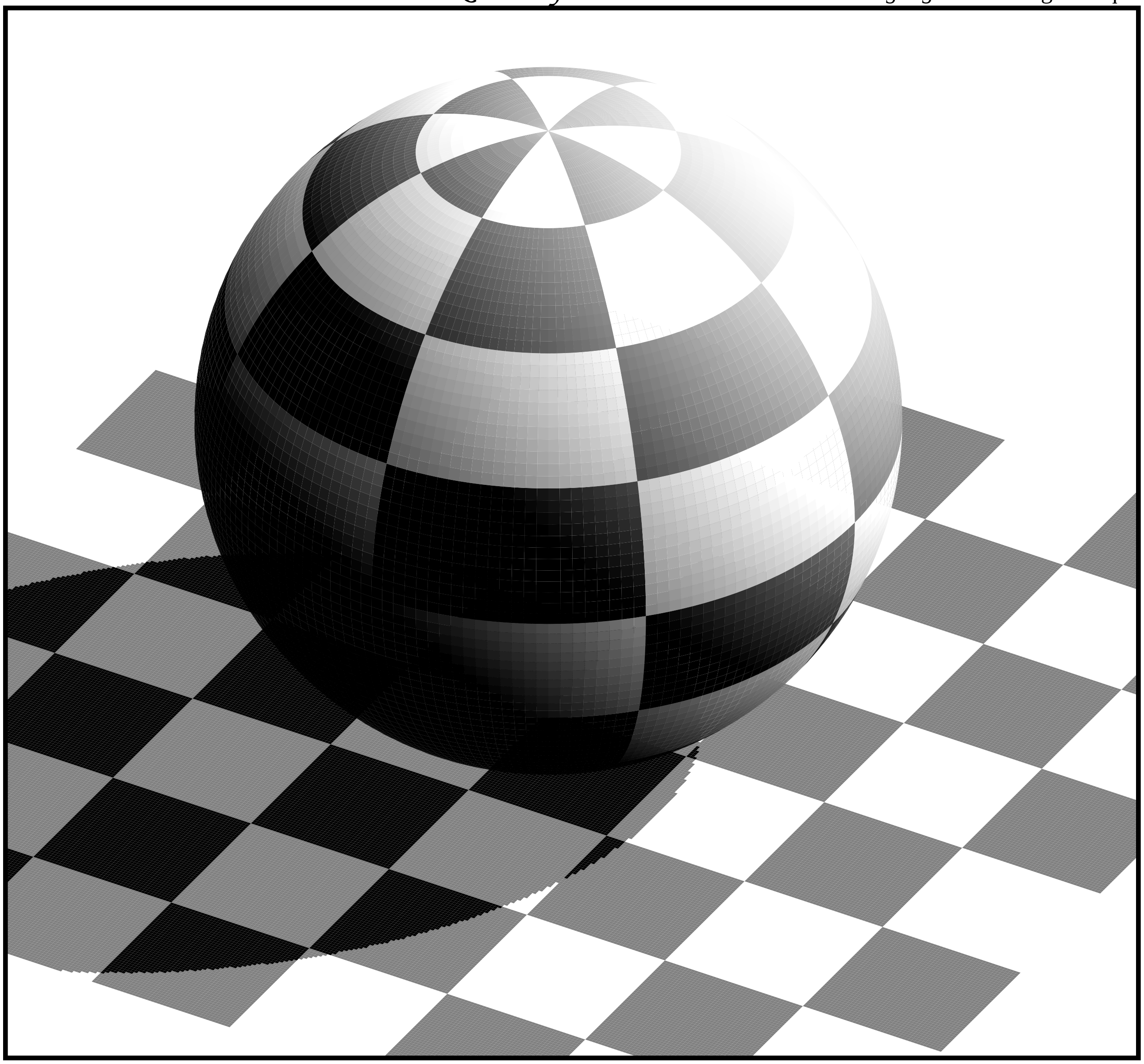
Ansvarig utgivare: Milagros Izquierdo



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Bulletinen

utkommer tre gånger per år I Januari, Maj och Oktober. Manusstopp är den första i respektive månad

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Detta Nummer

Detta nummer kommer att (återigen) domineras av en av mina intervjuer, men jag väljer att kalla den med den mer passande beteckningen 'konversation' denna gång inspirerad som jag är av den klassiska boken av Eckermann 'Gespräche mit Goethe'[1]. Nu handlar det om min f.d. handledare David Mumford, och liksom i fallet med intervjuerna med Hersh och Illusie i tidigare nummer vill jag tacka på det hjärtligaste Bengt Johansson vid NCM som gjorde dem möjliga genom resebidrag. Denna senaste intervjun gjorde jag redan för sex år sedan men har förblivit opublicerad. Det kan vara dags att låta den se dagens ljus. Arne Söderqvist inkommer med en skrämmande redogörelse om hur det kan gå till vid tjänstetillsättningar även i matematik. Man misstänker att detta bara är toppen av ett isberg. Göteborgs Universitet var i blåsväder för en tid sedan rörande lagvidriga tillsättningar. Vidare har på vår ordförandes anmodan Pär Kurlberg och Anders Holst skrivit om de smått katastrofala konsekvenserna av det nya Ladoksystemet. I sista stund har även inkommit en av mig beställd bokrecension av Lars Wern angående Max Tegmarks uppmärksammade bok. Slutligen har jag bett David Wells, engagerad schackspelare och Math Educator i London, att skriva om just matematik och schack. Många matematiker är skickliga spelare, många andra i likhet med mig är totalt inkompetenta[2]. Vad beror detta på? Jag har speciellt i åtanke två av mina kolleger Vasil Tsanov från Sofia och den framlidne Vikram Mehta vid Tata Institute i Mumbai, två framstående matematiker om än inte i världsklass. Jag minns speciellt en bussfärd i Rumänien sommaren 1983, under vilken Tsanov spelade mot Faltings. Även om Faltings tilläts göra om sina drag blev han hela tiden oundvikligen till sin stora frustration slagen. Mehta fällde i ett annat sammanhang kommentaren om den ivrigt schackspelande Serre att 'he is a lousy player'.

Rolf Pettersson vid Chalmers har nyligen avlidit. Han blev under sin tid något av en legend bland gamla chalmerister eftersom han i motsats till professorer mötte alla studenter, inte bara de matematikinriktade. Av en händelse träffade jag på några pensionärer tillika före detta chalmersstuderande på Öresundståget härom sommaren, och den matematiker de kände till bäst var just Roffe Pettersson. Han nådde en viss ryktbarhet bortom Chalmers med sina diagnostiska prov som han presenterade för nyinkomna studenter under en lång tid. Dessa prov, som av förklarliga skäl inte kan publiceras, inriktar sig på elementära färdigheter som man kan förvänta sig att en gymnasist skall behärska även om de inte söker en teknisk utbildning. Från dessa data kan man se hur studenterna blir mindre och mindre förberedda. Vad detta beror på kan man spekulera. Bernt Wennberg, prefekt vid institutionen och tillika medlem av Boltzmanngruppen där RP verkade, skriver minnesrunan.

Vår ordförande Milagros har nyligen blivit hedrad med en medalj. Närmare omständigheter och redogörelser sker på annan plats i numret.

[1] `www.math.chalmers.se/~ulfp/Review/eckermann.pdf`

[2] Visst kan jag tänka i förväg. Jag gör A så gör min motståndare B men då kontrar jag med C och denne tvingas göra D men då gör jag honom matt. Men denne är av någon anledning inte samarbetsvillig och gör inte ens B! Detta är frustrerande.

Abstract games and mathematics: from calculation to analogy

David Wells

The famous column of that Martin Gardner wrote for Scientific American ran from 1956 to 1986. Most of the columns were about mathematical recreations such as hexaflexagons, magic squares, card tricks, polyominoes and the Soma cube, but he also discussed many mathematical games such as tick-tack-toe, Hex, dominoes, Nim, Sprouts and Brussel Sprouts, The Turing Game, The Game of Life, Cram, Quadraphage, and in July 1962, 'Some diverting mathematical board games', and of course the title of his column was Mathematical Games.

Why? The abstract games that Gardner discussed and analyzed obviously have something in common with mathematics - and with the mathematical recreations he presented - but what is it, and do the shared features extend to more complex games such as chess and the oriental game of Go?

Let's start at the beginning. For all practical purposes, the counting numbers, whatever your number system, are defined and created by very simple and abstract rules. The rules create the numbers, and tell me (and you) that the next number after 4189675583579246533 is 4189675583579246534. Incidentally, but it is a significant point, there is a non-zero probability that that number has never before in the entire history of the world been written down

The rules of the Hindu-Arabic system which we use are exceptionally simple and powerful and allow us not only to count on 'for ever', but they make sums and differences, products and even quotients, rather easy to calculate.

Abstract games, such as chess, are also defined and created by rules, though the rules of chess (and of Go) are rather more complicated and arbitrary than those of the Hindu-Arabic system.

This explains why they can be easily transported across human linguistic and cultural boundaries unlike any other aspect of human culture.

These rules, for the counting numbers and chess, (and other non-trivial abstract games, such as Go, or Hex) create structures of extraordinary richness, though this richness is implicit rather than explicit. There is nothing in the rules of chess about weak squares, the relative value of the knight and bishop (which anyway is a function of the position) or the possibility of sacrificial moves. All these features were only discovered experimentally, as a result of the experience of playing the game. (This richness of chess, and its source, is not always appreciated, even by philosophers of mathematics, which can lead to entirely false conclusions being drawn. SEE [Wells 2017]) Similarly, in mathematics the rules which generate the counting numbers have nothing to say about prime numbers, about factors, about fractions - indeed, they have nothing to say about addition or multiplication let alone the commutative and distributive 'laws'. These are also implicit in the method of counting, which is why small children can appreciate them as a consequence of their own problem solving.

Related to the shared concept of rules, mathematicians talk about calculations, and chess players talk about calculating the next move, so let's look at what calculate means in each case.

Suppose that I am teaching young pupils and their task is to calculate 264 x 35. This is a challenge because they either do not yet know how to use a standard long multiplication algorithm, or they know but I have forbidden them to use it because I want them to develop their number sense - which is a mathematics teacher's term for what a chess player might refer to as tactical sense.

In mathematics, these rules are not arbitrary. They follow from the nature of the Hindu-Arabic counting system (or any other sufficiently powerful counting system.) Pupils who learn by experience will understand very clearly why 264 x 35 must be equal, among many other possibilities, to 264 x 30 + 264 x 5.

One tactic is to calculate 264 by 40, because doubling is so easy, and then calculate 264 x 5 as 132 by 10 (doubling one number while halving the other is a basic tactic for multiplication and division problems) and then subtract. A similar tactic is to calculate 264 x 30, and then as before, but add. A third tactic would be to calculate 132 x 70.

A psychologist studying problem solving would likely represent these possible tactical moves as a (short) tree of possibilities.

Now turn to the same youngsters playing chess. One has a Rook and a king, the other has only a king which will soon be checkmated. The lone king is already close to one edge of the board and the attacking player has a choice of moves to force checkmate. There is a choice of effective moves, and subsequent sequences and the enemy king is soon checkmated, meaning that it can be captured next move.

This situation and the possible sequences can also be represented by a tree of possibilities, and the verb calculate refers in both cases to the process of exploring different routes through this tree, which is created by the young mathematician or the young chess player as they think about the initial position or situation.

That was a very simple example of an analogy between chess and mathematics, in terms of elementary calculations. However, there is more to both activities than 'mere' calculation, so let's look at a slightly harder example.

We are in the 6th form and 16-18 year-olds are trying to integrate some elementary, but not trivial, functions. They have learned that there are various standard strategies for such integrations, such as integration by parts, substitution, and the use of infinite series. The first is as much a tactic as a strategy: it is easy to check and either works or doesn't.

Substitution is definitely a strategy, a general approach which can be realized by a wide variety of possible moves. The experienced student, and her teacher (more so) and the professional mathematician (even more so) will have a feeling, an intuition, for the type of substitution that is likely to work. It could be, for example, that the situation from which the integral arose suggests a trigonometrical substitution - or suggests that that is most unlikely to work.

The use of infinite series is a very powerful method, but with what could be a defect: the result may be unrecognizable as a closed form, so you are left with the series. This might not matter if you are going to plug it into computer program to calculate particular values, or it might be a disappointingly obscure result if you are hoping for some deep insight into the nature of the integral.

Whatever the 'player' decides to do, the initial situation or position offers a range of possibilities which can, once again, be represented in a tree. In order to solve the problem, the 'player' calculates (that word again) the results of a particular substitution, or calculates the first few terms of an infinite series in the hope of recognizing it (thank you, Mr Sloane) or otherwise explores the tree of possibilities.

Compared to our first case study, however, the tree of possible moves here is rather large, and it could well be that the 'player' only explores a bit of it - necessarily - and misses another branch which would have led to success.

Now for a chess analogy. During their dinner hour, some of the pupils relax by playing chess. In our particular position, Black has a strong attack against the White king position. The White defensive pieces are badly placed and the pawns in front of the White king are raked by Black's bishops. Black may immediately think of the possibility of a bishop sacrifice, capturing a pawn to expose the White king to further attack, but losing the bishop, which 'in general' is worth about three times as much.

Alternatively, there may be many other ways to continue the attack, including manoeuvering your pieces to improve your position before taking decisive action. (The military analogy is obvious and sound.)

Because the choice of legal and plausible sequences of moves in any but the simplest chess positions is so vast, far beyond human calculation, Black will have to rely - again like the young mathematician, but perhaps more so - on an intuitive understanding of the position. This intuition has a double function. It eliminates many plausible moves as irrelevant, while enabling the player to judge the value of each final position in his analysis - the end of each branch, as far as he calculates - and therefore to look ahead much further. As she looks ahead, she is continually judging: is the position favourable to? How favourable? More favourable than alternative reachable positions?

This sacrifice immediately creates 'in theory' and in the Black player's mind, a tree of possibilities. Once again, the tree is complex, and because chess is played mentally it is difficult to trace all the possibilities. Indeed, it may well be impossible to follow the branches to a definite conclusion, in which case the player may judge that a particular sequence results in a position which is favourable to him - and more favourable than other sequences he has examined, and so he chooses it.

Notice at this point an obvious difference between maths and chess: the game is competitive, so when Black considers the tree of possibilities he has to allow for every possible (plausible) move by his opponent. However, this makes no difference to our analysis, provided we bear in mind that the qualification plausible might possibly take into account Black's insight into White's mentality. Most players, most of the time, 'play the board not the man' but in desperate circumstances - a lost position, extreme time-trouble - objectively 'bad' moves may be chosen to maximise the chance of the opponent making an error.

There are two differences between our first pair of analogues and the second pair. The latter are more complex, and they involve intuition, feeling, judgement, all based on (extensive) past experience, (and therefore on memory) as well as on ability or talent.

Our next pair involve a further feature, planning, plus the appearance once again of intuition: it is a grave error to suppose - as the badly taught often believe - that 'playing' mathematics and chess, just because the basic 'laws' or 'rules' are so clear, is only a matter of logic. It is not, because logic - searching out the best 'move' in any situation - we could be talking real life here - politics, for example, or everyday human relations - requires imagination and insight, and intuition. The reason in all these cases is the same: the worlds of mathematics, and chess, and politics, are vastly too complex to be comprehended in their entirety by the players (the very simplest cases excepted) and so we depend on imagination, etc., to guide us through the labyrinths.

We move on. A strong chess player is considering her position. She is aware of many tactical possibilities but none of them seem advantageous, so she is thinking strategically, long-term and globally rather than locally and short-term. Her position has certain strengths and weaknesses, as does her opponent's. Her extensive past experience helps her to judge their effects, and the board as a whole. For a start, who stands better, she or her opponent? Suppose she concludes that she is better off: how can she improve her position? How can she turn a promising advantage into a decisive one?

After several minutes thought, she decides that a queenside attack is possible despite her slight weakness in the centre. She has long been aware of this possibility because it is standard strategy in the type of position which she has reached out of one of her favourite chess openings. On the other hand, the precise position on the board is a novelty which she has never seen before, so it has to be treated in part by analogy (analogy, again) with other previous similar positions, and partly sui generis.

Her provisional plan leaves a choice of many possible moves, or, we might say, manoeuvres since strong players do not think in terms of single moves, or even short sequences, but in larger and more subtle units. She could advance her b-pawn, threatening to disrupt the black pawn structure but the black knight can move to defend it, so she abandons that idea pro tempore. Perhaps she can distract the knight. She considers Bg5 simply threatening to exchange her rather feeble bishop for the useful knight, but this leaves her centre too weak .....

..... To cut a long story short, she ends up by exchanging pawns in the centre, playing a different manoeuvre to prevent the knight coming to the defense of the queenside, and only then plays b4.

Her thinking can be categorised as a subtle combination of tactical analysis, alias calculation, strategical insight based on a deep understanding of the position and past experience, and many essentially intuitive judgements of the resulting possibilities, forced by the impossibility of calculating everything.

What about the mathematician? Let's suppose (topically) that a dynamic computer geometry program suggests that a certain geometrical figure has property X. The challenge is to prove it. At first sight, there is no reason why it should not be proved by Euclidean means, but where to start?

Traditionally, proofs in Euclidean geometry - of novel theorems - require the examination of, once again, an extensive tree of possibilities aided by intuition. Can the theorem be proved from the original figure as it stands? What other properties does it suggest, by analogy? What other theorems does it resemble? Perhaps some extra construction is required, but what? The possibilities are vast, indeed, in theory they are infinite, unlike the finite range of possible moves on the chessboard.

Perhaps a Euclidean proof seems to be practically impossible or at least very difficult and not efficient - but for the mathematician this is not the end.

Chess, occidental chess as codified by FIDE, is a single game. Euclidean geometry can also be thought of as a game, as R.L Goodstein explained. [Wells 2012:76] He had presented the axioms of projective geometry light-heartedly in Geometry in Modern Dress, first in terms of typists and the typewriters they used at the International Typewriting Agency, and then in terms of the Game of Letter-Board. [Goodstein 1938: 217]

He presented the same analogy in Axiomatic Projective Geometry, written with E.J.F. Primrose. Chapter X is titled 'Geometry as a Board Game': 'The game is played by placing rows of letters..... in columns on a "board". Each column serves to express an attribute of the geometry....' and so on. [Goodstein 1953]

In Recursive Number Theory, (1957) he discussed instead, 'Arithmetic and the Game of Chess': 'To the numerals correspond the chess pieces, and to the operations of arithmetic, the moves of the game. But the parallel is even closer than this, for to the problem of defining number corresponds the problem of defining the entities of the game....' [Wells 2010; 2012a]

Indeed. However, faced with a geometrical problem, the mathematician has choices denied to the chess player - he can switch to 'another game'. An obvious first choice is Cartesian geometry. This strategy reduces the problem to one in algebra, except that the term reduces may be inappropriate: it could turn out that the geometrical property being investigated cannot be expressed 'elegantly' in algebraic terms, in which case a proof by algebra might be even harder than one by Euclid.

