NEWSLETTER

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Mathematical Beauty

BeNeLearn 2010

The Replicator Project

News from the Benelux Association for Artificial Intelligence

AI & Industry

Editor-in-chief

It is my pleasure to launch in this issue the new section AI & Industry. Koen Hindriks will act as its section editor. We as Board of the BNVKI/AIABN feel that it is important that our links with the industry are strengthened. Therefore, Koen has accepted the post of liaison with the industry within our board. And to express our wish to have stronger bonds with industry, we have decided to give birth to this new section in the newsletter. Of course, we have had (industrial) demonstration sessions (with an award sponsored by SKBS) for many years at our BNAICs. The last years we even had special AI & Industry sessions. But still we paid no special attention to this in the newsletter. With this new section we wish to fill in this black hole and we hope to see many reports on successful applications in industry from now on. After all, to use a more than 700-year old phrase, 'the proof of the pudding is in the eating'.

But how **do** AI applications in industry fare? Although we as AI-society know how abundant the application areas must be, we still don't hear many success stories. I can see at least three reasons for that.

First, let's put the question whether AI *indeed* has found its way into industry. So, a quick view on the web was in order. In an overview of application of AI in Wikipedia, we find a non-exhaustive, but nevertheless large list of application domains (such as Finance, Medicine, Heavy industry, Transportation, Telecommunications, Toys and games, Music, Aviation), and a large list of applications. Thousands of AI applications are deeply embedded in the infrastructure of every industry. See also, e.g., AAAI's extensive list of AI applications. So, then again, why don't we hear so little from industrial AI success stories?

A second reason might be that AI indeed has found its way into industry, but no longer is recognized as AI. Nick Bostrom, Director of the Future of Humanity Institute at the UK's Oxford University, said in an interview with CNN that AI-inspired systems were already integral to many everyday technologies such as internet search engines, bank software for processing transactions and in medical diagnosis. "We have seen incremental progress in AI but not yet the great breakthroughs that people were predicting 30 or 40 years ago", Bostrom told CNN. "A lot of cutting edge AI has filtered into general applications, often without being called AI because once something becomes useful enough and common enough it's not labelled AI anymore." Bostrom says that traditional "top-down" approaches to AI, in which programmers coded machined to cope with specific situations, should be supplemented by "bottom-up" systems inspired by enhanced understanding of the neural networks of the brain, leading to more subtle forms of AI. In this respect, see also the Ph.D. thesis abstract of Tijn van der Zant (*Generative AI: A neo-cybernetic analysis*), on pp. 95-96 of this issue. Ray Kurzweil believes the development of artificial superintelligence will herald a "singularity", in which human cognitive abilities are enhanced by brain implants (Kurtzweil, 2005, *The singularity is near: when humans transcend biology*, New York: Viking). All in all, results enough and even more potential.

A third reason for the relative silence on industrial AI applications surely is the shyness of companies to reveal their secrets. After all, if a company reveals the methods and techniques used in its most successful applications, competitors on the market will quickly copy them. So, some aloofness is understandable and justified. However, publishing on your successes without too much detail has also the advantage of PR. Moreover, it may lead to a tighter cooperation between researchers and developers.

Concluding, I am sure that there must be many, many applications of AI around, also in Belgium, The Netherlands, and Luxembourg. (I leave the suggestion of our chairman to annex the Principality of Sealand aside.) A first contribution in the new section gives a nice report on Almende's Replicator project (pp. 99-100). Well worth reading! So let me finish this editorial with a "Call for More Reports on AI Applications". Show us your successes (and also failures, which are useful to learn from in order to come up with better solutions)! This also can be done in the form of interviews. Contact our fresh section editor (for address details, see the back cover of this issue), who is eager to receive any information from you in written or oral form.

Wikipedia's AI applications overview: **http://en.wikipedia.org/wiki/Applications_of_artificial_intelligence**
AAAI applications overview: **http://www.aaai.org/aitopics/pmwiki/pmwiki.php/AITopics/Applications**
CNN's interview with Nick Bostrom: **http://www.cnn.com/2006/TECH/science/07/24/ai.bostrom/**
Almende's Replicator project: **http://www.almende.com/research/current-projects/replicator.html**

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The photographs on the front cover and on p. 100 are by courtesy of Almende, Rotterdam.

Front cover: Screenshot of the Live Robot3D simulator software (see pp. 99-100 of this issue).

The deadline for the next issue is: **October 1, 2010**.

BNVKI-Board News

Antal van den Bosch

Quite soon our community will convene at BNAIC-2010 in Luxembourg, our association's most recent member state to add, and unless we also try to annex the Principality of Sealand, the union of the three Benelux countries seems to be just the right coverage of our association to have aimed for. The strong new groups in Luxembourg of course underline the sensibility of the move to be the "Benelux AI Association". The board very much looks forward to the Luxembourg BNAIC.

A hope that is likely to come true is that the BNAICs will see increasing numbers of Master's students at the conference. The association has always fostered and encouraged student initiatives. Board member Annette ten Teije is our liaison with the existing initiatives, such as the Dutch AI students association, the NSVKI, as well as *De Connectie* (http://www.connectie.org/), a student-run AI pop science magazine. Understandably, these organizations have to deal with frequent changes in the people who run them – there is no such concept as the eternal student any more. We try to support them where we can, and we'd like to encourage you to spread the word to students in your direct environment, for instance to take up the role of editorial board member or contributor. It's fun to sometimes do a bit more with AI than just the research you are supposed to do.

BNVKI/AIABN General Assembly

October 26, 2010
Luxembourg, Luxembourg

During the lunch break of the 2nd day of BNAIC 2010 the BNVKI/AIABN general assembly will be held. Provisional time and location are 13:45 hr. at Salle Metz (but check the announcements at the BNAIC site). All BNVKI/AIABN members are cordially invited to attend. The agenda reads:

0. Opening
1. Minutes meeting general assembly October 30, 2009 (see the October 2009 issue of the BNVKI Newsletter, pp. 96-97)
2. Announcements
3. Financial Report 2009
4. Auditing committee 2010
5. Progress report 2010 and plans for 2011
6. Constitution of the Board
7. BNAIC 2011
8. End of meeting

Mathematical Beauty

Henk Visser
Haarlem

(*Math, Log, and Comp have just visited an exposition of mathematical art, and back in the L.E.J. Brouwer Institute they have a new subject for discussion.*)

COMP. I liked the computer art at the exhibition, what is your opinion?

LOG. I was impressed by the beauty of the earlier computer drawings by Csuri. The later ones, in colour, became less and less mathematical, and I didn't appreciate these examples of computer art.

COMP. Is there something like mathematical beauty in computer art? What do you think, Math?

MATH. As always, beauty is in the eye of the beholder. But the real question is whether an artefact can have certain mathematical properties which evoke aesthetic emotions in some observers.

COMP. What kind of artefacts do you mean? I can understand that artefacts that count as mathematical can have such properties. For example, mathematical principles, mathematical procedures, mathematical proofs, mathematical figures, mathematical formulas, mathematical models, mathematical puzzles, and mathematical games.

LOG. Can you mention mathematical games?

COMP. Draughts, chess, poker, billiards ... You can easily amplify my list!

MATH. Billiards is not a mathematical game, simply because it cannot be described in mathematical terms only. There are physical constraints.

LOG. This condition makes it also difficult to speak of mathematical art.

COMP. I accept that. But it does not exclude that a piece of art can have mathematical properties which are considered beautiful by some people, including Log and myself.

MATH. Apparently the question is in general: with which properties of mathematical artefacts does this occur? But I don't think that it is appropriate to try to answer such a general problem. It is better to first inspect special examples of beautiful pieces of

mathematics, and see what we can infer from the results of the inspection.

LOG. Then you must give such examples!

MATH. I can only speak for myself, but who knows, do you also regard my examples beautiful.

COMP. Go on, Math!

MATH. Comp mentioned already various kinds of mathematical artefacts, such as mathematical formulas. Let me give a well-known example, Heron's formula. Given is a triangle *ABC*, with lengths of its sides *a*, *b*, *c*.

If we put (*Math uses the blackboard*):

$$s = \tfrac{1}{2}(a + b + c)$$

then the area of *ABC* is

$$\sqrt{s(s-a)(s-b)(s-c)}$$

COMP. This formula is new to me!

LOG. You belong to the generation which did not learn geometry in the way Math and I did. But what do you think of this formula?