On the other hand - there are many possibilities - an algebraic proof, perhaps by brute force - might reveal structural features which pointed the way to a purely geometrical proof, algebraic calculation acting as a powerful heuristic.

Suppose that Descartes is no help. There are still many similar possibilities, other analogous ways of thinking about - interpreting - representing - the original problem. One strategy which stronger school pupils can use is to represent points as weighted means of the end-points of a segment. It might be that the property queried can be represented simply and elegantly in that form, in which case a proof might be found very easily by, again, brute force, by calculations that are in themselves routine.

At this point we can see the activities of 'playing' mathematics and playing chess, diverging. The role of calculation continues to be shared, though there is an important difference. Calculation in chess is very seldom routine - and in positions where it is routine for a competent player, such as checkmate with rook and king against king, the competent loser will recognise the simplicity and resign rather than insult the winner.

Calculation in mathematics is often extremely subtle and non-routine: Euler's calculations in his proof of his Pentagonal Number Theorem are a good example. [Polya 1954:96-98] [Wells 2012:81-83]

Polya, who is writing on the subject of Induction and Analogy in Mathematics, goes overboard in interpreting Euler's proof as 'entirely devoted to the exposition of an inductive argument'. Quite the contrary, Euler's proof is almost entirely devoted to brilliant game-like manoeuvres - so the theorem illustrates all three aspects of mathematics, the game-like, the scientific, and the perceptual, which lies behind both the other aspects and which includes the perception of analogy. the interpretation of game-like statements, or 'seeing what they mean'. [Wells 1988; 2012b]

However, mathematical calculation is often very routine indeed, as in Mathematical Methods as used in all of applied mathematics and the hard sciences. (There is no applied chess.) This is so because mathematics is not arbitrary, generally speaking, whereas chess is arbitrary and you have at every move to examine, or at least be acutely aware of, all of the board to determine whether an idea, plan or tactic that you have in mind actually works in the present situation.

In mathematics, in contrast, you can often focus on a bit of the problem situation, and, for example, quote and use a previous result. This saves immense time and effort, and also means that mathematical knowledge is to a degree cumulative - it builds on previous results in a natural manner.

In chess, every position is sui generis and therefore has to be considered on its own merits. Previous games and positions and tactical and strategical ideas are necessary, in fact they are essential, but they only provide analogies to aid the current analysis by suggestion, hints and ideas.

As we ascend from the most elementary chess and mathematics to higher levels, intuition, imagination and insight, those features of human thinking which are so difficult to program into a computer, also remain essential.

The role and importance of analogy changes, however. At an elementary level, a sense of analogy draws attention to parallels between one situation and another, and if one is grasped, quite probably the other can be grasped too.

At a higher level in chess, subtle analogies, which may be very difficult to perceive, and beyond most players, or liable to be misunderstood, are an essential guide to the strong player's thinking.

Once the player gets beyond the opening, the chances that she has ever seen the position on the board in front of her before, is almost zero. It follows that every position has to treated anew - but with the essential guide of analogies. Without them, each position would be novel but also meaningless: the player would have nothing more to go on than crude calculation and would perforce be a novice. With analogical perception, every position, no matter how apparently unusual or novel springs to meaningful life, allowing the player to grasp its significance, within the limits of her ability.

At a higher level of mathematics, which older school pupils will already just about reach, analogy already has an additional and most profound role, relating not to subtle connections within one game - though they remain important - but to parallels between superficially different games which have, as it were, the same or closely related underlying structures.

Hence the central role of structure in (modern) mathematics. As Goodstein also wrote in his Essays on the philosophy of mathematics, '[mathematics] is the continual creation of new games and the comparative anatomy of games'. [Goodstein 1965] That is an understatement, and potentially misleading, but he is pointing in the right direction.

We might add that it is tragedy that the static concept of structure in school mathematics was promoted in a pedagogically absurd manner by the Modern Mathematics Movement / the New Maths and the 1960s and 70s, while the dynamic role of analogy has been ignored - but that is another story. ['Structure through Problem Solving', in Wells 1989])

High-level mathematics introduces yet another feature. Ironically, arguments cease to look ,just like (long) calculations and often contain a rather large amount of English, with symbols interspersed. Why is this and what is happening?

Let's start proving that $x^2 + y^2 = z^2$ has a parametric solutions, We might start by observing that,

If $x^2 + y^2 = z^2$ then we can assume that x, y and z are co-prime.

This is not a sequence of game-like moves, but rather an appeal to the reader to agree that this is indeed obvious - unless the expected readers are beginners, in which case the argument might be elaborated.

An analogue in chess might be the comment in the annotation to a game - the comments added by a master player between the lines of the literal move-by-move game record - that if White moves the threatened rook, he will lose his queen. Having alerted the reader of the book or newspaper chess column, no further comment is supposed to be necessary.

The reader of this mathematical sentence is supposed to realize that if any two have a common factor, the third must share it and it can be divided out. Once again, 'no further comment is necessary'.

However, should be wish to elaborate, we do know that all mathematical arguments can be 'translated' using symbolic logic and suitable symbols for relations such 'divides into without remainder' into a sequence which does look much more like the record of a chess game. Unfortunately, such sequences also tend to look like a page from Russell and Whitehead's Principia Mathematica, or a page from an unannotated computer program.

Such sequences can fairly be described as game-like, because every move is indeed strictly according to some formal axiom or rule.

Purely symbolic chains of reasoning are simply difficult to follow, so mathematical arguments exploit the fact that mathematical results are cumulative, to present what we might call 'pseudo-English' texts that, in effect, explain at a higher level what is going on.

Similarly, in chess where the naked game-record may mean very little to most readers of a book of 'Kasparov's Best Games', or a newspaper chess column, the game record is annotated to explain in more-or-less detail what the players were trying to do, what the point of a particular move was, to highlight tactical and strategical ideas, and so on.

Continuing our proof we 'observe' that,

'x and y cannot both be odd, otherwise z would be of the form $4n + 2$, and not a square.'

This is also heavily into English, but once again we could if necessary translate it into a sequence of game-like moves, starting with the partial 'reduction',

$x = 1 mod 2$ and $y = 1 mod 2$ implies that $x^2 + y^2 = 2 mod 2$

and so on, and so forth.

At every stage, as the argument proceeds, we shall be calling on previous results, well-known facts, and (rather basic) calculations, all leading to the conclusion we desire, embedded for the sake of clarity of exposition in a linguistic matrix.

Let's draw this sketch to a close. Mathematics and chess both involve abstract entities created entirely by abstract rules: the rules and entities are universally shareable. This leads to the crucial presence in both of calculations, and of a central role for analogy. However, there are already important but subtle differences because the rules of chess are arbitrary to a high degree, while those of mathematics are not.

Like all human thinking, analogy also plays a central role in the thought of chess players and mathematicians, but one again there are subtle but crucial differences.

Finally, the striking but incomplete analogies between chess and mathematics are highlighted again if we compare an annotated record of a game of chess with a record of a mathematical proof or argument, in which the English language - or Swedish, or French, or Urdu - features strongly, as a means of illuminating for the benefit of readers or auditors the ideas being exploited.

Is that all? Are there no other differences between chess and mathematics? Not at all, of course they differ in other respects too - but once again, that is another story.

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Chess and Mathematics

A Commentary

Ulf Persson

Fasadmalning i Barlinek - juni 2013 foto: *forfattaren*

Who is the best chess player among mathematicians? Who is the best mathematician among chess players? Those two need not be the same, it all depends on your definition of a chess player and a mathematician. You can make the criteria stringent enough in order to make the two groups disjoint, and there would be no candidates for either, or you could make them embrace all mankind and then the answers would be different.

By any kind of reasonable criteria Emanuel Lasker is a strong candidate for both. He was born in the German town of Berlinchen (as of 1945 Barlinek, situated in Poland) on Christmas Eve 1868 and died in New York 1941. He was world champion of chess between 1894 (after having beaten the first champion the legendary Steinitz in a series of 19 games that lasted for over two months with 10 wins, 5 losses and 4 draws) and 1921 when he lost against Capablanca in Havanna (he was bothered by the heat). No one has been world champion for so long, and it is doubtful that Laskers tenacity at the top will ever be matched. Professionally Lasker was a mathematician. He finished his thesis on a topic on infinite series (üer Reihen auf der Convergenzgrenze) at Erlangen in 1900 under Max Noether but his greatest mathematical achievements were with the daughter Emmy referring to the Lasker-Noether theorem concerning primary decomposition of ideals. Lasker proved it for polynomial rings, and Noether extended it to what later would be called Noetherian rings. This is a fundamental result and still taught in elementary commutative algebra. Later on he also took on philosophy. Einstein reportedly called him the most interesting man he ever met in later years and they remained friends although Lasker questioned the very linchpin of relativity theory, namely the invariance of the speed of light in a vacuum. But it is mostly as a chess player Lasker is remembered, and his various chess books certanly reached a far wider audience than his mathematical articles.

Another quite not as flamboyant character was the Dutch Max Euwe (1901-1981) who was the fifth world champion between 1935 and 37 (punching a hole in the reign of the Russian Aljechin 1927-46[1]), as well as the President of FIDE during the 70's during which it came to

[1]Readers who like to add two and two together are now able to make a complete list of all the world champions of chess and their reigns from 1886 and sixty years on.

his lot to supervise the legendary encounter between Spasski and Fischer on Iceland. In fact he played himself against Bobby Fisher once, with one win and one draw (one may remark that Fischer was 13 at the time). He was also a professional mathematician who became a pioneer in computer science in the 50's. Although his mathematical accomplishments are not as well-known as that of Lasker.

Those characters are of the past, now it would be impossible to imagine a world champion of chess to have any serious side interest, let alone a world-class mathematician being seriously into chess competition. I guess the competition is too stiff, there is no longer any room for the well-rounded individual, just as in the academic world, few if any move seriously from one discipline to the other, as was possible in the past. I am in particular thinking of distinguished physicists moving into serious philosophy, such as Ernst Mach. But anyway I am thankful to Thomas Weibull who pointed out two mathematical academics doing very well in chess. One is Edward Formanek, a retired professor from Penn State specializing in commutative algebra and who has the dubious distinction of being the first international master to lose against a computer program (HiTech in 1988[2]), and maybe more seriously John Nunn, who started out as a chess prodigy and then proceeded to study mathematics at Oxford being its youngest undergraduate since the future Cardinal Wolsey in 1520[3]. He would actually in due time belong to the top ten players in the world after having resigned his lectureship at Oxford to become a full-time professional, but according to the present world champion too intelligent to ever have been a contender for the number one.

Now what about Swedish mathematicians and strong chess players? If we restrict the notion of Swedish mathematicians to those who have been Presidents of the Swedish Math Society and/or received the Wallenberg prize, we have Olle Häggström (2188) and Arne Meurman (2022), where the numbers refer to the points in the Elo ranking (more of that below). The former is among the 300 best active Swedish players and the latter among the top 500. If we are willing to cast our nets wider, by making a more generous definition of what is a mathematician, we will be able to catch bigger fish, in this case Thomas Ernst who is grand master, and a point rating of 2370 and who has written a thesis in analytic number theory and then produced a number of publications. As to the points, the current champion the Norwegian Carlsén once reached 2882, highest ever scored by mere humans.

Now this points to another important difference between mathematics and chess. There is no corresponding system for mathematicians, basically because mathematicians cannot be compared directly with each other, while that is the whole point of chess. Had there been such a point system it would have been very easy to hire people, any minimally competent secretary could be entrusted to the task, indeed it could be mechanized. This is of course what the bureaucrats are aiming for, producing a system awarding points on the basis of papers written and quotations. But that is another story material for another commentary.

As to the Elo system, so named after a Hungarian-American by name of Arpad Elo (1903-92) who designed it, it is based not only on the idea that the larger the point difference

[2] A rival - Chiptest would later beat world champions and develop into Deep Thought and Depp Blue which may be more known to readers.

[3] Readers versant with Henry VIII and his reign would be rather puzzled by the date supplied by Wikipedia. Henry VIII became king in 1509 and Wolsey was very much a senior figure, in fact being born in 1473. If it is true, a more appropriate date would probably be something like 1486.

between two players the more likely the one with the higher point will beat the one with the lower, but that there should be a nice numerical relation. One naive thought would be that the probabilities should be multiplicative, so if $p(x)$ denotes the probability that a player with score s would beat one with score $s+x$, we would have $p(x+y) = p(x)p(y)$. However as clearly $p(0) = \frac{1}{2}$ this is absurd. What about replacing p with $q = \frac{p}{1-p}$ then $q(0) = 1$ and we are talking. We would then get (assuming q multiplicative) $q(x) = e^{-kx}$ for some k and thus $p(x) = \frac{e^{-kx}}{1+e^{-kx}}$. Now things are more complicated due to draws and it is more convenient to talk about expectations (1 for a win $\frac{1}{2}$ for a draw and 0 for a loss) so instead we talk about expectations instead and the scale is in fact so adjusted that $E_x = \frac{1}{1+e^{-kx}}$ with $k = \frac{\log 10}{400}$. Now how does this correspond to the empirics of the situation, after all there is a lot of data on played games. Now the beauty of the whole thing is that the point scores are adjusted after each encounter as to comply with the actual data. Thus if a strong player loses against the weaker one the Elo points of the latter are modified upwards and that of the former downwards. Exactly how this is done is a matter of convention and technicality, trying to balance stability against quicker convergence against the ideal goal. That this system works fairly well is a testimony to the relative objectiveness of performance. In principle this could also be used for soccer teams, but I suspect it would not be as robust, as the notion of transitivity is not as stable as in chess.

Chess would be meaningless without competition[4], mathematics is not, although there is a fair amount of competition in mathematics, at least in the juvenile initial stages of a fledging mathematician. But mathematics has intrinsic interest apart from individual upmanship, it is not a mere game after all, it does have a relation to reality (and what could be more real than numbers?) and has applications, and is of course far more varied. On the other hand the kind of brutal combinatorial intelligence that might be the hallmark of a chess player, often comes into play when a mathematician encounter technical snags, but then there is another kind of motivation that enters. And motivation pertaining to deep emotional undercurrents is what really determines what you apply your intelligence to, without it there is no stimulation of the imagination. Thus you can formulate many mathematical questions about chess, which would be of no interest to a professional chess player.

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[4]I recall in my youth being told that the allure in chess for a Fischer was the crushing of the ego of his opponent.

Tjänstetillsättningar

Arne Söderqvist

Tillsättning av tjänster inom offentliga sektorn ska enligt lagen ske medelst utlysning och den objektivt sett mest kvalificerade bland de sökande ska erbjudas tjänsten. Att det ofta inte går till som sig bör har nyligen uppmärksammats i bla. en artikel i Göteborgsposten, där det hävdas att omkring 90 tjänster vid Göteborgs universitet tillsatts på uppenbart lagvidrigt sätt. Förutom att i smyg rekrytera medarbetare ur egna sociala nätverk förekommer falska utlysningar. Det kan gå till som när de avgångna riksrevisorerna en gång rekryterades, alltså så att man först anställer och därefter publicerar en annons retroaktivt, så att ansökningstiden redan har gått ut vid publiceringen. Ett annat sätt är att annonsera i tid, men där kraven är så snävt formulerade att de egentligen utgör ett signalement på den person man haft i åtanke.

Ordspråket säger "Lika barn leka bäst". Det är i själva verket detta som är problemet. Man vill ha medarbetare som tänker i precis "rätt" banor. Detta gör verksamheten likriktad och man avhänder sig möjligheten till korrigering om det spår man följer råkar leda åt ett olyckligt håll. Personer som erhållit sin anställning utan utlysningsförfarande släpar på en hedersskuld och vaktar följaktligen sina tungor. Blir de alldeles för obekväma kan de ju påminnas om hur tjänsten en gång erhållits och man kunde hävda att den plötsligen måste utlysas.

Ofta är det inte ens tjänsteutövningen man har för ögonen vid tjänstetillsättningar, utan man prioriterar istället helt andra saker, såsom gemensamma fritidsintressen. Det är ju praktiskt att kunna komma överens om bokning av tennisbanan och att organisera sjösättning av sina segelbåtar i arbetsplatsens lunchrum.

Jag har egna erfarenheter av hur tjänstetillsättningar gått till vid Södertörns högskola och vid KTH i Södertälje och Haninge. Jag sökte en gång en tjänst vid KTH i Södertälje. Tjänsten var annonserad i Stockholms stora dagstidningar. Jag hade förvisso tur som fick tjänsten. Annonsens rubrik var nämligen **KTH SÖKER TVÅ PROFESSORER**. Men i det finstilta längst ned stod bla. att man även sökte en adjunkt i matematik. Detta uppmärksammades naturligtvis inte av särskilt många som, liksom jag, var gymnasielärare.

Efter några år sökte man åter igen en adjunkt i matematik. Den gången framhävdes detta även i rubriken. Naturligtvis blev det många sökande, varav flera hade disputerat. Man hade emellertid en viss person, en gymnasielärare, i åtanke, som dessutom fick tjänsten. En av de disputerade överklagade och vann. Då vidtog man manövern att tillsätta dem bägge på en och samma tjänst! Den som disputerat tilldelades dock mest meningslösa arbetsuppgifter. Hans kompetens utnyttjades aldrig och han var illa sedd i personalrummet. Till sist, efter ett par år, avskedades han pga. bristande arbetsuppgifter. Innan dess fick han bla. sitta i sitt tjänsterum och digitalisera dokument genom att skriva av dem.

Jag hade min huvudsakliga undervisning på KTH:s Basår. Som chefer hade jag två andra gymnasielärare i matematik som var äkta makar. De hade, liksom så gott som alla mina kolleger, erhållit sina tjänster genom social nätverksrekrytering. Mannen hade seglat upp till positionen "avdelningschef" och hans hustru till proprefekt. De var förstås inga matematikvirtuoser. För att behålla auktoriteten över sina underlydande betonades sådant de själva var bäst på, nämligen rena formalia. Tämligen meningslösa formulär skulle fyllas i, korrekt och i tid. Gjorde man "fel" kallades man till upptuktning, ibland av båda makarna samtidigt. Meningen var att man skulle känna sig som ett litet barn som varit ute för länge och missat den angivna hemkomsttiden.

Basårskurserna styckades sönder och organiserades precis som i gymnasieskolan. De båda cheferna var ju gymnasielärare och kunde inte tänka sig någon annan möjlighet. Kurslitteraturen skulle bestå av gymnasieböcker. (Chalmers nyttjade böcker speciellt anpassade till sitt basår, men dessa förkastades på KTH.) Avnämaren av basårsstudenterna var i första hand KTH:s matematikinstitution. Kontakterna med denna rann emellertid raskt ut i sanden.

Undervisningen skulle standardiseras och helt bygga på vad som stod i läroböckerna. Det var inte lämpligt för någon lärare att stödja sig på sin egen professionalism och därmed göra några utvikningar. Alla lärares undervisning skulle vara identisk. Många av kollegerna upplevde detta som ett stöd, men jag upplevde det som en tvångströja.