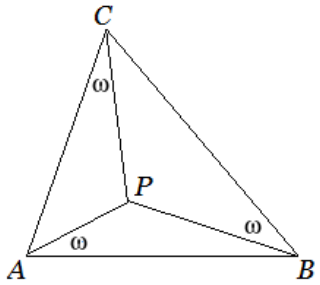
COMP. Very interesting, even beautiful, especially because the formula for *s* is also quite illuminating, certainly if we write it slightly different:

$$\frac{a + b + c}{2}$$

MATH. So what makes it beautiful to you?

COMP. Its simplicity.

MATH. Geometry, as I learned it in my youth, is full of simple formulas. Since Antiquity mathematicians were looking for beautiful theorems, in the hope to get immortality. Look at the following figure:



Brocard proved that there is exactly one point *P* with the property that the three marked angles ω are equal. But this was not all. If the angles of the triangle *ABC* are α, β, and γ, then the following equation applies:

$$\cot \omega = \cot \alpha + \cot \beta + \cot \gamma$$

Since then, the point *P* is called a Brocard point.

COMP. Long live Brocard!

LOG. It seems that geometricians have a preference for formulas of a certain kind. But what do you think of

$$e^{i\pi} + 1 = 0$$

COMP. That is more familiar to me. It is easy to prove it with the help of Euler's formula

$$e^{ix} = \cos x + i \sin x$$

I remember how surprised I was when I solved the problem of differentiating the function

$$\frac{\cos x + i \sin x}{e^{ix}}$$

MATH. There is a story that tells what Richard Feynman wrote in his diary, when he, fourteen years old, saw this formula for the first time: 'the most remarkable formula in math'. Both formulas are remarkable indeed, the former because it brings the most famous mathematical constants, 0, 1, π, e, and *i* together in one short equation. But who finds it therefore beautiful?

LOG. To me, this is a rhetorical question. Simplicity is not a necessary condition for beauty.

MATH. We need more examples. What do you think of the next one:

$$\int_0^\infty \frac{\sin y}{y}\, dy = \frac{\pi}{2}$$

LOG. Many Fresnel integrals have nice properties. Here is another one:

$$\int_0^\infty \frac{\sin y}{\sqrt{y}}\, dy = \sqrt{\frac{\pi}{2}}$$

MATH. I am glad that you also mentioned the variant with the square root sign. We must consider the two integrals together, in order to see that adding a square root sign in the left part, results in adding a

square root in the right part too. I find this a beautiful property of these integrals.

COMP. It seems that you don't find the formula beautiful, but a dynamic property of the formula so to say.

MATH. To take over your way of speaking, a formula alone is too static to me. Another example: once I asked my students to rewrite the following expression as a single product:

$$(ac - bd)^2 + (bc + ad)^2$$

Not all of them solved this problem, but even the students who failed, found the solution beautiful:

$$(a^2 + b^2)(c^2 + d^2)$$

LOG. Apparently they had not expected this outcome.

COMP. I assume that the outcome was also a surprise for the students who solved the problem. Its simplicity and perspicuity is perhaps not enough for an aesthetical reaction. Suppose, namely, that you would have given the following exercise:

Prove: $(ac - bd)^2 + (bc + ad)^2 = (a^2 + b^2)(c^2 + d^2)$

Then this easy problem would not evoke aesthetical feelings, I think. The same holds, if this formula is presented as a theorem. Moreover the left part of the equation is not very attractive.

MATH. This can be remedied:

$$(ab + cd)^2 - (bc + da)^2 = (a^2 - c^2)(b^2 - d^2)$$

COMP. That is better! You see, I like formulas with a perspicuous structure. Now there is a cyclical progress in the left part of the equation.

MATH. We see that perspicuous structures are not given, but must be made by the mathematicians themselves.

LOG. Do you think that results are passed over, when no perspicuous representation can be found?

MATH. That is too strong, but it is clear that all those simple notations, think of gamma and beta functions, are invented in order to get surveyable theorems.

COMP. I am sorry, but I have never heard of such functions.

MATH. I can easily give you the definitions, they are not all to complicated for mathematicians who often work with them. The following equation may suffice to illustrate my point:

$$\mathrm{B}(x,y) = \frac{\Gamma(x)\,\Gamma(y)}{\Gamma(x+y)}$$

LOG. It also happens that one gets an unexpected result. In that case it comes as a surprise. I assume that the mathematician who found the theorem $e^{i\pi} + 1 = 0$ was delighted!

MATH. The same holds for practically all mathematics students, when they see this formula for the first time, I think.

COMP. I already told you about my experience with the derivation of the formula via the differentiation of a function which appeared to be constant.