Något år innan min pensionering fick jag informationen att jag skulle få en ny kollega. Samtidigt uppmanades jag att stödja denne "tills han hunnit bli varm i kläderna". Jag frågade vilka meriter vederbörande hade, i förhoppning om att det kunde vara någon med högre examen som kunde inspirera både studenter och kolleger. Men fortsättningen blev häpnadsväckande: Jag fick svaret "Han är god vän med É" och så nämndes namnet på en annan kollega. Jag förtydligade mig genom att säga att jag förstås avsåg akademiska meriter. Då fick jag svaret "Jag vet inte, men du kan ju själv fråga honom när han kommer!"

Han kom och visade sig vara en gymnasielärare. Jag skrev då ett e-brev till all personal vid hela KTH, med kopia till utbildningsministern och även all personal på Chalmers. Jag förklarade att jag vägrade allt samarbete med en person som inte fått sin tjänst på lagstadgat vis. Det uppstod förstås rabalder. En jurist på KTH förklarade att det allvarliga i sammanhanget var min arbetsvägran, som egentligen utgjorde grund för avsked. Jag blev kallad till ett möte med en högre chef från KTH i Stockholm. Jag spelade in samtalet, med tanke på vad som hänt i Uppsala några år tidigare. Det allra första jag fick höra i förhöret var "Varför i helvete måste du skriva till Chalmers om detta?" Jag kunde inte hjälpa att jag föll i skratt, vilket gjorde min motpart än argare. Men jag gick skadeslös ur situationen och fick stanna på min tjänst till min pensionering något år senare.

Inom privat företagsamhet finns det inget hinder för att anställa vänner och bekanta. Där finns emellertid kontrollfunktioner, såsom bokslut, orderingång och eventuella reklamationer, som vittnar om effektiviteten. I värsta fall blir det konkurs. Inom offentlig verksamhet är det emellertid annorlunda. Konkurs är definitivt inget alternativ. Man har dock försökt ta efter den privata sektorn på olika sätt, bla. genom att använda "genomströmning" som ett effektivitetsmått. Om detta har det debatterats en hel del i media på sista tiden, där historieprofessor Dick Harrisson i Lund varit en av dem som hörts mest i debatten. Min erfarenhet av begreppet är att det ingalunda fungerar som ett effektivitetsmått, alltså precis vad Harrisson också hävdar. Finns det tex. alls någon student som skulle reklamera en välvilligt rättad tentamensskrivning?

Jag har vissa idéer om hur de problem jag beskrivit ovan borde åtgärdas.

- Tjänster som tillsatts utan utlysning bör utlysas på nytt. Tjänsteinnehavarna får naturligtvis gärna vara medsökande.
- Alla lediga tjänster ska ovillkorligen utlysas.
- Alla lediga tjänster ska beskrivas sakligt med adekvata krav på den sökande.
- De sökande till en ledig tjänst ska rangordnas av sakkunniga; helst utomstående sådana. Så bör vara fallet även för "lägre" tjänster, såsom adjunktstjänster.

På så vis kommer en mångfald idéer att ohämmat kunna diskuteras bland chefer och kolleger. Verksamheten kommer inte att bli bunden till ett visst spår, som kanske leder åt ett olyckligt håll. Det är egentligen bara fråga om att genast börja tillämpa gällande lagar och förordningar.

Anm. Jag har inte angivit namnen på de chefer och kolleger jag åsyftar i artikeln. Den som vill kan få mina påståenden verifierade genom att vända sig till mig på adressen `arneso@kth.se`.

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ICIAM

The next ICIAM Board meeting will be in Valencia, Spain, on May 20th, 2017, at 9am. As it has become customary, SEMA will be hosting a two-day workshop entitled "International Workshop on Industrial Mathematics" on May 18 and 19. Those of you willing to present a talk at this workshop are invited to visit the meeting page `http://www.uv.es/iwimath17/` [1] register your intention, and submit a title and abstract. Those presenting a talk at the workshop will have their hotel expenses covered for 4 nights (May 17-20). We encourage everyone intending to attend the Board meeting to register at the site, so that we know how many people we should expect.

Location, Dates, and Webpage Valencia, Spain May 18-19, 2017 (workshop) and May 20, 2017 (Board meeting), see `http://www.uv.es/iwimath17/` [2]

Akuta problem med Ladok3

Anders Holst (LTH) & Pär Kurlberg (KTH)

Enligt planerna kommer de stora lärosätena (matematikinstitutionerna) att införa Ladok3 under 2018.

Den största användningen av Ladok vid institutionerna är för inrapportering av resultat och betyg för grundutbildningsstudenter. Vid de stora matematikinstitutionerna skall ofta ett stort antal resultat rapporteras in under begränsad tid; det är inte ovanligt med 1500 resultat under en tentamensperiod fördelade på fem-sex kurser med mellan 20 och 1000 resultat och det finns i allmänhet föreskrifter om att (rättning och) inrapportering skall vara avslutad inom viss tid efter provet. Matematik är nog inte ensamt om att finna arbetsflödet i Ladok3 besvärligt, men vi tenderar att ha stora kurser och kommer att stöta på problem före många andra. Samfundet vill uppmuntra att matematikrepresentanter på så många lärosäten som möjligt är med och betatestar. Det finns en stor poäng i att personal på många lärosäten verkar för förbättringar, det torde vara svårare för ladok3-utvecklarna att ignorera samstämmig kritik. Ifall förbättringar måste skötas av lokala it-enheter finns förhoppningsvis mycket att vinna på att samarbeta.

I nuvarande Ladok görs rapportering på följande sätt. Först läggs resultatet in av en administratör med behörighet för detta utgående från rättningsprotokollet. (Det finns möjlighet att mata in rättningsprotokollet i form av ett excel-dokument.) Sedan skrivs ett protokoll ut som kontrolleras och skrivs under av examinator för att sedan arkiveras.

I Ladok3, som är helt webbaserat, är förmodligen tanken att lärarna själva skall sitta och mata in betygen, även om t ex LU och KTH hittills sagt att man tills vidare kommer att fortsätta låta administratörer göra det. Riktigt problematiskt är att det inte stöder uppladdning av betyg från excel-ark (eller textfil etc), trots att detta mycket länge lär ha varit med på kravspecifikation. Vidare kommer all arkivering att vara elektronisk. Examinator attesterar de införda resultaten elektroniskt och det finns ingen möjlighet att få utskrifter av protokoll annat än som skärmdumpar. Att kontrollera att de attesterade resultaten blivit korrekt införda är nästan omöjligt. Flera matematik- institutioner (KTH, LTH, Linköpinguniversitetet), har fått pröva att använda Ladok3 för att rapportera in resultat.

1. Erfarenheter från Matematik LTH

Vid Matematik LTH prövade vi att rapportera in resultat med Ladok3 under omtentamensperioden i början av maj. Tanken var att sedan fortsätta använda Ladok3 för resultatsrapportering men erfarenheterna var så förskräckliga att vi såg oss tvungna att återgå till det gamla Ladok. Våra nuvarande administratörer skulle inte ha en chans att hinna föra in resultaten i tid med Ladok3. En del av våra problem beror nog på det system för anonym tentamen som vi har i Lund, men tillräckligt många nackdelar bör vara oberoende av detta. Problemen är i hög grad kopplade till att utvecklarna inte föreställt sig skrivningar med mer än 100 skrivande, och inte heller att många av de skrivande blev förstagångsregistrerade för flera år sedan.

Inläggning av skrivningsresultat

1. Resultat kan inte läggas in som en excelfil utan man måste arbeta med systemets användargränssnitt.

2. Enligt våra administratörer tar det upp mot två timmar att förbereda systemet för inläggning av resultat på en skrivning.

3. Ett stort problem är att för ett givet prov måste de aktuella studenterna plockas fram från varje kurstillfälle för sig. För en deltentamen på kursen FMAA01 Endimensionell analys Đ som getts sedan 2007 behöver till exempel 61 kurstillfällen gås igenom. (Det blir alltså fler tillfällen än gånger som kursen givits- enligt uppgift beroende på att studenter kan registreras på olika aktivitetsgrad. T ex har FMAA01 sex kurstillfällen som startade 2013-09-02.

4. Varje sådant tillfälle representeras av en länk till en lista med samtliga studenter som började vid det tillfället men inte blivit godkända på det aktuella delprovet. Ofta blir det ett par hundra studenter av vilka en handfull deltog i det aktuella provet och skall väljas ut.

5. För varje kurs behöver alltså många tillfällen gås igenom men gränssnittet visar inte på något sätt vilka tillfällen som är färdigbehandlade så om man inte gör en skärmdump och markerar på den är det mycket lätt att missa att granska ett tillfälle.

6. När man till slut valt ut alla berörda studenter och skall börja lägga in resultat är det mycket obekvämt att systemets standardinställning är att visa 25 studenter i taget medan vi ofta har flera hundra skrivande. Det går visserligen att ändra detta till 100 men om man skrivit in resultat innan man kommer ihåg att göra detta byte så försvinner de inläggningarna, och varje gång man byter sida så återgår systemet till att visa 25 studenter per sida. Det går alltså inte att byta standard.

7. Åtminstone den aktuella realiseringen av systemet är oerhört långsam. När man skrivit in resultat för studenterna på den aktuella sidan så tar det ett par minuter från det att man bett systemet spara och gå vidare tills nästa sida kommer upp. Om man å andra sidan tvingas göra paus några minuter för att telefonen ringer så blir man utslängd från den aktuella sidan utan att de införda resultaten sparas.

8. Om man skrollar långt ned i resultatslistan syns inte kolumnrubrikerna.

9. Ett irritationsmoment är att i de rättningsprotokoll som systemet genererar åt lärarna står betyget till vänster om skrivningspoängen medan det är tvärtom på inmatningssidorna.

10. Det går inte att få en utskrift av de inlagda resultaten för kontrolläsning.

11. För flera av våra delprov gäller att man bara är behörig att delta om man fullgjort vissa obligatoriska moment i motsvarande kurs. I den installation av Ladok3 som vi fick pröva fanns inget verktyg för att identifiera studenter som inte var behöriga att tentera.

Inläggning av betyg på kurs

1. Även vid inläggning av kursbetyg måste man gå igenom ett stort antal kurstillfällen för varje aktuell kurs. Jämför punkt 3 ovan.
2. I nuvarande Ladok kan kursbetyget beräknas automatiskt i de fall det baseras på ett enda delprov. I Ladok3 måste det läggas in manuellt.
3. När man skall lägga in kursbetyg så går det inte att på samma skärm se studenternas resultat på de delprov som ingår i kursen.

Attestering av resultat

Vid LTH prövades Ladok3 för attestering en gång till, på en tentamen med 196 deltagare.

1. Erfarenheter vid attesteringen är analoga med dem som beskrivs nedan. Även denna gång fick man till slut meddelandet "systemfel" (med tillägget "attesteringen misslyckades") . Vid kontroll i gamla Ladok fann vi dock att alla resultaten lagts in.
2. Då man skulle attestera resultat visades studenterna ordnade i bokstavsordning efter efternamn medan tentanderna i våra rättningsprotokoll vid LTH är ordnade efter anonymkod. Denna kombination leder till orimligt mycket arbete om man skall kontrollera att resultaten som man skall attestera blivit rätt införda. Antingen får man söka fram de olika anonymkoderna en efter en eller så får man avanonymisera alla tentor och sortera dem efter efternamn.

Erfarenheter från Matematik KTH
Attestering av resultat

1. Man måste välja betyg för varje student med hjälp av rulllistor, tangentbordsstyrning "lär komma" men är inte klar i dagsläget
2. Dessutom fungerar kontrol-f för sökning efter namn inte, oklart om det fixas.

Vid KTH har man beta-testat ladok3 för en kurs med runt 130 tentander, nedan finns två loggar över erfarenheterna samt kommentarer. Man fick hjälp av administratörerna att lägga in betyg, så nedanstående berör bara attesteringen - oroväckande att den "enkla delen" visade sig så strulig. Det rör sig förvisso om en delleverans, så många saker blir förhoppningsvis bättre men oroande är att mycket funkar dåligt så sent i processen - man får intryck av att konstruktörerna inte talat så mycket med (delar av) slutanvändarna; arbetsflödet blir knöligt istället för enkelt, särskilt för större kurser.

Logg 1

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1. Loggar in.
2. Går till mina attesteringar.
3. Klickar relevant tenta. Blå snurra 21 sek, inget händer.
4. Provar igen. Blå snurra 21 sek, inget händer.
5. Provar igen. Blå snurra 21 sek, inget händer.
6. Provar igen, kommer in. Attesterar ca 15 personer, blå snurra i 10 sekunder.
7. Blir "utkastad" (måste ge lösen igen pga säkerhet vid själva attesttillfället
- det ersätter signatur. Men det är ok.)
8. Går till attesteringar.
9. Klickar tenta. Blå snurra 21 sek, inget händer.
10. Provar igen. Blå snurra 21 sek, inget händer
11. Loggar ut, loggar in.
12. Provar igen. Blå snurra 21 sek, inget händer
13. Provar igen. Kommer till SLUT fram till attest igen.
14. Attesterar ca 100 namn. Trycker attest. Blå snurra i över en minut. Får
meddelandet "Systemfel". Verkar som betyg blivit inlagda, men jag kan ej verifiera -
attesterade studenter "borta". Efter denna attest går jag in igen. Måste vänta över
en minut på blå snurra.
15. Attesterar några nya namn, samt några "saknade" (se nedan.)
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Kommentarer:

Vissa personer "saknas" i första vändan, d.v.s. de finns i min sorterade lista, men dyker ej upp i attestlistan. Det visar sig att de dyker upp i andra vändans attestlista. Detta stör bokföringen - kan ej enkelt bocka av studenter en efter en.

Svårt att kontrollera på namnlistor - går inte att "lägga linjal" på skärmen. Även om man försökte hålla nogrann kontroll på "saknade namn" (och föra anteckningar i min betygslista), visade det sig att 5 namn slank igenom. (Lätt att missa saker när man flyttar blicken mellan fönster.)

Som vid LTH, Har nu attesterat allt som verkar finnas i systemet, men går det inte att dubbelkolla att alla namn som finns på min tentalista är införda - inga namn visas över huvud taget, och man kan inte ens se antalet betyg som införts.

Det tog över 25 minuter för att attestera ca 150 studenter. Det borde bara vara att jämföra två listor, men går mycket långsamt.

Logg 2 `Jag gick sedan in och gjorde en "ströattestering". Knackade lösen för att skriva på (vilket är ok), blå snurra i ca 10 sekunder, och sedan får jag en mer eller mindre blank sida. Ingen bekräftelse att betyget nu finns inrapporterat+attesterat. Förvisso bättre än meddelande om "systemfel" som första gången, men mycket problematiskt.`

Kommentarer:

Det är mycket viktigt att veta om det attesteringen registrerats. Som examinator har vi ju ett stort juridiskt ansvar för att saker blir inrapporterade i tid - att då inte få en bekräftelse är mycket problematiskt. Jag har för övrigt varit i kontakt med kollega på annat lärosäte där systemet är utrullat. Enligt denne har standard blivit att ingen bryr sig om att kolla av studentlistan vid attesteringen - de bara klickar på attestknappen. D.v.s. viss utformning av system leder till "pragmatisk användning" som i någon mening är juridiskt helt felaktig.

Conversation with David Mumford

Ulf Persson

The intended victim David Mumford opens the door. A slim and youthful appearance, with long hair as of yet untainted by gray, collected into a pony-tail. A loft apartment in Boston dominated by a huge room, almost cubical in shape, with a kitchen in a corner. On the tall ceiling as well as on the extensive walls spectral images are appearing at diverse locations, as the relative positions of a dodecahedral shaped prism on a windowsill and the sun changes over time. The prism, along with a model of a fossilized brain in its middle, is a peculiar gift from the I.H.E.S. The floor space is taken up by bedding. The night before descendants of his artist wife have indeed descended for a weekend visit. Coffee is being offered. After all this is how it is done in the Stieg Larsson's trilogy, the Swedish connection of which must be both intriguing as well as instructive. The wife expresses some surprise that no recording equipment is around, just to be told that the interlocutor to act as a interviewer possesses a photographic memory. The session is about to be started. The victim lounges on a couch remarking that it feels more like being at a psychiatrist expecting to perform free associations, than to be subjected to a regular straightforward interrogation.

Ulf Persson: Let us begin from the very beginning. What are your first memories?

David Mumford: Those must have been from when I was three. We moved from England to the States. My father was British, my mother American. It was at the time of Dunkirk, that event must have made a traumatic impression on me. We lived nearby...

UP:....Three Bridges...

DM: Yes. Some of the returning British expeditionary forces were billeted with us. In America we lived by Long Island Sound. We had nannies, and I remember one of them explaining to me the facts of life, at least as they pertained to plants. I recall finding it very neat. I was at the time fascinated by biology, especially how the human body worked. I knew of course that people ate, and that it came out some other way, concluding that there must be a tunnel from the mouth. I got an idea of how to create an improvement, a super-duper man. I used an erector set, but was rather disappointed by its limited capabilities for the complexity of the task.

UP: Let us backtrack slightly, What did your parents do?

DM: My father had worked in Colonial Education and had started a school in Malangali, Tanzania, based on the idea of "appropriate technology", formulated at that time by anthropologists. They taught hygiene and plumbing, irrigation and fertilizers and brought an elder from each tribe so the village would believe these technologies worked. He had a strong belief in the value of every culture and later worked for the UN from its beginnings until his death in 1950. My mother was the home maker that was considered her appropriate role in that pre-women's-movement time.

UP: When did you become interested in mathematics?

DM: I found elementary mathematics boring. It was so easy. The only difficulty I can possibly recall was remembering that $8 \times 7 = 56$. However, an older brother had some math books, and in that way I encountered algebra and trigonometry. In algebra I was a bit perplexed. I knew of course that there were negative numbers -2 and such, and that was neat. But the minus sign was also an operator, although I would not have been able to use that terminology at the time; because it denoted subtraction. How could one be sure that $a - 2$ was the same thing as $a + (-2)$? I asked my older brother. He did not understand at all what I was asking, so I did not get any help. As to trigonometry I made a circle with degrees and a lever you could move around...

UP:...a mechanical contraption?

DM: Yes. I used it for measuring heights of trees. I have always been fascinated by the applications of mathematics. As a child I wanted to become an engineer. I was fascinated by large human constructs. I remember encountering the George Washington Bridge. Finding it incredible that humans could make something so big. I still think it would be a very great idea if the Russians, the Chinese and the Americans could get together and build a bridge over the Bering Straits.

UP: That would be a symbolic thing.

DM: Much more than symbolic. It would be of great commercial value, allowing goods to flow back and forth by railway. Everybody would benefit from it.

UP: Because of the Global Warming an old idea may finally come true - The North West passage. Maybe that would make the idea of a bridge obsolete. But we are getting sidetracked. I heard that you were interested in computers early on.

DM: That is true. In addition to the erector sets there was also another sequence of kits, science kits which allowed you to build things. The simplest of them just involved constructing a door-bell or some such thing but the more advanced allowed you to construct far more interesting gadgets. I had always been interested in electrical circuits . The idea that with some simple things like a crystal and some wires you could actually catch radio waves and listen to broadcasts fascinated me immensely. It was almost magic.

UP: Those kits were common in the past. I too had an erector set the first in the series, while my younger brother got the more advanced ones at the same time. He was much more accomplished than me although he was four years younger. I wonder what has happened to those kits?

DM: They probably got swamped by lego.

UP: I think that company started when I was a child. In the beginning there were only basic blocks available, at the time of my children the kits were much more elaborate. I think that is bad, it more or less compels you to follow instructions and complete some elaborate construction, after it's done the project is concluded and you are not encouraged to try out your own things, like a simple set of basic blocks forces you to do. My favorite toys as a child were some simple unplanned building blocks, cut out from some lumber at my grandfathers farm.

DM: Yes, we also had a large collection of wooden building blocks, with which we played a lot. There were even some kits with more advanced pieces out of which you could build log-cabins. But I think we are digressing.

UP: That is the whole point. But to get back, we were talking about you and computers.

DM: Yes when I was fifteen during my last year at Exeter, I entered the Westinghouse Science competition. I had found a large supply of relays from the War and decided that they could be used to construct a computer. I was given a fairly large sheet of plywood onto which I screwed them. The problem was when relays were activated. I wanted them to break connections as well as make them and so I had to bend the metal tongues. It worked beautifully, but only for a week or so. Those metal things slowly regained their original straight shapes and I had to re-bend them again. The whole thing was shipped to the contest, and was rather badly beaten up during the transport. Then I used some paper tape coming from those old adding machines, you may remember those mechanical gadgets..

UP:..I do. I even used one in the late sixties to make calculations for some course on probability...

DM: Anyway the paper somehow caught fire from a spark in the process of operation, and subsequently the plywood too, and it all went up in smoke.

UP: So this was the end of your early infatuation with building computers?

DM: Actually not, although it would have provided a fitting and dramatic ending. I was involved with an analog computer for two summers working at the Westinghouse Atomic Power Division. It was based on two two-dimensional grids whose voltages simulated fast and slow neutron density in a cross section of the core. You manually read out voltages from one and set resistors accordingly on the other. But that does not seem to have made the same impression on me.

UP: You liked to build things. Did you not ground your own lenses too?

DM: Yes, I was fascinated by astronomy...

UP:.. I guess most mathematically inclined children are. Numbers, especially huge one, are intimately involved, unlike the case of dinosaurs, another common obsession in childhood.

DM: That is not quite true. I was always intrigued by the time-scales of the geological eras. To get back on track. I always liked to get my hands on tangible things. Yet I realized that I was not very good at manual things, having far too many thumbs in my hands. I was much better at the theoretical.

UP: It were the underlying principles that fascinated you, but implementing them was frustrating, too many irrelevant complications, such as those metal tongues refusing to stay bent.

DM: Exactly. It was very frustrating.

UP: To me those kits remind me very much of programming. The excitement of programming is that you build things, just as you put things together from an erector set. The difference being that you are saved those small petty frustrations that mar more material constructions.

DM: Not entirely. I once had a program in C, where I had a division using pointers and the slash. The program failed to deliver. I wasted so much time. Finally I reduced it all down to one line, and then it dawned upon me. Using pointers you write a star to get the number pointed to, but together with a slash you get the code which starts a comment! No books warned you about this idiocy. After that I abandoned C and have been using Matlab for the last twenty years. It saves you from all such silly nonsense. And it is now very efficient and works very fast, almost like compiled code.

UP: Programming is very obsessive. In mathematics you often get stuck and have no idea how to proceed. Never so in programming. You are actually continually interacting with someone, albeit a machine, and getting responses. When trying to fix a program you are always just about to succeed. This makes it very hard to stop.

DM: Yes I have wasted much time that way. But I find this mixing of mathematical concepts with calculation very satisfying.

UP: To me computers are like turning the spirit into flesh. It transforms mathematics from the mind to the real world and literally makes it physical and in my opinion shows that mathematics is independent of the human mind. It is truly fascinating to see mathematical ideas tangibly manifested.

DM: Unfortunately competence in mathematics and what I would like to call calculation is rarely combined in single individuals. My students usually belong to one or the other camp, almost never both. Sometime they do not even know themselves which. I had once a computer whiz who fancied himself a mathematician, and a natural mathematician who believed he could program. I gave them problems according to their conceptions of themselves. They got nowhere. Then I had their problems switched and they did beautifully. What you say about turning the spirit into flesh is very true. As I have already told you, I like to get my hands on tangible things...

UP: ...and calculations are tangible. Deductive proofs are of course fine, without them mathematics would degenerate, yet they do not always carry conviction, so it is very nice to have results numerically confirmed as well.

DM: Yes, and I am consequently always a bit suspicious of mathematics that cannot be implemented in this way. Such as uses of say ultra-filters.

UP: Yes, many of those logical concepts seem to be figments of the mind, such as higher cardinalities. They are in a Popperian sense not falsifiable.

DM: Yet they are fascinating too. Do you know Harvey Friedman at Ohio State? He has been trying throughout his career to really pin down the Gödel statements – true facts which are not provable in such-and-such a formal theory. He wants to make them as concrete and down-to-earth as possible. He seems to be getting down to some exciting things. This direction started with Ramsey theory. In all these statements, you ask, for any number n, what is the m for which something holds. If the m's are too rapidly increasing as a function of n, they can't be shown to exist in various formal theories.

UP: As I said, deductive proofs are necessary for the solidity of the mathematical enterprise, but that does not mean that they are humanly understandable.

DM: Manin likes to quote me on this. For one of my early papers for Inventiones I "knew" that a certain fact had to be true, and I finally came up with a formal proof of it. But in no sense did it provide any illumination and I said that in the paper. A heuristic reasoning is often far more satisfying in this regard, even if it is not rigorous.

UP: The point of rigor is of course to make something objective and exportable. I would say it is analogous to an experiment in science that can be reduplicated. Mathematics is of course a collective enterprise. Many proofs are like calculations. They provide verification but not necessarily understanding. What carries conviction is how a result meshes with other results, especially if it explains them in new ways.

DM: That is very true.

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UP: Let us go back to your life. After Exeter you went to Harvard. Were you sure at that time that you wanted to major in mathematics?

DM: I was wavering between mathematics and physics. I really wanted to understand quantum theory. I still do. Of course as a child I had initially been interested in all sciences. As I grew older I lost interest in biology, although as you may recall it was revived later on, and I became fascinated by the classification of plants, mushrooms and such things.

UP: There is something about the self-sufficiency of mathematics which is extremely seductive. The idea of conquering the world by thought alone must be one of the most exciting ones possible. Of course the idea is fraught with a certain megalomania. But before getting into mathematics I would like to ask you about your extra-mathematical activities at Harvard.

DM: My mother wanted me to be cultured. And leafing through the impressive course catalogue that Harvard supplied, my room-mate Peter Maggs and I thought it would be a shame not to sample some of its riches. In fact Peter wanted to learn a foreign language, an exotic one preferably. Russian or Chinese? He flipped a coin. It turned out to be Russian. He later became a lawyer fluent in soviet law as well as the language and recently went to Tajikistan to help them write a new constitution so they can trade with reliable contracts with other countries. In my case those crazy courses had no such momentous consequences. I took courses on Chinese art and Anglo-Saxon. In art courses I wrote term papers, some reasonably good I thought. Some got me C's other A's, I could never understand why. Those grades seemed so haphazard to me. I guess I did not get the melody. Two disciplines intrigued me a lot, but I was scared of them. Music was one. I cannot sing, I cannot hold a tune, and I worried that I would not be able to memorize melodies, something which comes easily to so many people. Philosophy was the other. There were too many "isms" and idiosyncratic uses of ordinary words. I was bothered by having the illegitimate desire to know the "truth" about things.

UP: But you had wide-ranging interest. You told me once that you read William James big psychology treatise when you were twenty and you loved it.

DM: I have always been very interested in the working of the brain, but at the time there was even less theoretical understanding than the small amount known today, the theories seemed to me on a Mickey-Mouse level. This has changed a bit in the past fifty years, but still the basic theoretical models remain experimentally unconfirmed. The imaging of the brain lacks the required resolution. At the time I had a girlfriend who was one of the few women at MIT. The professors loved her and in this way I got to know many of the leading brain researchers, such as McCulloch and Pitts. I recall in particular Jerry Lettvin. He was doing an experiment on a hugely fat cat. I was disconcerted with the casual way he did it. He took a piece of cotton dipped in something and pushed it right through a nostril into the brain and de-corticalized it just like that. Then he recorded responses in the brain stem.

UP: I guess he was more interested in a living brain.

DM: That makes sense. He was doing studies on vision, in parallel with the work done by Hubel and Wiesel on cat's and monkey's vision. It is a shame that he did not get the Nobel prize too. Anyway those poor monkeys. They had a hole in the back of their skulls removed and replaced by plastic through which needles could be poked into the brain while its head was fixed in a vise. There is no empathy here, in either direction, as there is between humans and their dogs or horses.

UP: Biology is thought of a wet science. I suspect that you shied away from not only getting your hands dirty. To return the issues of mathematics versus physics. What was it that tipped the balance?

DM: Frustration with the weirdness of quantum field theory was of course an important negative reason...

UP: ..this is very common experience among mathematicians..

DM: Could be. As to positive reasons on the math side, I did well on the Putnam exam which gave me confidence. But for more sustainable reasons, take the quality of the faculty of mathematics. I remember especially Ahlfors, Mackey, Gleason, later on Tate, but most of all Zariski.

UP: Tell me more about them!

DM: Ahlfors was like a rhino. He charged into the lecture room and went straight ahead writing on the blackboard. Later when we became friends I got to see other sides of him, especially when he relaxed and drank a bit. He was almost a Jekyll and Hyde character. Mackey I met through Kirkland House where I was assigned. I had hoped to join the cultured crowd at Eliot or Lowell, but it did not work out. Kirkland was for the jocks. But Mackey, who was still unmarried at the time, was affiliated with it. We used to meet for lunch. He gave me his lecture notes. They were wonderful. I devoured them.

UP: Mackey married late I recall.

DM: He used to say that he had his first cup of coffee at twenty, his first drink at thirty, his first experience at forty ...

UP: ... when he married?

DM: I do not know, his first child was at fifty or thereabouts.

UP: And so on?

DM: He took things slowly, math and life. He took some pride in it. He also refused to accept grant money for his summer research.

UP: He was independently wealthy? I once heard him say that he was initially reluctant to go into mathematics, as you would not make a lot if money, and such things were important to his family.

DM: I do not know about that but his eccentric nephew runs "Whole Foods". Anyway his argument was that once you started to accept money, the funding agencies would eventually feel entitled to meddle with your research.

UP: This is actually what seems to be happening.

DM: Exactly. Gleason, on the other hand, was very fast in math, quite adventurous and gave courses in areas he was just learning such as algebraic topology. That's where I first heard of exact sequences. What he really loved were problems where algebra, geometry and analysis all had to be combined, where you needed to be a mathematical journeyman. He was the opposite of Mackey in that George had to think things through, piece by piece, while Andy seemed to see things in a flash. He whipped me in Go, even with a 7 stone handicap if I remember correctly this humiliation.

UP: But it was Zariski who enticed you the most.

DM: He had a very impressive personality. He had a way of making his mathematics seem so alive, of making it a rich and lively world into which he alone might guide you. At tea time, if you asked him a question, he would say "Let's sit down in my office". There he would carefully cut a cigarette in two (his doctor had forced him to cut back his smoking and, in fact, lung cancer never got him), put it in a long holder with a filter, take a deep puff and start to lay out the story for you. In his courses you could tell which theorems he felt were serious. He lectured as though he was proving them for the first time. He would start with carefully naming all the players, establishing some lemmas which positioned them on the battlefield. Then it got serious and his handwriting got smaller. Then would come the central step, suddenly clarifying the picture. The final part he dashed off, the new territory conquered. You could see how pleased he was.

UP: So this was the reason?

DM: No. It was the mathematics.

UP: How did you learn Algebraic Geometry. At the time there were no text-books, I assume. Did you just jump into the water attending his seminars. Sink or swim. I suppose he had a big group of students around him? That might have given some support.

DM: I was not totally unprepared. I had had a fair amount of projective geometry, differential geometry and topology. But then I took a course in algebraic curves from Tate. I wrote a paper for this on infinitely near points and how to calculate the genus of a plane curve from the infinitesimal invariants of its possibly quite complex singularities. I loved this, it was very beautiful and instructive. This introduced me, in my early graduate days, to the three approaches to algebraic curves. As projective curves of course; then as Riemann surfaces, a very different approach, with connections to Teichmüller theory. And finally as fields of transcendence degree 1, with valuations as points. To thoroughly digest this picture, being able to go from the one to the other, was truly fascinating and taught me a lot. Then a bit later I chanced upon Semple and Roth's old book. It connected me to classical 19th century geometry with its treasure-trove of examples. I had also read some commutative algebra. The book by Zariski-Samuel had just come out. What Zariski had done was to find the geometric meaning of so many key algebraic ideas like integral closure and valuation rings. But commutative algebra without the geometry seemed to me a rather dry subject.

It was Zariski's seminars that defined us as his students. In one of these, he would say what we were to cover but not name who would speak until the hour of the seminar itself! Terrifying. I recall once starting out saying that 'for simplicity let us stick to characteristic zero, it will make things clearer'. Zariski did not agree. It taught me a lesson. Heisuke Hironaka and Mike Artin were his students at the same time. They were a little bit older than me. Hironaka Zariski had met when he had lectured in Japan and had brought him along to Harvard. Yes we gave each other support of course, and we occasionally discussed between ourselves the technical aspects of our own work. Hironaka was engaged in birational geometry, Mike was making étale cohomology work, and I had been drawn by moduli spaces.

UP: This has been the Leitmotif for your work in algebraic geometry?

DM: One could say so. In fact it goes back very far. As a child I was fascinated by maps, the scaling down, the neat way of representing reality. After my father died and we were about to move I made a very detailed map of our lawn and garden, marking the position of every bush. My interest in moduli spaces is surely based on this. The same desire to package reality in a simple way that is immediately fathomable.

UP: Moduli led to geometric invariant theory.

DM: In fact during a visit to England when I was a graduate student I came across several old books on 19th century invariant theory in the cellar of Heffer's bookstore. This was on a summer trip to Europe with Erika. I haven't said a word about my personal life but I was married in 1959, a couple of years out of college, and we had a son in 1960, after getting back from Europe. I was pretty young but married life seemed great. It kept me in the real world and Erika was amazingly supportive of my work. This was before the "Women's Movement" and it was assumed that all women, even Radcliffe grads like Erika, would marry right away and have kids. We eventually had four which certainly kept us busy. Now everyone has a so much harder time resolving their priorities.

Anyway I was very much intrigued by these books and the subject. I was at first taken aback by it. What is this? All those computations of specific examples and this black magic 'symbolic method'. But this naturally led me to papers by Hilbert. The first one, the classical one in which he shows finite generatedness...

UP: ... which was denounced by Gordon as religion not mathematics..

DM:.. and the second, which was more interesting and relevant, I did not come across to until after I already had my Ph.D. I had worked out a theory for stable points, but my first criterion for stability involved volumes. It was in Hilbert I discovered the idea of using 1-parameter subgroups. This really made stability much easier to compute, and got the subject off the ground.

UP: Did you get any help from Zariski when you worked on that and your thesis?

DM: No, I talked to Nagata a bit when he visited but mostly I struggled on my own. Moduli was not something Zariski had thought about. As I have already explained all of us talked to Zariski and to each other, and held seminars. But this was more in the interest of attaining a comprehensive picture of the whole subject, reading his notes, his and Enriques's books. In fact, Barry Mazur and I used to egg each other on saying we ought to master all of math – ah, the ambitions of youth. But it was certainly true that the great charm of algebraic geometry was the fact that so much math comes together in this field: projective geometry, differential geometry, commutative algebra, complex analysis of both the one and several variables kinds, topology, number theory. Everything was there!

UP: At some time thereafter you must have met Grothendieck. What was your impression of him.

DM: I have never met a mathematician that smart. He thought so quickly you could hardly keep up. He was full of energy and enthusiasm. At one point he was giving three courses simultaneously. And above all he had given the subject simple and sound foundations. The notion of a scheme was obviously the right one, but at the time it met with a lot of resistance. Especially Weil, who had tried earlier to put algebraic geometry on a firm basis in a really quirky way, was disparaging. Weil simply did not accept that he was now an old man and that he had been out done in the Bourbaki style he had created.

UP: Weil had a reputation for being nasty. I recall the lecture he gave inaugurating the Science Center at Harvard. He started out by denouncing the architecture as being horrible.

DM: That was in character. When I just was coming out as a mathematician I submitted what was basically my thesis to the Annals. I met Weil in his capacity as a editor-in-chief and he started out by asking me where I had gone to school and university. I was delighted. Weil was taking a grandfatherly interest in me. Then he suddenly shifted gears, saying that though my draft contained nice results, the style of the paper was completely unacceptable, that it was that of an informal letter between good friends, implying that I had learned nothing in school about writing. OK I hadn't been at a Lycee or a Grande Ecole. That pissed me off so much that I vowed never to publish in the Annals after that. The American Journal of Mathematics was much more understanding of my typically informal style.

UP: What made Grothendieck so special?

DM: Clearly he was able to carry the art of abstraction one extra level. What was truly amazing, however, was this ability of his to relate these very abstract ideas to very concrete problems.

UP: His abstractions were not for the sake of abstractions?

DM: Not at all. He could see that they were inevitably forced on you from concrete problems. He knew exactly what he was doing.

UP: Unlike many other mathematicians who have a penchant for abstractions.

DM: Exactly. His methods were the opposite of mine – I want to anchor mathematics in the tangible, the concrete and illuminating example. I think so much of mathematics would be more accessible if it is viewed from representative examples, rather than being presented in the most general way possible. At least this is the way it is for me. Take the example of the classification of simple Lie groups. You can do it all from top down by the yoga of root systems and all that. But the classification of simple Lie groups only involves five exceptional cases and four general families. Those are numbers low enough to enable you to get intimately acquainted with each and everyone on their own terms. I wanted to understand it like this so I taught a course this way which later became the starting point for Fulton and Harris's book.

UP: The Russian tradition is very good in this respect of presenting mathematics.

DM: They are wonderful. They have understood how it should be done. In many cases if you really understand SL(2) then the rest follows.

UP: While on the topic of Grothendieck, let me digress. Why did he drop out of mathematics?

DM: Is that not clear? He was burnt out. He had worked 24-7 for more than a decade.

UP: It came suddenly?

DM: I would not say so, you could see it coming, at least in retrospect. All those loose and naive ideas, 'survivre' and everything.

UP: He worked too hard? Did you ever relate to him socially when he was at Harvard?

DM: A little. But almost all the stuff we talked about was mathematics.

UP: He was totally immersed?