LOG. You used the word 'process' in a formula. This reminds me of Pascal's triangle in which there is also a progress, this time in the way the triangle is built.

COMP. I know, it works with sums of two adjacent numbers:

1
1 2 1
1 3 3 1
1 4 6 4 1

MATH. Do you also know the triangle with which we can compute the subsequent possible ways in which a number of so-called alternatives can be ordered by an irreflexive and transitive preference relation and a transitive indifference relation of strict weak orderings?

COMP. Can you first give examples?

MATH. Yes, suppose we have two alternatives *a* and *b*, then we can prefer *a* above *b*, or *b* above *a*, or we can be indifferent about *a* and *b*, in notation:

(*ab*); *ab*, *ba*

You see, there are three possibilities.

With three alternatives *a*, *b*, and *c*, there are thirteen possibilities:

(*abc*); *c*(*ab*), (*ab*)*c*, *b*(*ac*), (*ac*)*b*, *a*(*bc*), (*bc*)*a*; *abc*, *acb*, *bac*, *bca*, *cab*, *cba*

It takes some time, but with four alternatives we find seventy-five possibilities. Now we put 1 at the

top of the triangle, and multiply it first by 1 and then by 2, so as to get the second row, consisting of 1 and 2, together three. Then we multiply the 1 by 1, the sum of the 1 and the 2 by 2, and finally the 2 by 3. This results in the third row, consisting of 1, 6, and 6, together thirteen. Similarly, with the factors 1, 2, 3, and 4, we get the fourth row, consisting of 1, 14, 36, and 24, together seventy-five.

1
1.1 2.1
1 2
1.1 2.(1 + 2) 3.2
1 6 6
1.1 2.(1 + 6) 3.(6 + 6) 4.6
1 14 36 24

1
1 2
1 6 6
1 14 36 24

COMP. Let me compute the next number of possibilities:

1 14 36 24
1 30 150 240 120

1, 30, 150, 240, 120 make together 541.

LOG. The triangle does not struck me as very special, but the procedure is perspicuous, and, in a sense even beautiful. Am I right when I suppose that your proof follows the construction? Is it also beautiful?

MATH. The proof leads to the construction, but I hesitate calling it beautiful. Perhaps we can discuss the question of beautiful proofs later on?

(*The dean of the department, a professor in applied mathematics, enters the room.)*

MATH. Good afternoon App, what brings you here?

APP. Nothing special. I was interested in your activities. Sometimes I have the impression that you are engaged in psychological if not philosophical discussions.

MATH. That is not wholly beside the truth. Today, we are talking about mathematical beauty, and we try to find examples in order to get more grip on it. Do you have favourite examples?

APP. I am almost ashamed of saying it, but I am still astonished of the beauty of Pythagoras' theorem. It is amazing that this extremely simple theorem has so many applications. Moreover I think also of surprising proofs, to begin with Euclid's own one.

MATH. We discussed this proof when we dealt with redescriptions, although not in connection with its possible beauty. But talking about the abundant amount of applications of the Pythagorean theorem, I have a new one that was unexpected to me, and I cannot help that I find it beautiful. Undoubtedly Log and Comp remember my preoccupation with triangular numbers. My new example is the problem of finding two triangular numbers which have again a triangular number as their sum. A few days ago I felt dull, and therefore I made by head a list of the first twenty triangular numbers, in order to make a list of such lucky pairs. Let me write them down:

1, 3, 6, 10, 15,
21, 28, 36, 45, 55,
66, 78, 91, 105, 120,
136, 153, 171, 190, 210

COMP. And you noticed immediately that 6 + 15 = 21, in other words that t(3) + t(5) = t(6), I suppose.

MATH. Yes, this is a solution beginning with t(3), and I called (3, 5, 6) an 'Orphic triple', named after the Orphics, who formed a bond of a kind with the Pythagoreans. Theodor Gomperz once called Orphism and Pythagorism *die weibliche und männliche Verkörperung derselben Grundrichtung*, the female and male embodiment of the same fundamental school. Isn't that beautiful?