DM: Totally immersed. I have never met anyone so caught up in mathematics as he was. Working very hard from morning to night, day after day, week after week. It was inevitable I think. No human can carry on at that pace. Also he was naive. Very naive, even for a mathematician. He just could not come to terms with the fact that some of his fellow mathematicians were not totally honest, or whatever. Life is compromise. For some one like Grothendieck compromise does not exist. He was too relentlessly logical. By the way in the recent book by Reuben Hersh, a book that contains a bit too much gossip for my taste, there is a very good section on Grothendieck.

UP: We were talking about abstractions. I guess what makes mathematicians stand out, even rather mediocre ones, is this natural ability to catch on to abstraction. Still if you think about it, mathematical concepts do not really involve that many levels of abstraction. The approach of Bourbaki who thinks of mathematical structures in terms of sets of sets, and sets of sets of sets etc, lends itself naturally to such a quantification. And if you would think about it, the number of levels would turn out to be not so high. Maybe four or five or some such number. Anything higher the human mind cannot really relate to in any real and imaginative way.

DM: This reminds me of "seven plus minus two". Are you familiar with that?

UP: No.

DM: It's about the brains limit to thinking about more than about seven objects and all their relations at one time. This limitation is even reflected fMRI brain scans, with a limited number of concentrated clusters of nerve cells firing simultaneously at different parts of the brain. It has been shown when you are thinking really hard the music of the brain waves changes. No more alpha waves. I think we are coming up against real hard-wired limitations on human thinking, and that it could be, as you suggest, reflected in the levels of abstraction we can really fathom.

Here's an example illustrating your thesis of limited levels of abstraction. First we can think of individual numbers such as 2011 say, which are themselves abstractions from counting real objects, years in this case. Then we can go higher and think of an unknown number n and do algebra. That we do all the time. But there is another level beyond that, namely n as a random variable chosen from a probability measure on the natural numbers. The last step makes for a real effort of abstraction, and without making that abstraction probability theory will be beyond you.

UP: And there is no fourth level beyond that in this particular hierarchy.

DM: None known to man, as far as I know.

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UP: Could you tell me something about the mood of the 60's?

DM: The mood? Yes, I would say that the 60's constituted the culmination of the modern mathematics. Now we are living in the post-modern world. What I mean is that the efforts of putting mathematics on a unifying abstract basis were more or less completed. It had started with Hilbert's Grundlagen der Geometrie lecture and point set topology and continued with Emmy Noether and the German school of algebra and with Banach spaces and functional analysis. The Bourbaki school was the embodiment of this ambition. They managed, if not quite, to put all of mathematics on a unified basis. Of course they could not cover everything. The grand reworking of algebraic geometry was not subsumed in Bourbaki, although the underlying Commutative Algebra eventually was. And Hörmander's definitive treatment of linear partial differential equations appeared elsewhere.

UP: There is no analysis in Bourbaki. And incidentally none at Harvard.

DM: Yes that is true with some qualifications. At Harvard both Gleason and Mackey lectured on stuff which was based on the abstract development of PDE's, Gleason from the point of view of functional analysis and in particular Banach algebras, and Mackey naturally saw everything from the group representation perspective. But when it came to the nitty-gritty of PDE's none of that was being worked on at Harvard.

UP: You were speaking of post-modernism.

DM: Yes, the taste of mathematics changed. Concrete problems came once again to the fore. Non-linear PDE's are still a case by case study. This was so especially in algebraic geometry, to which Grothendieck had bequeathed such beautiful and powerful tools which cried out to be exploited. Another major factor was the advent of the cheap and powerful computer.

UP: As I recall you got an Apple in the early 80's.

DM: Yes it changed my life. It was also about the time Mandelbrot came to visit Harvard...

UP: He told me that he taught you programming..

DM: Did he really say that? He was a bit of a megalomaniac, part of his charm. It was really Dave Wright. True I got very excited by this new toy. I wanted to know how the damn thing really worked so I learned the Apple's assembly language by implementing Rabin's algorithm producing 100 digit primes. Or better: prime up to a very high degree of probability. Number theory might have been the first subject that felt the impact of computers. It had started rather early with Swinnerton-Dyer in the 60's and the Birch-Swinnerton-Dyer conjecture. But most of all the wild behavior of dynamical systems was discovered, so actually we should go back to Ed Lorenz in the 50's.

UP: The subject would have been impossible without the computer. All those strange attractors that appeared when numerical experiments became feasible. Still some work was done long before, I am not thinking only about Julia sets, Carleson had a student, Brolin I think was his name, back in the 60's who did much theoretical work, without the benefit of computers! His thesis was ahead of his time. As I recall he did not have a subsequent career in mathematics. He had anticipated many of the results that came later.

DM: For Ed Lorenz, those calculations were very time-consuming and carried on through punch-cards. Now with modern PC you can do his experiments so easily, and get one nice picture after the other on your screen.

UP: So let us change tacks. Many people were quite shocked, not to say dismayed when you left algebraic geometry. They felt that you had betrayed them, and they could not understand why you left a field in which you were an, if not the, undisputed leader, for one in which you would play a rather obscure role. Some even went as far as to say that your work on AI and vision was crap.

DM: Ooph. I never imagined that people would feel betrayed. The subject of algebraic geometry was alive and well and infinitely more vigorous when I left it in 1983 than it had been in 1950, when it could be said that Zariski and Weil were the only people pushing the subject forward. As for whether what I was doing was crap, I thought about my shift as becoming a little fish in a big pond instead of a big fish in a little pond (relatively speaking). My goal in doing vision was not to make a big splash but to understand what was the 'right' mathematical model with which to describe what is going on when we or other animals analyze their sensory data. With colleagues and students, I do feel we made some progress with this. This is not a goal that is shared by either engineers or psychologists studying vision, so it not something which makes much of a stir.

UP: *This verdict reminds me that ignorance and arrogance often go together.* I have found that the less you know about a subject, the easier it is to hold strong opinions on it. But from what you have revealed about your childhood and youth this move of yours seems very natural after all.

DM: I should add that the 80's was a very difficult decade for me. It started with the purgatory of being chairman. Switching fields might also have been a way of finding new excitement. But later, math took a back seat to my personal life as Erika became ill. That's another story.

Returning to your point, what startles me about some of my colleagues in mathematics is that they lack the desire to see the big picture. I mean, maybe they are happy to be experts in a specific area of math and don't want to hear about other areas of math; or maybe they only like math and don't want to know anything about other parts of science. In the end, there are also the really big questions. When I was in college I thought a lot about the meaning of life as I guess all adolescents do. And I simply have not ceased to do this. So trying to understand a bit more about vision was a small step to look at a bigger picture.

UP: The big difference between apes and men is supposed to that the latter have an extended childhood. The mind of a developing chimpanzee fuses too early. As Aldous Huxley remarked, an intellectual is someone who is not only interested in sex and money.

DM: That is funny. As I said I have always been interested in the big picture and everything that impinges on it. It could be Buddhism or the logical foundations of mathematics.

UP: Should one think of your work in algebraic geometry as an interlude, however glorious? You once told one of our colleagues that algebraic geometry appeared to you as a distant dream.

DM: I suspect I was trying to avoid being asked to give an opinion on some paper in algebraic geometry! Of course many things in life appear as distant dreams to me now. I am still interested in algebraic geometry. I think wonderful things have been done in recent years, especially the Mori theory of birational geometry. Have they now completely understood the birational geometry of 3-folds? The birational geometry of surfaces, as taught to me by Zariski, was one of the things that enticed me into the field.

UP: I must admit that I have not been following it so closely. It is all so technical.

DM: I am surprised. All those flips and flops are they not wonderful? I remember of course a lot of algebraic geometry on different levels. Details and such ephemera evaporate quickly as soon you stop thinking of them on a daily basis, but deeper insights stay with you much longer. By the way have they not now classified all surfaces with $p_g = p_a = 0$?

UP: That would be surprising, and that I definitely would have known. I very much doubt it. But maybe you mean surfaces with maximal $K^2 = 9$ where you made the first breakthrough. That I can believe, for such surfaces you know where to look, for those with lower K^2 the situation is a mess, I doubt whether there will ever be a complete classification, although by general nonsense we know that there are only a finite number of cases. To dwell on algebraic geometry, what do you think of as your lasting contribution? Moduli theory?

DM: Certainly moduli theory has always been very close to my heart. But on another level, I would point to my exploitation of exact sequences of coherent sheaf cohomology in to answer geometric questions. So many of the classical problems of the Italians yield so easily through those simple methods and after Serre's initial paper, this was a fruit ripe for the picking.

UP: I remember when I encountered them, I was a bit disconcerted. It took out the thinking, you just set something up and did a few mindless computations.

DM: This is the point of mathematical techniques, to carry your thinking beyond the reach provided by your natural muscle power, which at least when it comes to technical thinking is very feeble. There is the limit I mentioned before – thinking about more than seven elements is very hard.

UP: So maybe it was your getting an Apple that pushed you into AI?

DM: I would not say it was so simple, but certainly it contributed. On the other hand I cannot see how I would have been able to stay innocent of computers for long, even if Steve Jobs had not encouraged me. But it is true that in a sense the transition was rather abrupt and can be pin-pointed. There was a conference in Italy, I forgot where exactly, at some bay, somewhere. Sorrento?

UP: It was Ravello in 1982. I was there.

DM: So you were there. Good. I was staying in the same hotel as Jayant Shah on that trip. You know Shah?

UP: I met him of course, he was writing a thesis on quartics when I came to Harvard, and I was told once that he had designed a sky-scraper one kilometer tall.

DM: Yes, he is proud of that. Actually higher as the top was supposed to be level with the peak of Mt. Fuji. The problem was going to be the ice forming on the immense guy wires. Anyway we met with one bottle of single malt scotch each as a result of flying. That certainly loosened up our thinking. And we decided that the way AI had been conducted up to then seemed totally inadequate. David Marr, who did tremendous work in the 70's, had been his neighbor. Maybe what was needed was a mathematician's perspective! It led us to a joint paper introducing variational techniques into vision. It was later that another colleague, Stuart Geman, introduced me to the use of probability and Bayesian statistics. I did not know either probability or statistics while I was working as a pure mathematician. But probability theory really lies at the heart of almost all applied mathematics, and especially when it comes to the problem of how we learn, how we acquire knowledge.

UP: This is a classical philosophical problem indeed.

DM: But it is not just a problem of philosophy. It is an engineering problem as well. Remember I think of myself as an engineering wannabe. Probability theory brings it down from the exalted realm of metaphysical speculation to the world of real life where survival is the bottom line.

UP: I have always wondered whether your interest was about the brain or about artificial intelligence as manifested by computers, ultimately by algorithms as envisioned by Leibniz.

DM: Both of course.

UP: So your interest in computers may have inspired you to understand the brain, and the way the brain works may have given inspiration as how to tackle the engineering problem as you put it.

DM: That is one way of putting it, as long as you keep in mind that computers and brains are fundamentally different in at least a dozen ways. I've sometimes lectured on how different they are.

UP: So what interests you most?

DM: Doing high-quality brain research involves a lot of resources to which I have no access and techniques in which I have never been trained. So naturally the contributions I can make would be on the AI-side, although I would prefer not to refer to it as AI. There's another reason why I shy away from neuro experiments. I believe all mammals at least have some sort of consciousness and unfortunately, as I mentioned before, the best data comes from experiments with awake behaving animals. But university animal facilities are a lot like the meat industry factories where the animals are basically in concentration camps. Not that I'm a vegetarian or have any right to preach.

UP: In your work on vision, I guess two strands of interest merge. On one hand the problem of implementing animal visual skills by computer, and more generally how the computer can simulate intelligence; on the other hand fascination with how the brain actually works. Those two strands are very different as you just pointed out, although it is assumed that they can simulate each other. What strikes me about the brain is its stability. In a computer a tiny mistake may make the whole thing come crashing down.

DM: This is not so surprising after all. The brain is no computer, as I have already said, it does not have a CPU, nor any separation at all between memory and processing. Everything is done with parallel processing, not serial. The architecture is totally different.

UP: How important is the architecture really? In much brain research, classical as well as modern, there is an emphasis on localization - the geography of the brain so to speak. But the deeper features of the brain are not localizable.

DM: What do you mean by that?

UP: The brain has the ability to relocate its functions. It has a drive to manifest itself.

DM: You are oversimplifying a lot of things here. Firstly one should make a distinction between the mind and the brain, the former being the evasive epiphenomenon of the actual brain processes. Secondly the basic connectivity of the brain is hard-wired. True children's brains have a lot of plasticity, and it is possible to relocate some of its functions after trauma, as you say. But at my age there is no plasticity at all. A stroke leaves permanent irreparable damage.

UP: .. so if you are going to have a stroke have it when you are young..

DM: .. and get done with it you mean. One should not exaggerate the plasticity either. The primary motor area initiating muscular commands running down the pyramidal tract cannot be relocated. Relocation seems restricted to the higher functions.

UP: Human intelligence is very much tied up with social interaction. In fact Keith Devlin has a theory that mathematical ability is the ability to hijack the social brain for mathematical purposes. That mathematicians engage with their objects in the same way that people engage with other people, being attentive to nuances and combinations and all kinds of subtle undercurrents.

DM: In fact, as Dunbar has shown, the more advanced the brain the larger the social group that can be maintained. According to his theory, for humans we are talking about something like 150 people. Anything beyond that and we are lost. You really can only be close friends with about that number of people, engaging in their lives. Beyond that number there can only be peripheral acquaintances.

UP: But the problem of consciousness is intractable.

DM: So much nonsense has been said about consciousness. This guy, what was his name, who wrote on the bicameral mind and claimed that individual consciousness dates from 1000 BC ...

UP: ... could it be Jaynes.. I have it at home. I never got around to reading it...

DM: .. don't read it, it is all ridiculous. This does not stop me from having my own theory. All mammalian brains basically have the same structure. There is a six layered cortex surrounding an interior body called the thalamus – sort of a seventh layer which is in constant 2-way communication with the cortex. Parts of the thalamus are relays, conveying sensory signals from the body to the cortex, but others are not. The others receive most of their input from the cortex itself. Harth has speculated that signals from the thalamus to the cortex in non-sensory areas may be giving us the sense that we are observing our own brain and is this not one of the main ingredients of consciousness?

UP: So this structure is unique to mammals, you do not see it in reptiles.

DM: Yes, nothing like it is present in reptiles.

UP: So as you said before all mammals have consciousness.

DM: All right but let's be careful. I guess there is a continuum. I have a cousin with an advanced state of Alzheimer's disease. Surely she has some consciousness, but the question is how much, and how fragmented it is. She cannot form sentences, she cannot recognize many people. And also many primitive mammals do not have nearly as many distinct areas in their cortex. Whales are very interesting because the layers of their cortex seem quite differently structured. But I think we are really digressing now.

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UP: As we have just noted, you have had two careers. An early one in pure mathematics, and your later one involving applied. What is really the difference between pure and applied mathematics? It has become fashionable lately to deny that there is any difference and refer to the giants of the past, such as Euler and Gauss, who freely moved around in the mathematical landscape recognizing no artificial borders. As I see it there are two aspects to applied mathematics. One is the social, namely that what you do has to be useful to society at large, which often boils down to having commercial applications and paying dividends. The second is more intellectual, by embedding mathematics in a real life context, more things will impinge on it, and hence there will be a richer web of associations which will engage your imagination more vividly.

DM: I think one also has to make a distinction between 'real' applied mathematics and phony ones. In real applied mathematics you engage yourself in the real world in all its messy complexities and out of that you try to abstract some aspects that can be treated mathematically, being all the time humbly aware that you can never capture the complete picture. In phony applied mathematics you start with some piece of mathematics and force applications into its mold. Such preconceived notions unless luckily corroborated tend to more and more diverge from anything useful. Several people have tried to use algebraic geometry in applications like vision or neural nets or the like but I have found that mostly nonsense.

UP: So in other words if you are going to do some applied work in biology say you have to become a biologist yourself.

DM: That is more or less true. You have to be genuinely interested in the biological problem itself, and want to solve it. It does not necessarily mean that you have to become a biologist like the others; on the contrary, your mathematical perspective will make you stand apart, but hopefully enable you to contribute something genuinely new.

UP: The crucial point is that you, not the biologist, have to discover what sort of mathematics is relevant. You should not expect the biologist to come to you and say "I am working on something and I have run into a few technical mathematical problems, could you help me with these?"

DM: Exactly. The biologist is not competent to formulate their issue as a mathematical problem. Why should he or she be? Not only do they generally lack mathematical training, their intellectual temperaments are non-mathematical. Often, I am sorry to say, that is the reason they went into biology to escape mathematics. So the mathematical problem cannot be treated in isolation, there has to be a constant going back and forth. If not, the detached mathematical problem will simply drift away and become increasingly irrelevant as I have already noted.

UP: But how does it work out in practice?

DM: This is another problem. Biologists are usually rather suspicious of mathematicians. They think we are too abstract and too ignorant.

UP: The forays into biology made by people in catastrophe theory in the 70's did not entirely endear biologist to mathematicians, as I heard from a friend in biology. They did find them indeed arrogant and ignorant.

DM: But to be more specific, we have many theories of the brain we want to have tested. The problem is that in order to do so you need the latest state of art in equipment. This is very expensive. You need to apply for million dollar grants. Funding agencies will never consider individuals, only groups. You need to attach yourself to another group doing other experiments and try to persuade them that what you want to do is very important.

UP: And this is not easy.

DM: It is definitely not easy. What you can hope for is that they will try and be accommodating, but it also means relinquishing control, and they will do your project their way, invariably distorting it. As I noted biologists are not mathematicians, they will not appreciate the mathematical subtleties. The only hope is if there would be some person with a foot in each camp. In fact I am really fortunate in that a former Chinese student of mine, Tai Sing Lee who is now at CMU, has established himself as an experimentalist as well as brilliant theoretician.

UP: Why is it so difficult for a computer to recognize objects?

DM: It is a question of recognizing significant changes. Take a face, where we humans are unsurpassed when it comes to recognition, although by the way there are some strange defects in our abilities. We cannot easily recognize faces when they are showed upside down, or on a negative, although from a computer point of view, such transformations are trivial to deal with. Faces look very different depending on lighting and position and, in fact, changes in those obviously account for the greatest changes in the pure image. As humans we have learned to disregard the lighting and position changes which actually occur in our experience although not wild ones. Disregarding these, we can concentrate on the essentials whatever they are exactly. To identify those is the basic problem in computer vision.

UP: Would you care to elaborate further?

DM: One thing we need is a kind of 'grammar' of vision. To identify basic objects and their sub-objects, and the whole hierarchy that ensues.

UP: So this is similar to language with clauses and phrases making up a sentence?

DM: Yes, they are very similar although there are reasons why the visual grammar is more complicated. Not only is it a question of two dimensions, but also that the two dimensional image is a projection of three.

UP: Verbal communication is 1-dimensional, but this apparent simplicity is I guess misleading. Words are related to each other in very subtle ways, and in a sense do you not need to understand most of what a sentence is about in order to be able to interpret the word flow properly? I guess something is similar when it comes to vision. Most of the visual images we encounter are familiar to us, thus we can concentrate on the small differences.

DM: Analysis of straightforward sentences is complicated but not impossible.

UP: But when it comes to the meaning of a sentence, such as in a joke or when ironically delivered, you cannot get it from the words alone, you need to intuit the speakers intention, and then you get very close to assuming a 'soul'.

DM: Forget about the 'soul', and also forget about such second order phenomena as irony and jokes, first order is already complicated enough! An innocent word such as 'it' always refers to something, and you have to infer from the context what the 'it' refers to. In an interchange 'it' could refer to something that was mentioned several minutes or more earlier.

UP: But in order to know what 'it' refers to means that you need to be privy to some understanding that is not manifested in the actual words and structure of the text. It transcends it.

DM: Your verb 'transcends' suggests it is mysterious. I agree that it is a very complicated question, which is far from being fully understood, yet ultimately there is no mystery, if you recall that all communication is embedded in a context with tacit assumptions. Of course a text taken out of its context is bound to be incomprehensible, but once you start to involve the general context, the mystery is bound to eventually dissipate.

UP: As to an image: you do not take it all in immediately. The eye zig-zags across the image in jerky movements. There is a technical term for that which evades me at the moment. I guess the information taking proceeds linearly.

DM: They are called saccades. How could it do otherwise? Information has to be processed through time. The point is that you are learning the context of the whole image so you can use your general knowledge at the same time that you are analyzing the two dimensional structure of the specific image.

UP: Of course through the linear sequence of sentences we can build up very complicated multi-dimensional structures, at least in a metaphorical way. It reminds me of the way you learn a piece of mathematics. First you are forced to follow a time sequence, some topics are introduced before others, and in the beginning you think that this is an intrinsic feature of the subject. But when you command it, you can go back and forth in any order.

DM: An example is the synthesis involving algebraic curves and Riemann surfaces etc. that I talked about.

If you let me digress a bit, there's a simple example of how global and local knowledge can blend. This is the most successful program for machine translation of one language into another. The IBM group headed by Jelinek worked with the proceedings of the Canadian parliament which are conveniently published in both French and English. Working globally, you form a statistical dictionary, assigning to each English word probabilities of its various possible translations into French (allowing multiple words or an empty translation too). Then studying the English locally and by itself, you form huge tables of probabilities of all three word sequences, called 'trigrams' in actual speech. Now the wonderful rule of Bayes comes in. Given the French, you find a string of English words which maximizes the product of two probabilities. One is a sort of English language coherence: multiply the conditional probabilities of each new word given the previous two (which you get from the trigram tables). The other measures whether this string explains the French: this comes from the statistical dictionary. The mind blowing thing is the power of multiplying these two terms. Each alone is so crude, yet together something pretty close to the right translation emerges!

UP: To change the subject. You have two sets of students. What was really the difference between those in algebraic geometry and those in vision?

DM: That did not make such a great difference really. The subject matter did not matter that much compared to the difference between Brown and Harvard students. Harvard undergraduates are really already graduate students. They are so ambitious, so competitive. The Brown undergraduates are more open.

UP: But would it not be easier to be giving problems in vision. The students would be part of a team?

DM: Well, in both math and vision, I have sometimes had a number of students at the same time with related projects. I am not the most patient of teachers, as you have sometimes reminded me, and I'm sure that when I had such groups, the students talked more to each other than to me and that this was a big help. But in both math and vision, it is still a matter of individual work. As I have mentioned, one problem in applied topics like vision is that students rarely combine practical skills with theoretical. The great hurdle they need to overcome in their education is that it is not enough to come up with an algorithm that works. They also need to investigate when the algorithm doesn't work. And that is of course part of a more general phenomenon, not restricted to students, of people tending to ignore data that do not agree with their approach.

UP: This is Popperian falsifiability again. You really only learn from mistakes.

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UP: The general issue of applied mathematics relates to what people in general should know about mathematics. You have some definite ideas on mathematical education I have heard. There was ten years ago some kind of math war raging in the States, and you took an anti-traditionalist stand.

DM: Some of those stands taken by my fellow mathematicians I very much took exception to. I thought they were insensitive and unrealistic and arrogant. I will not mention any names. My stand is simple. Say five percent of the population takes to mathematics naturally. In general education it is the other ninety-five percent we need to worry about. To teach those we need to relate mathematics to their daily lives and show how important it is. Quantitative illiteracy, as Lynn Steen calls it, is a real handicap. People have a right to be at least moderately competent in basic mathematics. In an article I am co-authoring with Sol Garfunkel we are trying to break into the Atlantic Monthly. You may know that magazine, it often publishes quite intellectual material?

UP: Of course I have heard of it, but in fact never dipped into it. Did it not have an article on a big fight at the Institute back in the 70's.

DM: That could be true. You are digressing. Back to the article. We want for example everyone to be taught the mathematics of finance, the 'syntax of money' as Robertson Davies calls it.

UP: To make people rich? Or simply to motivate them by means fair or foul?

DM: People need to know about basic finance to succeed in their own personal lives. Most people after all will borrow money to buy a home. They need to know about mortgages and compound interest so they can plan ahead. And with modern computer software this can be made very tangible indeed, vary a few parameters and you can see how the graphs change.

UP: They need to understand graphs.

DM: Exactly. People should be taught useful things above all. Society is getting more and more complicated, and it is a democratic right to be in possession of some basic quantitative skills. They need to understand data and know the rudiments of statistics. They need to know something about how the machines around them work – airplanes, computers – and how the math frames the laws that constrain them.

UP: What about popularization of mathematics.

DM: What do you mean?

UP: Books like "One, Two, Three ... Infinity" by Gamow, books by Philip Davis, and others had quite a lot of influence on me in my early teens. I have heard that you found Hogben's "Mathematics for the Millions" useful.

DM: That is true. In general I must say that I am rather skeptical of those books churned out by established popularizers for a simple reason: I believe that you cannot even sketch any substantive mathematics without using formulas. If you try to do it without formulas people will learn nothing. You must try to re-educate your readers by reminding them of their high-school algebra. True, you need to sweeten the pill a lot in a popular book. I grant that there has to be a lot of gossip, anecdotes, intriguing pictures, but when all is said and done if you want to impart some real mathematical insight – and if not I simply see no point in writing such books – you need to resort to formulas. I worry that in our own coffee-table book 'Indra's Pearls' we did not carry this didactic mission far enough.

UP: There were a lot of pictures.

DM: True, but in the end you need to understand those pictures, otherwise they are not instructive and ultimately no longer intriguing but just boring. We didn't do enough to help math-phobic readers remember what a formula is all about. Talking to my former student Larry Gonick, who writes terrific cartoon guides to all kinds of science, I thought we needed to insert gremlins swarming over key formulas, each personifying and explaining the role of one term. Might have helped.

Speaking of pictures, I am surrounded by artists in my family. My second wife Jenifer is an artist, as is my oldest son Steve, his wife Inka, my sister Daphne and her ex-husband Charley, my step-son Andrew – another son Peter is a photographer, a step-son Ally a graphic designer, a step-daughter Nina does jewelry .... All this made me think of the links between art and math. Both have had a 'modern' 20th century period picking apart their components and abstracting from their direct links with the world. I've given several talks to lay audiences using art, which all educated people tend to know well, to explain what has been going on in math, which they rarely know.

UP: The subject of popular mathematical expositions naturally invites the subject of intra-mathematical communications. To be blunt. Why are mathematical talks so bad?

DM: I think that modern technology is a big part of the problem. In the old days when people used chalk on blackboards, they could not go so fast. You had time to digest definitions and if there was a decent amount of board space, key points didn't disappear for a while.

UP: I think that there is even more at stake. A lecture delivered in person is much more intimate.

DM: If a person talks to you in your office, there is never any problem of not following.

UP: In a personal conversation information and understanding seems to be conveyed so much more efficiently. This is what we have evolved for. The art of personal communication has not improved since antiquity.

DM: It is also a matter of attitude. My brash friend from British Columbia, Bill Casselman, actually ranked the talks at Hyderabad and gave them grades. 'Bill' I told him, 'why do you not publish your list'. I guess he did not want to make so many enemies. But it would be a good thing if speakers at the ICM were made aware of their talks being critically assessed.

UP: It is so much a question of attitude. The prevailing one seems to be a macho one. “I just made those slides on the plane last night, sorry for the mistakes” kind of thing. As if they would not like to be bothered. I think that actually making people feel ashamed would go a very long way to improve the situation. Having such a list published might have a salutary effect on future speakers.

DM: That could be true.

UP: You have recently been engaging yourself in the history of mathematics especially Indian mathematics. This seems to be an appropriate interest for an aging mathematician. Andre Weil became quite interested in it at the extended end of his life.

DM: The aging mathematician. Speak for yourself, and Weil we can keep out of it. To be interested in the history of mathematics is not just a hobby when in dotage but very natural and essential to any reflective mathematician. When you have seen in person fifty years of history, the reality of how fast things change is in your face. I was naturally led into it when I was giving a course at Brown to non-math majors.

UP: Math appreciation on the model of courses on art and music appreciation?

DM: You can put it that way. But I wanted my course to be really serious. What I mean is that I really wanted to impart some genuine mathematical understanding through drawing on the tangible reality in which each student is immersed. We introduced a bit of Fourier stuff via music and analyzing the voice of a secretary singing the scale. Over and over again during our conversation I have emphasized the tangible basis for mathematics. I cannot do that too much.

UP: But you are now publishing articles in scholarly journals and attending professional conferences on the subject. How do you find your new colleagues.

DM: Yes, I always prefer to do things in a serious way. As to my colleagues in mathematical history I do not know how to put it. I am considered an outsider, and that I can understand, but I feel them to be a bit...

UP: ..pedantic?

DM: That’s too strong. I find them so very cautious and so reluctant to look for the larger picture. They are always admonishing me not to be anachronistic, not to jump to conclusions, not to impose my own inappropriate cultural biases onto a totally different past. I guess these are their professional standards.

UP: Are you familiar with the British historian and philosopher R.G. Collingwood?

DM: I’ve heard the name.

UP: You should read him. He is very good. He revolutionized my understanding of the task of the historian and what history is really about.

DM: And what does he say history is really about?

UP: To reconstruct the past in the present. As I understand it essentially a forensic exercise. Most important, and it is here human history differs from natural history, to reconstruct the thought of the past.

DM: This makes sense. The documents of history are so spotty and have so many gaps, if not the writing of history would be straightforward. You really need to be able to interpolate.

UP: And what enables you to do so, is to intuit the underlying thought, and hence reconstruct the concomitant intentions, without which much of human activity would be totally incomprehensible.

DM: Exactly. When you read those old documents you recognize the thought behind it all. You read Archimedes and you feel he is thinking exactly like the brilliant contemporary mathematicians you have read. Human nature has not changed, has it? Although the historians are for ever warning me to be careful, not to impose my own thought and cultural prejudices on the past, I think the challenge is to find what is the same and what is different.

UP: Human nature is the same. This is what makes human history fascinating. If human nature had changed a lot, history would lose much of its appeal. It is the excitement of finding the same nature, which you can relate and even identify with, in drastically different contexts. And when it comes to mathematical thinking it has a universality across cultures and hence across time, which non-mathematicians do not really appreciate it. Just as an engineer is much more competent than a historian to elucidate the significance of some machinery of the past, a mathematician is in a much better position to understand the evolution of mathematical thought than a mathematically untutored historian. To throw away this method provided by the universality of mathematical thinking, perhaps the most stable and culturally impervious of all human activities, is to give up the one powerful method at our disposal.

DM: Once again this ties in with my general approach of how we acquire knowledge. It is all about Bayesean statistics, where we have an a priori theory of human nature which we combine with the data, historical documents in this case, to form a posterior probability distribution of the full ancient events.

UP: What is most amazing thing in the history of mathematics?

DM: Amazing?!

UP: Or interesting, or intriguing?

DM: Don't change the wording! Let us stick with 'amazing'. That is a truly strong word. What do you have in mind?

UP: The question was given by a friend of mine as part of a take-home exam on a summer course on the history of mathematics. My answer would be that there is a history after all. That problems are solved, that they have a solution. How come we did not only come up with intractable dead-ends such as odd perfect numbers. The fact that the Fermat conjecture did connect with elliptic curves that just had happened to be developed and be available to the mathematical community is a kind of miracle.

DM: Speaking about intractable problems, I am surprised that stable homotopy for spheres still has resisted so much effort. One would at least naively think it would be more tractable than other questions which have been solved in recent years.

UP: And then there is magic in mathematics. The first time that you really encounter it is in complex function theory. It is amazing that most people we know do not know about complex numbers.

DM: Do you think everyone ought to know about them?

UP: I guess so. Although complex function theory is probably beyond most people.

DM: How do you prove that $e^{i\pi} = -1$?

UP: Is that not basically by definition?

DM: No, no. How do you think Euler came up with it? In fact he was interested in all the solutions of the differential equation $y^{(4)} = y$ and by having two solutions with identical initial conditions you end up with the formula $e^{i\theta} = \cos(\theta) + i.\sin(\theta)$. Alternatively you can think of the limit $(1 + x/n)^n$ for arbitrary x including i. You can think of imaginary interest, continuously compounded.

UP: This would tie up with your concern for mortgages.

DM: Sure, this is everyman's entree into complex function theory. I used this for an after-dinner talk once.

UP: You do not disdain elementary mathematics?

DM: On the contrary. What is your favorite proof of the Pythagorean theorem?

UP: Dividing the triangle into two similar triangles each similar to the original, and then use scaling and additivity of areas.

DM: Yes that's beautiful but I slightly prefer the Chinese one with one square inside another, the inner one being tilted and touching the outer square once on each side.

UP: That would be more elementary, the advantage of the former is that it ties in naturally with the essence of Euclidean geometry, arbitrary scaling and non-congruent similar triangles.

DM: My proof just uses invariance under rotation.

UP: But lengths and areas are also rotationally invariant in non-Euclidean geometry.

DM: Good point. I guess I also use the existence of rectangles with four right angles which fails in the non-Euclidean case.

UP: What parts of mathematics do you feel least comfortable with?

DM: Graph theory.

UP: That is very interesting, I do not like it either.

DM: It is not that I do not like it or that I find it unimportant. On the contrary, I like the results. It is just that I have no feeling for how to prove things. The proofs seem so tricky and oblique to me. I would never come up with them. But it is important, and there are some really nice results, such that by Erdös, on random graphs made by adding edges at random. At a definite point, it is overwhelmingly likely that it acquires one very large connected component, and the rest will be very small.

UP: I definitely do not like graphs. I have no emotional attachment to them. I find them sterile objects that do not at all engage my imagination. Although of course from a formal point of view, any mathematical theorem can be codified into one involving graphs.

DM: Thought is also often modeled as a graph with several basic types of edges. Roget's thesaurus makes the words of a language into a huge graph. By the way, I do not particularly care for finite groups either. Again so many confusing tricks. I have never really gone beyond the Sylow theorems and character theory.

UP: I like finite groups. I find them fascinating, something I can relate to emotionally.

DM: Good for you.

UP: We have been touching upon your childhood and your work. No doubt you have many other interests only marginally related to your work. You referred briefly to your fascination with plant classification earlier. India could be brought into this context. You have visited it many times, and surely it has been important to you both personally and professionally. How did your relations with India start?

DM: It was by pure chance. Seshadri had contacted me. His notion of stability for vector-bundles tied up with my own. We invited him to visit Harvard. While there, he brought up the idea of me visiting India. At the time it seemed a huge adventure, a fantastic place as described by Kipling. How would we live in India?

UP: So you first went in 1968.

DM: No, it was earlier in 1967. We came for the academic year 67-68 and put our kids (we had two at that time, Steve and Peter) in school. The original idea was to go to Cyprus, and then to get a car and drive to India. At the time it was feasible. Iran was open to the West, Afghanistan still had a King I recall. The only problem might have been crossing from Pakistan to India.

UP: Pakistan would have been no problem, and Afghanistan is to the north and could easily been sidetracked. In the 60's and 70's I believe there was even a bus service from London to New Delhi once a week.

DM: Really? Anyway the Six Day War occurred. We decided we had to skip those adventurous plans. Instead we went to Israel for a few weeks. Israel was very different then from what it has become now. There was still a lot of left wing idealism, the kibbutzim were thriving and a naive person like me could hope that an enlightened government might impose for a Pax Israeliana on the Middle East. After all, Moshe Dayan had wisely refrained from a military occupation of the Temple Mount. And none of those wild Russians had yet arrived on the scene. We had a very nice time there then. We stayed at a Moshav close to the beach where we went every day and I worked there. Then we flew to Bombay.

UP: So what was your immediate impression of the country?

DM: I was aghast at the abject poverty yet intrigued by the lack of overt unhappiness. At the time one could not yet live on the premises of the Tata Institute. I commuted by bus along with those poor women who had to work on construction sites, carrying mortar on their heads, often while nursing children. The fares on the bus were dirt-cheap, half a cent or something, so they could afford it. I was struck by the fact that they seemed so happy and animated. They were deprived of all those things I as a citizen of the most prosperous country in the world took for granted and assumed were absolutely necessary. It made me start thinking. As a mathematician I thought in terms of numbers. What constitutes real wealth? Were the pioneers of the west, surrounded by natural resources more comfortable in their warm log-cabins and actually richer than medieval kings shivering in large stone palaces? One way at least to linearly order societies and classes is to ask how much energy is at each person's disposal. I started computing and looked up statistics in the library.

UP: But the Indians are living like the Europeans did in the 19th century. The original traders must not have had the sense that they were coming to a poorer country. To the English, the Irish may have been as backward and poor as the Indians.

DM: I do not believe that. I think that the standard of living was much higher for the 19th century Europeans, the life expectancy much longer.

UP: I am thinking of the rural populations. I think that their lot did not significantly change from medieval times to the end of the 19th century.

DM: And the caste system was very strange.

UP: But natural. I guess it exists in all societies, but only in the Indian has it become so codified and rigidified.

DM: It is really nothing but slavery.

UP: But originally it was designed to attach people to occupations. Life becomes much simpler when you do not have to choose your work or your spouse. And besides the caste system simplifies social intercourse, we talked before about the 150 person limit. Society as a whole becomes much more manageable when it is broken up in chunks.

DM: There is of course no end to the possibilities of justifying the system, at least to those whose interest it is to conserve it.

UP: There is one aspect of your professional life we have not touched upon yet.

DM: There are many.

UP: Could well be, but I am in particular thinking of your Presidency of the International Mathematical Union (IMU) 1994-98. How did it come about? Did you campaign for it?

DM: Are you crazy?

UP: But when it was proposed to you, you did not mind?

DM: Of course I did not jump at it, but Seshadri had told me being on the Executive Committee was a pleasant job. I was vice-president first and then Jacques-Louis Lions and Jacob Palis had become good friends so when they asked me to move up, it was hard to refuse.

UP: Did you accomplish something lasting for the mathematical community?

DM: I was involved in some things I am happy about, such as the Chinese bid for the ICM, the first Third World country to do this. But to answer your question truthfully, I have to admit that I did not really accomplish anything. And that was not because of lack of trying mind you. I tried several initiatives but none came to fruition.

UP: Why was that.

DM: I guess I am not a politician. I have no real feeling of how politics works. I was naive and thought that all it took was to suggest some obviously good idea and people would more or less instantly agree and jump on board!

UP: Could you give an example?

DM: You know about Phillippe Tondeur?

UP: The name seems faintly familiar.

DM: He has this wonderful idea of a 'World Mathematical Library'. It simply means that every bit of mathematics should be digitized and be freely available on the Internet. Such an obviously good idea, a winner for everyone.

UP: I would say that one of the most frustrating things in mathematical research is to find out whether what you are thinking of has been done before or not. If you have a good idea, especially in the case of a subject on which you are not at the forefront, chances are that someone may have already thought about it. There is a story about a student of Hilbert who discovered that his theorem had already been proven, and Hilbert simply admonished him for reading too much.

DM: Yes, and with all the mathematics on line, you could just search and find out. No more of the kind of frustrations that seem to bother you. So I naturally embraced this idea, and already having created the Committee on Electronic Information and Communication at IMU there was a natural forum.

UP: I recall digitization being discussed at the General Assembly in Shanghai in 2002. There were about an estimated 40 million of pages of mathematics available since antiquity. It may seem a lot, but it struck me at the time that the number of pages is dwarfed by the population of China. It high-lighted for me the modest physical presence of mathematics in the world. Surely one Chinese individual is much more than an average page in mathematics. As I also recall there were some problems with copyrights.

DM: That was just an excuse. There were in fact several important factors which prevented this idea from being successfully implemented. For one, unlike you, mathematicians in general were very slow in grasping the obvious benefits of having every paper, every published bit of mathematics at your fingertips.

UP: But they could have been educated?

DM: Sure but this has turned out to have taken several decades. The real obstacles were those mathematicians who were actually involved in publishing or even in digitization. They simply refused to act together for the common good, because they saw it as an attack on their fiefdoms.

UP: This is what politics is all about.

DM: I guess so. The AMS, whose activities were subsidized by their journals, was run by an arch conservative who always saw a dozen reasons why any change was doomed. And then of course we have the big publishers. They saw new money in the older stuff, provided of course that they sewed up the digitization themselves.

UP: Charging exorbitant prices no doubt for the access.

DM: That goes without saying. And to really bring home the last point, take the example of Springer, which to me is the saddest thing around. Springer, which under people like Ferdinand Springer and Klaus Peters served the needs of the mathematical community...

UP: ....This idealism used to be a hallmark of publishing firms in the past...

DM: This certainly used to hold for at least academic publishing. Now Springer has been sold to venture capitalists, whose only object is to make a fast buck.

UP: I had no idea. I have always vaguely associated Springer Verlag with Axel Springer and his Bild Zeitung.

DM: They share the names, and they both publish, but that is all they have in common. Julius Springer founded Springer Verlag back in the 19th century and Ferdinand and Fritz were sons of his. The actual story is of course a bit complicated, as you may know that the world of big corporation entails complicated chains of ownerships and mergers.

UP: ...You sometimes suspect thats some of those chains close up into cycles....

DM: The publishing industry is no exception. In 1999 Bertelsmann, which was privately owned by the Mohn family, acquired a majority share in Springer-Verlag. But they were over extended and a few years later it was widely reported that they were selling Springer. At the ICM in Beijing in 2002, a group of Presidents of all the major math societies got together and wrote Reinhard Mohn about the possibility of extracting the mathematical subset of Springer – hoping we could find some way of preserving the old partnership with the community. This letter probably never even got to Mohn and soon after British venture capitalists acquired both Kluwer Academic Publishers and what was now called BertelsmannSpringer. After their efforts to 'maximize value', i.e. bleed the math and other professional communities, there was announced in 2009 yet another sale of Springer to actually a Swedish financial investor EQT and to the Singapore government financial investment firm GIC.

UP: I hear EQT took the lions share. It all seems very convoluted.

DM: The complications are ultimately irrelevant. What matters is the bottom line. Mathematicians are being exploited by the big publishers and they hate to admit it. Not only do they charge obscene prices for their flagships journals...

UP: ...As I understand it Acta Mathematica the flagship of the Mittag-Leffler Institute and the lasting accomplishment of its founder, was recently taken over by Springer. I do not know all the details...

DM: That fits with the general picture. As I was saying, not only do they charge obscenely, and that one can understand the motivation for, even if you oppose it. But they even are so petty as to engage in nit-picking smaller things. It is as if their greed knows no bounds.

UP: You are thinking of?

DM: Actually there is an Indian book on the the History of Math which is being sold in India for $31, but which they market for $199 in the West. They probably got the Indian book for half of what it was selling for in India. This is offensive. What I think is needed is that our community simply form an old-fashioned trade union.

UP: But is this not what IMU is? The International Mathematical Union?

DM: In name only.

UP: All this talk about digitization makes me think about its drawbacks as opposed to its obvious benefits. If you are hard-nosed unsentimental about it. It will mean that in the future, books will become obsolete. I am of course talking about the physical book, which you can hold in your hand, turn its pages, and put it into your shelves, where it will become furniture, in fact I would say the most important furniture in your home. Sleep you can always do on the floor.

DM: I don't see why books should suffer the same fate as journals. No one reads journals cover to cover so you might as well put the few articles you really want to refer to on your computer. But I suspect books will always appeal to new generations as a wonderful way to package thoughts.

UP: But what will happen if initiatives such as Kindle become established. I cannot imagine that it will be the same thing virtual flipping pages on the screen, but that is not the main point, future generations may accustom themselves. But with something like Kindle there is no longer any point of having a personal collection, everything is accessible to you out there.

DM: I tend to agree.

UP: I think that bringing things home with you matters. To appropriate a small part of the huge universe out there into your own privacy. This is I think a fundamental instinct. There is much talk about Internet making it obsolete for people to learn and memorize facts. They are out there, at your fingertips, anyway, thereby greatly enlarging your capacities. But in order to think creatively and intimately, you have to learn facts, to truly integrate them into your thinking. They have to be accessible in short-term memory so to speak. In a sense this is what collecting books is all about. With modern technology this will get lost, and the tangible physical connections with knowledge will be severed. And then there is another issue, which sometimes is addressed, namely the long term stability of the electronic medium into which a larger and larger part of our cultural heritage is being transferred. Will libraries consisting of physical books be destroyed by future generations? And then when the electronic storage decays? And then there is also the stability of soft-ware. An electronic file can only be read and interpreted by the right soft-ware. Will there be incentive enough to always upgrade old files. Much of what I wrote on computers in the late 80's is now obsolete, as I have changed operating systems and wordprocessors. I think this is actually not uncommon.....

the ostensible interviewer gets lost in a long soliloquy but suddenly wakes up to his responsibilities

.....You must be getting tired. We have covered a lot of ground. Dare I ask you in conclusion – do you have a philosophy of life?

DM: Well, you were the one who solicited from me an article on Platonism for the Newsletter of the European Math Society. As you will remember I was a strong defender of Platonism and was roundly attacked, e.g. by Davies as well as Davis. It seems to me that ideas and concepts indeed have a reality, but a reality which is on a wholly different plane from the reality of matter. On this plane, for example, relations are not relations within space-time (x before y in time, x inside y in space), but instead ideas lie in a vast graph as I mentioned before (x is a special case of y, x is the value of property z of y). Materialist reductionism seems to me a narrow-minded simplification. Life seems on a basic level a huge mystery and that it is arrogant to impose such a strait-jacket on the ultimate reality of the complex place in which we find ourselves.

Certain strands of Buddhism, by the way, are reductionist the other way around! They assert that all beings are 'empty', that they exist only by virtue of their connections to many other, equally empty things. Essentially, all that exists is a graph joining essentially empty nodes. Incidentally, spirit is a third thing, neither a concept nor material. Of course, there are plenty of reductionists who want to reduce everything to spirit. My preferred non-reductionist metaphor that life resulted from a love affair between spirit and matter.

You know there is this radical group, promoted by Kurzweil and Moravec, that says there will come (they think in terms of decades, not centuries) a 'singularity' in which biology using human gene manipulations will fuse with intelligent robots made with nano-technology and possessing super-human skills. You can read about the idea on the web. The singularity would be the opening of the ultimate Pandora's box. It feels to me hard to reject this wild idea out of hand but I, along with half the sci-fi community, wonder where spirit would fit in after that.

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Förslag till Wallenbergpristagare

Wallenbergpriset har delats ut sedan 1983 (under detta namn sedan 1987) av Svenska Matematikersamfundet. Det har delats ut till speciellt löftesrika yngre svenska disputerade matematiker, som ännu inte erhållit en fast forskartjänst. Wallenbergpriset har varit den mest prestigeladdade utmärkelse som en yngre svensk matematiker kunnat få inom landet. Den uttalade avsikten med priset har varit att uppmuntra matematisk forskning. De flesta av pristagarna har också fortsatt sin karriär som matematiker vid svenska universitet och större delen av pristagarna är idag professorer. Priset är i år på 300 000 kr.

En priskommitté bestående av Alexandru Aleman (sammankallande), Pär Kurlberg och Jana Björn har utsetts av samfundet. Kommittén ber genom detta brev om förslag för år 2017.

Förslagen ska innehålla motivering och gärna ett CV samt tänkbara sakkunniga som kommittén skulle kunna tillfråga. Den person som föreslås ska vara högst 40 år vid utgången av 2017 och ha disputerat då samfundet fattar sitt beslut. Personen bör ha bedrivit väsentliga delar av sin matematiska forskning i Sverige, men behöver inte vara född i Sverige.

Förslagen skall vara kommittén tillhanda senast **17 mars 2017**. Förslagen kan sändas med epost till

alexandru.aleman@math.lu.se

Titelsidans illustration

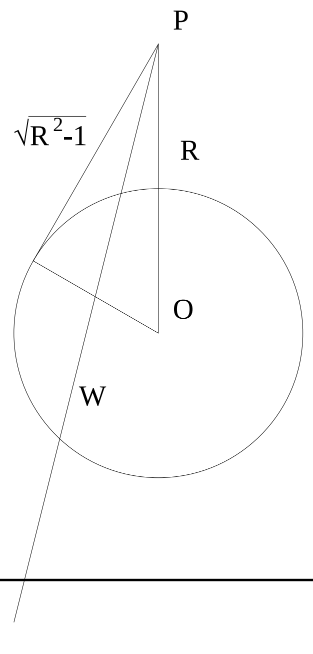
Ulf Persson

För att göra bilder i 3-dimensioner skapar man punkter med 3-koordinater (x, y, z) och projicerar på de två första (x, y). Dessa tre koordinater kan man vrida på via $SO(3, \mathbf{R})$ och jag finner det behändigt att se dessa som kombinationer av vridningar i x-,y- och z-axlarna. På sådant sått kan man lätt betrakta en 3-dimensionell figur från olika synvinklar. Den projektion man får är då den som syns från oändligheten, en så kallad ortografisk. För att få ändliga projektioner modifierar man x, y med en faktor av ett enkelt bråk i z och R där R är avståndet. De tekniska detaljerna är lätta att lista ut.

En sfär får man genom att rita ut projektionerna av ytelement, naturligt nog de som angränsas av longituder och latituder. Om de senare ritas ut får man naturligt en känsla av sfärens välvdhet. Man kan även få den genom att belysa den med lämpligtvis en oändligt avlägsen ljuskälla (som solens?) och genom att ta skalärprodukten $< W \cdot N >$ mellan strålarna enhetsriktning W och ytelementets normalvektor N får man en lämplig gråskala för ytelementet. Jag har modifierat denna för att i tillägg kunna få rutmönstret att framgå tydligt. Rutmönstret framkommer genom att jag håkker reda på varje elements position (om de sfäriska ko-ordinaterna är givna av θ, ψ (i hela grader) betraktar jag $[\theta/45] + [2 \cdot (\psi + 90)/45]$ modulo 2 och färgar ljust eller mörkt beroende på värdet (vilket givetvis modifieras via den ovan beskrivna skuggningen). Schackmönstret som sfären står på konstrueras på samma sätt, dock med en modifikation för skuggan. En punkt $P = (x, y, -1)$ befinner sig i skuggan av sfären belyst från riktning W om och endats om

$$- < P, W > /\|P| \geq \sqrt{1 - \frac{1}{\|P\|^2}}$$

. Bilden nedan förklarar allt (notera att sfären har radien 1 och dess centrum befinner sig i origo)



Notera att gråskalan på de vita rutorna i skuggan faktiskt är densamma som gråskalan på de svarta belysta rutorna!

Tegmark och Universa

Lars Wern

Boken "Vårt matematiska universum" av svensken Max Tegmark (verksam vid MIT) har undertiteln "Mitt sökande efter den yttersta verkligheten". Författaren framhåller att han har skrivit en självbiografi som mest handlar om fysik och som är "allt annat än en vanlig populärvetenskaplig bok". Med den stora frågan "Vad är verkligheten" som utgångspunkt berättar han personligt och underhållande om vad vi vet och inte vet om den fysikaliska verkligheten med start ute i världsrymden och avslutning i det subatomära mikrokosmos. Enligt honom står vår bristande förmåga att förstå medvetandet inte i vägen för en "full förståelse av den yttre fysikaliska verkligheten" vilken han väljer att se som rent matematisk. Tegmark menar därmed att alla strukturer som existerar matematiskt även existerar fysikaliskt i ett multiversum. Här anser han en viktig ledtråd vara att man funnit det nödvändigt att "fininställa den mörka energin ner till 123 decimaler för att det ska uppstå beboeliga galaxer".

Jämfört med antropiskt resonemang om tur är detta försök att finna en förklaring mer tillfredsställande och omnämnt av mig tidigare i oktobernumret 2007 av Utskicket under rubriken "Tankar om Ganelius bok, lek och matematik". Förklaringen kan ses som en uppdaterad version av hur Platon uppfattade den fysikaliska verkligheten. Från idén att denna är knuten till en matematisk struktur utvecklar Tegmark tanken att allt som existerar matematiskt även existerar fysikaliskt. Själv ser jag det som att spänna vagnen före hästen och som mer konstruktivt att söka finna en modell av den fysikaliska verkligheten där det genereras matematiska strukturer såsom i en generell matematikmaskin eller dator. Det skulle göra den djupgående kunskapen idag om datorer exploaterbar för att få en bättre förståelse av den fysikaliska verklighetens innersta natur.

Tegmarks multiversum - där vår hemvist svarar mot att mörk energi är fininställd med 123 decimaler - utmanas av den förklaringsmodell som föreslogs i oktobernumret 2009 av Utskicket under rubriken "En ny kosmologi". Med den modellen kan allt observerbart spåras till funktionen av en dator. För den datorn går det via elementarladdningen och kvantfysiken i stort plus teorin om allmän relativitet att beskriva klockfrekvens, kommunikation, logikfunktionalitet och minnen som har fysikalisk existens. Och för mörk energi blir det sistnämnda ett onödigt antagande.

Sammanfattningsvis har boken nästan 500 sidor med en ganska lättläst genomgång av den moderna fysiken och med kommentarer där det är lätt att instämma åtminstone för mig. Tre exempel: "Vi lever förmodligen inte i en simulering", "Mycket talar för att det inte finns någon annan livsform som är lika avancerad som människan i hela universum", och "Vetenskap utan etik är blind, etik utan vetenskap är lam". På mer än 30 avslutande sidor framför Tegmark synpunkter om hot mot livets framtid till följd av naturkatastrofer, kärnvapenkrig som startas av misstag, fientlig artificiell intelligens, etc.

Rolf Pettersson död

Bernt Wennberg

Rolf Pettersson var född den 22 november 1937 och gick bort den 7 januari 2017. Han växte upp i Falköping, men kom till Göteborg, när han började läsa Teknisk fysik. Han blev snart engagerad som lärare vid Matematiska institutionen vid Chalmers, och kom att ägna hela sin arbetsgärning vid samma institution, som uppskattad lärare och forskare. Rolfs viktigaste forskningsintresse var transportteori, och den linjära Boltzmannekvationen, en integro-differentialekvation som bland annat har tillämpningar som modell för neutrontransport i kärnreaktorer. Ekvationen har ofta analyserats med spektrala metoder, men Rolfs bidrag till teorin var att tillämpa metoder som utvecklades först för att studera den ickelinjära Boltzmannekvationen. Det var dessa arbeten som ledde till att Rolf blev utnämnd till docent i matematik. Det har länge funnits en aktiv forskargrupp som intresserar sig för just Boltzmannekvationen, och Rolf var en aktiv deltagare denna grupp. Han hade också ett stort internationellt nätverk, och deltog regelbundet i åtminstone två större konferensserier, där han presenterade sina arbeten, sista gången så sent som 2015 i Taormina på Siclien. Rolf var också intresserad av tillämpad matematik, och det som länge kallades universitetens tredje uppgift, men som nu ofta kallas nyttiggörande. Han var aktiv inom matematikkonsulterna vid institutionen, och under30 år organiserade han en kontaktdag högskola-industri, där framförallt tidigare doktorander från institutionen, som påbörjat en industrikarriär, bjöds att komma och berätta om sin verksamhet. Denna kontaktdag lever kvar fortfarande, men i en lite annan form, eftersom den har blivet ett obligatoriskt moment i civilingenjörsutbildningen i teknisk matematik. Det är ändå för sin verksamhet inom grundutbildningen som Rolf är mest känd. Han var en mycket uppskattad lärare i civilingenjörsutbildningen, och det är många som nu har berättat om hans kvaliteter som lärare. Han var också läroboksförfattare, och otaliga är de blivande ingenjörsstudenter runt om i Sverige som har läst hans förberedande kursmaterial sommaren innan de börjat sina studier. Svårigheten för många studenter att ta steget från gymnasiet till högskolan intresserade Rolf, och hans långa serie med diagnostiska prov för nybörjarstudenter vid Chalmers ger en ovärderlig bild av hur matematikkunskaperna har förändrats under åren. Det var bland annat för detta arbete som han blev belönad med Chalmersmedaljen 2016. Rolf förblev institutionen trogen ända till slutet, och fram till i höstas kom han nästan dagligen in till institutionen. Vi är många som nu saknar en lärare, kollega och vän.

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Meeting of the Catalan, Spanish and Swedish Mathematical Societies

(CAT-SP-SW-MATH)

Registrering till **Katalanska, Spanska och Svenska matematiker-samfunden (CAT-SP-SWMATH)** (Umeå universitet, 12 - 15 juni 2017) kan fram till 19:e maj göras på hemsidan **http://liu.se/mai/catspsw.math/ registration?l=en**

Mötet består av tretton plenarieföredrag:

- **Tomás Alarcón**, Centre de Recerca Matemática, Bellaterra (Barcelona).
- **Yacin Ameur**, Lund University.
- **Viviane Baladi**, CNRS and University Pierre et Marie Curie, Paris.
- **Fabrizio Catanese**, University of Bayreuth.
- **Rosa Donat**, University of Valencia.
- **Maria J. Esteban**, CNRS & University Paris-Dauphine.
- **Luis Guijarro**, UAM, Madrid.
- **Kathryn Hess**, EPFL, Lausanne. EMS Distinguished Lecturer
- **Kurt Johansson**, KTH, Stockholm.
- **Jonatan Lennells**, KTH, Stockholm.
- **Maria Teresa Lozano**, University of Zaragoza.
- **Joaquim Ortega Cerdà**, University of Barcelona.
- **Marta Sanz-Solé**, University of Barcelona.

Och elva specialsessioner.:

1. Mathematical Biology	Theresa Stocks, `theresa.stocks@math.su.se` Julia Kroos, `jkroos@bcamath.org`
2. Commutative Algebra and Algebraic Geometry	Alberto Fernandez Boix, `albertof.boix@gmail.com` Julio José Moyano Fernandez, `moyano@uji.es`
3. Nonlinear PDEs	Erik Lindgren, `eriklin@kth.se` Erik Wahlén, `ewahlen@maths.lth.se` Henrik Shahgholian, `henriksh@math.kth.se`
4. SPDEs: From Theory to Simulation	David Cohen, `david.cohen@umu.se` Annika Lang, `annika.lang@chalmers.se` Lluís Quer-Sardanyons, `quer@mat.uab.cat`
5. Numerical Semigroups and Applications	Klara Stokes, `klara.stokes@his.se` Pedro A Garcia Sanchez, `pedro@ugr.es` Maria Bras-Amoros, `maria.bras@urv.cat`
6. Numbers in Number Theory	Joan C Lario, `joanclario@gmail.com` Klara Stokes, `klara.stokes@his.se`
7. Loci of Riemann and Klein Surfaces with Automorphisms	Javier Cirre, `jcirre@mat.uned.es` Antonio F Costa, `acosta@mat.uned.es` Milagros Izquierdo

8. Time-Frequency Analysis and Pseudo-Differential Operators	Carmen Fernandez, `Carmen.Fdez-Rosell@uv.es` Antonio Galbis Verdú, `Antonio.Galbis@uv.es` Joakim Toft, `joachim.toft@lnu.se`
9. Graphs, Hypergraphs and Set Systems	Victor Falgas-Ravry, `victor.falgas-ravry@umu.se` Lars-Daniel Öhman, `lars-daniel.ohman@umu.se`
10. Non-Commutative Algebra	Seidon Alsaody, `alsaody@math.univ-lyon1.fr` Alberto Elduque, `elduque@unizar.es`
11. Homotopy Theory	Tilam Bauer, `tilmanb@kth.se` Natalia Castellana, `natalia@mat.uab.cat`

Är man intresserad av att delta i någon av dessa specialsessioner kontaktar man en av dess arrangörerna direkt.

Välkomna!

För mer information se **http://liu.se/mai/catspsw.math**

◇ ◇ ◇ ◇

Workshop in Mathematics in Biology and Medicine,

May 11-12, Linköping

Dear colleagues,

we would like to inform you that the Research school in interdisciplinary mathematics and the division of Mathematics and Applied Mathematics at the Department of Mathematics (MAI), Linköping University are organizing the workshop

`Mathematics in Biology and Medicine`

The workshop will take place 11-12 May 2017 in Linköping. It will consist of a number of plenary lectures (45 min) and of short talks (20 min) in parallel sessions in the above topics. There will be a possibility for the participants to submit abstracts to be considered for the short talks. We will try to accommodate as many talks as we can but of course the number of slots is limited.

There will be no conference fee.

Further information can be found on the conference homepage (which will be gradually updated):

`http://liu.se/mai/mbm`

We would be grateful if you could distribute this information among your colleagues and others interested in these fields.

The following invited speakers have confirmed their interest in participating in the workshop:

Tino Ebbers (Linköping University - LiU)
Jenny Hagenblad (LiU)
Matts Karlsson (LiU)
Tom Lindström (LiU)
Thomas Schön (Uppsala University)
Jonas Stålhand (LiU)
Uno Wennergren (LiU)
Carl-Fredrik Westin (Harvard Medical School, Boston)

Organizers: Magnus Herberthson, Vladimir Kozlov, Emma Ljungkvist and Martin Singull

Medalj till Milagros Izquierdo

Göran Forsling (LiU)

Milagros Izquierdo har tilldelats hedersmedalj av UNED, Universidad Nacional de Educación a Distancia, Madrid, Spanien

UNED (Universidad Nacional de Educación a Distancia) är Spaniens största universitet med huvudsäte i Madrid och över 250.000 studenter. Hedersmedaljen kan ges till de som på ett utomordentligt sätt bidragit till universitetets forskning och utbildning.

I motiveringen lyfts fram hennes arbete i matematiska organisationer på nationell och internationell nivå, organiserandet av ett flertal internationella konferenser, den höga kvalitén på hennes forskning, forskningssamarbete med matematikinstitutionen vid UNED och deltagande i deras nationella och europeiska forskningsprojekt under många år, utbytet hon lett mellan Linköpings universitet och UNED vad gäller både studenter i Erasmusprogrammet och forskning, samarbete kring examensarbeten och doktorandhandledning, och den livsavgörande betydelse detta haft för flera studenter från UNED.

Hedersmedaljen delades ut i Madrid vid universitetets akademiska högtidligheter den 19 januari 2017.

Från UNED's hemsida

> *Catedrática pionera de la Matemática Pura*
>
> *La doctora Milagros Izquierdo Barrios es profesora de la Universidad de Linköping en Suecia y, además de haber contribuido notoriamente al desarrollo de la investigación matemática en su campo, ha mantenido una relación de colaboración importante con investigadores, profesores y alumnos de la UNED.*
>
> *La profesora Izquierdo fue una de las primeras mujeres en conseguir una cátedra en Matemática Pura en Suecia y actualmente es la presidenta de la Sociedad Matemática Sueca. Ha sido asesora internacional y representante de Suecia en los últimos años en los órganos más importantes a nivel mundial de la comunidad matemática.*
>
> *Como investigadora hay que destacar sus trabajos publicados en revistas internacionales con alto índice de impacto en el campo de las superficies de Riemann y las curvas algebraicas. Muchos de sus trabajos han sido en colaboración con investigadores de la UNED.*
>
> *Además, en la UNED ha codirigido tesis doctorales, ha orientado trabajos fin de máster y ha participado como miembro de Tribunal de tesis.*
>
> *Finalmente, aunque no por ello menos importante, como tutora Erasmus de los alumnos de la UNED que realizan estancias en la Universidad de Linköping , es de destacar la acogida que presta a nuestros estudiantes en Suecia, para algunos de ellos su paso por Linköping ha supuesto un antes y un después en sus vidas.*

KNUT OCH ALICE WALLENBERGS STIFTELSES RESEFOND

och

MATS ESSÉNS MINNESFOND

Svenska matematikersamfundet kan än en gång utlysa resestipendier avsedda för ograduerade forskare i matematik. Med ograduerade forskare avses de som ännu ej avlagt doktorsexamen. Wallenbergsstipendierna är till för att utnyttjas som delfinansiering för konferensresor och kortare utlandsvistelser. Stipendierna kan användas som hel- eller delfinansiering för resekostnader, logi, konferensavgifter och dylik, men inte till traktamente. Stipendiebeloppet är högst 4000 kr/person. Kostnader ska styrkas med kvitto vid rekvisition. Essénstipendierna är i första hand avsedda för deltagande i sommarskolor och liknande aktiviteter. I övrigt gäller samma regler som för Wallenbergsstipendierna utom att stipendiebeloppet kan vara minst 4000 kronor och högst 8000 kronor. Personer som fick resestipendium från matematikersamfundet i fjol kan inte komma ifråga i år. Till ansökan skall bifogas

- Meritförteckning
- Budget för resan
- En kortfattad redogörelse för resans betydelse för den sökandes forskningsarbete (denna skall vara styrkt med ett intyg från handledaren) samt naturligtvis adressuppgifter (inkl. e-postadress).

Det skall framgå huruvida ansökan avser Wallenbergs- eller Essénstipendier, eller både och. (Dock kommer Wallenbergs- och Essénstipendier normalt inte att utdelas samtidigt till samma sökande.)

Ansökan skall vara inkommen senast **31 mars 2017**, och skickas elektroniskt (en (1) pdf-fil) eller i pappersformat till Svenska matematikersamfundet attn

Klas Markström (`vice-president@swe-math-soc.se`)
Matematik och matematisk statistik
Umeå universitet
901 87 Umeå

ISAAC 2017 på Linnéuniversitetet 14-18 augusti 2017

Patrik Wahlberg

Institutionen för matematik vid Linnéuniversitetet är värd för den elfte ISAAC-kongressen 14-18 augusti 2017. ISAAC (International Society for Analysis, its Applications and Computation) är en icke vinstdrivande matematikorganisation med drygt 300 livstidsmedlemmar. Tidigare kongresser har hållits i London (Imperial College) och Ankara (Middle East Technical University). Den senaste kongressen hölls i Makao 2015. Organisationen ISAAC har som syfte att främja matematisk analys och dess tillämpningar inom naturvetenskap och teknik och även att underlätta vetenskapliga utbyten och verksamhet, speciellt med ekonomiskt svaga länder.

Det förväntas komma 400-600 deltagare till kongressen.

Mer information om ISAAC och kongressen hittar ni på

ISAACs hemsida: `http://mathisaac.org/`

Kongressens hemsida: `https://lnu.se/en/research/conferences/isaac-2017/`

Ni är välkomna att delta i kongressen.

1. Under fliken **Sessions** på kongressens hemsida finns de sektioner som beviljats. Ni kan kontakta en sektions organisatörer för att erhålla en inbjudan (om ni önskar hålla ett föredrag i sektionen).

2. Ni kan ansöka om att hålla ett oberoende föredrag (contributed talk).

3. Ni kan delta utan föredrag.

4. Ni kan ansöka om att organisera en egen sektion. För riktlinjer se hemsidan.

För mer information kontakta de lokala organisatörerna

Karl-Olof Lindahl `karl-olof.lindahl@lnu.se`

Torsten Lindström `Torsten.Lindstrom@lnu.se`

Joachim Toft `joachim.toft@lnu.se`

Patrik Wahlberg `patrik.wahlberg@lnu.se`

Department of Mathematics at Linnaeus University hosts ISAAC's eleventh Congress of Mathematics August 14-18, 2017. ISAAC (International Society for Analysis, its Applications and Computation) is a non-profit mathematical organization with more than 300 lifetime members. Previous congresses have been held in London (Imperial College) and Ankara (Middle East Technical University). The last Congress was held in Macau 2015. The organization ISAAC aims to promote mathematical analysis and its applications in science and technology and also to facilitate scientific exchanges and activities, especially with economically weak countries.

The number of participants is expected to be 400-600.

More information about ISAAC and the congress can be found at

ISAAC's website: `http://mathisaac.org/`

Congress website: `https://lnu.se/en/research/conferences/isaac-2017/`

You are welcome to participate in the congress.

1. In the folder "Sessions" at the congress website, you find the sessions granted. You can contact a session's organizers to obtain an invitation (if you wish to give a talk in the session).

2. You can apply to give a contributed talk (not belonging to the Sessions).

3. You may participate without giving a talk.

4. You can apply to organize your own session. For guidelines see the congress website.

For more information please contact the local organizers

Lokala Nyheter

Göteborg.

GU/CTH

Nyanställda

Martin Hallnäs, (lektor, Analys och sannolikhetsteori) Anders Södergren, (lektor, Algebra och geometri) Johannes Dröge, (post doc, Tillämpad matematik och statistik) Alexandr Usachev, (post doc, Analys och sannolikhetsteori) Qasim Ali, (post doc, Tillämpad matematik och statistik) Niek Welkenhuysen, (post doc, Tillämpad matematik och statistik)

Doktorsavhandlingar

(25/11) Magnus Önnheim

Titel: *Optimization, gradient flows and real Monge-Ampere equations*

Licavhandlingar

Kristin Kirchner *Variational methods for moments of solutions to stochastic differential equations*

Befordringar

Ann-Brith Strömberg, biträdande professor

Karlstad

Doktorsavhandlingar

(10/2) Martin Krepela

Titel: *The Weighted Space Odessey* [sic]

Nyanställningar

Martin Lind, (universitetslektor) Omar Richardson (doktorand)

Konferens:

7th International Workshop on Kinetic Theory & Applications Karlstads Universitet 19-21 Juni 2017

Mer information:

https://www.kau.se/matematik/aktuellt/7th-international-workshop-kinetic-theory-applications

KTH

Nyanställningar

Ellery Ames, (post-doc) Eric Ahlqvist, (doktorand) Parikshit Upadhyaya, (forskningsingenjör) Esubalewe Lakie Ydeg, (post-doc) Barbara Gris, (post-doc) Alicia Dickenstein, (gästprofessor) Alfonso Montes Rodriguez, (forskare) Lena Leitenmaier, (doktorand) Samuel Fromm, (doktorand) Oliver Gäfvert, (doktorand) Julian Mauersberger, (doktorand) Kevin Schnelli, (bitr. universitetslektor) Johan Wärnergård, (doktorand) Stephanie Ziegenhagen, (post-doc) Federico Izzo, doktorand

Disputerade

Ashraful Kadir Gustav Saeden Ståhl Gohar Aleksanyan Yuecheng Yang Jonas Hallgren

Avgående

Jonas Hallgren, doktorand Mariusz Hynek, doktorand Ralph Morrisson, post-doc Joakim Roos, doktorand Stephan Lester, post-doc Holger Kohr, post-doc Jonas Sjöstrand, forskarss. Kati Ninimäki, post-doc Maria Gualdani, forskare Fredrik Armerin, forskare

Linköping

Befordringar

Irina Asekritova (biträdande professor)

Elina Rönnberg (universitetslektor)

Nyanställningar

Jonathan Andersson, Roghayeh Hajizadeh, Hanifa Hanif, Emil Karlsson och Fredrik Laurén (doktorander)

Doktorsavhandlingar

Eric Setterqvist

Titel: *Taut strings and real interpolation*

Ossian O'Reilly

Titel: *Numerical methods for wave propagation in solids containing faults and fluid-filled fractures*

Lund.

Doktorsavhandlingar

(9/12) Johan Fredriksson

Titel: *Robust Rotation and Translation Estimation in Computer Vision*

(19/12) Behnaz Pirzamanbein

Titel: *Reconstruction of past European land cover based on fossil pollen data: Gaussian Markov Random Field models for compositional data*

Nyanställningar

Jens Wittsten (post-doc) Lea Miko Versbach (doktorand) Marcus Valtonen Örnhag (doktorand) Li Zhongguo (doktorand)

Mälardalens Högskola.

Nyanställningar
Milica Rancic, Universitetslektor
Doktorsavhandlingar
(7/12 2016) Betuel Canhanga
Titel: *Asymptotic Methods for Pricing European Option in a Market Model With Two Stochastic Volatilities*
(8/12 2016) Christopher Engström
Titel: *PageRank in Evolving Networks and Applications of Graphs in Natural Language Processing and Biology*
Licentiatuppsatser
(12/12 2016) Xiaomin Qi *Fixed points, fractals, iterated function systems and generalized support vector machines*
Nyanställningar
Per Bäck, doktorand i Icke-kommutativ geometri och icke-kommutativa algebraiska strukturer

Norrköping

Nyanställningar
Vivianne Deniz, universitetsadjunkt

Stockholm

Doktorsavhandlingar (2016)
(18/11) Bergvall, Olof
Titel: *Cohomology of arrangements and moduli spaces*
Handledare: Jonas Bergström/ Carel Faber, Opponent: Orsola Tommasi (Göteborg)

(7/9) Espíndola, Christian
Titel: *Achieving completeness: from constructive set theory to large cardinals*
Handledare: Erik Palmgren, Opponent: Benno van den Berg (Utrecht)

(27/5) Leander, Madeleine
Titel: *Combinatorics of stable polynomials and correlation inequalities*
Handledare: Petter Brändén/Jörgen Backelin Opponent: Carla Savage (Raleigh, NC)

(3/6) Oneto, Alessandro
Titel: *Waring-type problems for polynomials: Algebra meets Geometry*
Handledare: Boris Shapiro, Opponent: Brian Harbourne (Lincoln, NE)

(2017)
(20/1) Theo Backman
Titel: *Configuration spaces, props and wheel-free deformation quantization*
Handledare: Sergei Merkulov, Opponent: Sergey Shadrin (Amsterdam)

(9/2) Häkon Robbestad Gylterud
Titel: *Univalent types, sets and multisets - investigations in dependent type theory*
Handledare: Erik Palmgren, Opponent: Nicola Gambino (Leeds)
Licentiatavhandlingar (2017) Mitja Nedic: *Integral representations of Herglotz-Nevanlinna functions*
2016 Kebede, Sebsibew: *On Bernstein-Sato ideals and Decomposition of D-modules over Hyperplane Arrangements*
Marseglia, Stefano: *Isomorphism classes of abelian varieties over finite fields*
Nenashev, Gleb: *On a class of commutative algebras associated to graphs*
Nyanställda
Universitetslektorer: Alan Sola, Wushi Goldring
Biträdande lektorer: Jonathan Rohleder, Dan Petersen, Peter LeFanu Lumsdaine
Befordringar
Greg Arone befordrades till professor i matematik.

Umeå.

Doktorsavhandlingar
(21/10) Annelie Dyrvold
Titel: *Svårt att läsa eller svårt att lösa? Aspekter av svårighet i relation till naturligt språk och andra semiotiska resurser i matematikuppgifter.*
Nyanställningar
Klara Leffler (doktorand i matematisk statistik)
Pensioneringar
Roland Häggkvist, professor i diskret matematik, 28 februari.

KALENDARIUM

(Till denna sida uppmanas alla, speciellt lokalombuden, att inlämna information)

Meeting of the Catalan, Spanish and Swedish Math Societies
Umeå Universitet
12/6-15/6 2017

ISAAC 2017
Linnéuniversitetet, Växjö
14/8 -18/8 2017

Workshop in Mathematics in Biology and Medicine
Linköpings Universitet
11/5-12/5 2017

Författare i detta nummer

Göran Forsling Prefekt för matematiska institutionen vid Linköpings universitet.

Anders Holst Lektor i Lund verskam vid KTH.

Pär Kurlberg f.d. ordförande för samfundet 2013-15 Talteoretiker vid KTH.

David Mumford Nestor inom Algebraisk geometri och Fieldsmedaljör i Vancouver 1974. Sedan 80-talet engagerad i datorvision.

David Wells Brittisk Mathematical Educator och passionerat intresserad i spel. Författare till boken Mathematics and Games.

Bernt Wennberg Prefekt för matematiska institutionen vid CTH och Göteborgs universitet.Boltzmannist.

Lars Wern Kosmologisktinriktad pensionerad patent-ingenjör. Flitig medarbetare i såväli Bulletin.

Innehållsförteckning

Notiser