I went further with t(4), giving 10 + 45 = 55, and I made a list:

(3, 5, 6) ε O my new notation for t(4) + t(9) = t(10)
(4, 9, 10) ε O
(5, 6, 8) ε O
(6, 9, 11) ε O
(8, 10, 13) ε O
(9, 13, 16) ε O
(11, 14, 18) ε O

Do you also see what I found? Let me slightly rearrange the list:

(3, 5, 6) ε O
(4, 9, 10) ε O
(5, 6, 8) ε O
(6, 9, 11) ε O
(8, 10, 13) ε O
(9, 13, 16) ε O
(11, 14, 18) ε O

LOG. The Orphic triples in one and the same column increase with 3, 4, and 5. Does this have something to do with Pythagoras?

MATH. You are right! (3, 4, 5) is a Pythagorean triple:

(3, 4, 5) ε P my new notation for $3^2 + 4^2 = 5^2$

COMP. What about the lonely Orphic triple (4, 9, 10)?

MATH. Do you remember the Pythagorean triple with whole numbers that comes after (3, 4, 5)?

COMP. My geometrical knowledge is deficient, but I can still answer your question. It is (5, 12, 13).

MATH. Excellent! So I can amplify my list:

(3, 5, 6) ε O
(4, 9, 10) ε O
(5, 6, 8) ε O
(6, 9, 11) ε O
(8, 10, 13) ε O
(9, 13, 16) ε O
(9, 21, 23) ε O
(11, 14, 18) ε O
(12, 17, 21) ε O
(14, 18, 23) ε O
(14, 33, 36) ε O

LOG. I assume that this is correct. Is there also a list with the Pythagorean triple (8, 15, 17)?

MATH. Indeed:

(3, 5, 6) ε O
(11, 20, 23) ε O
(19, 35, 40) ε O
(27, 50, 57) ε O

COMP. It is easy to see that (11, 20, 23) and (19, 35, 40) are Orphic triples, 66 plus 210 is 12 times 23, namely 276, and 190 plus 630 is 820, but I must use my calculator to check if (27, 40, 57) is also an Orphic triple.

LOG. Wait (*She takes pencil and paper*) … I got twice the outcome 1653. It's OK. How do you find such solutions? Can you demonstrate it for the Pythagorean triple (7, 24, 25)?

MATH. I look at Orphic triples of the form (m, n, n + 1). Because t(n + 1) – t(n) = n + 1, I consider numbers m such that t(m) = n + 1, to begin with t(5) = 15. This gives

(5, 14, 15) ε O
(7, 24, 25) ε P
(12, 38, 40) ∉ O, because t(40) – t(38) = 40 + 39, and t(12) = 78.

Therefore I try t(6) = 21. This gives

(6, 20, 21) ε O
(7, 24, 25) ε P
(13, 44, 46) ε O, because t(46) – t(44) = 46 + 45, and t(13) = 91.

Now we can immediately calculate the next Orphic triple. We only need to expand (13, 44, 46) by (7, 24, 25):

(20, 68, 71) ε O

COMP. That is correct; t(20) = 210, and t(71) – t(68) = 71 + 70 + 69, and that is the same as 210.

LOG. No doubt there is a general theorem. Let me try:

if
(p, q, r) ε O and (a, b, c) ε P
implies
(p + a, q + b, r + c) ε O
then
(p + na, q + nb, r + nc) ε O

COMP. Can you say it in words?

MATH. If an Orphic triple can be expanded by a Pythagorean triple so that the result is again an Orphic triple, then this expansion can always be repeated with Orphic triples as the outcomes.

COMP. This sounds as if the proof is a question of mathematical induction.

MATH. Of course. You can give it to your students as an exercise. I give a hint:

Lemma

if
(p, q, r) ε O and (a, b, c) ε P
implies
(p + a, q + b, r + c) ε O
then
$(2p + 1)a + (2q + 1)b = (2q + 1)c$

APP. An interesting equation, certainly when you rewrite it as

$$((2p + 1)a, (2q + 1)b, (2q + 1)c) \in A$$

I like such simple relationships, and verifications which are not immediately obvious give me always a very good feeling.

LOG. What?

APP. Take Math's example of (3, 5, 6) ε O, (3, 4, 5) ε P, and (6, 9, 11) ε O. According to the formula, (6 + 1)3 + (10 + 1)4 must be (12 + 1)5, that is 65, and 21 + 44 = 65 indeed. Of course I didn't expect it otherwise, but nevertheless …

LOG. You mean, it comes still as a surprise. It seems to me that Math's general theorem, how elementary as it is, is again beautiful because of its surprise character. And I can now understand why mathematicians find so much beauty in results as Desargues' theorem, and Pascal's theorem, cumulating in the conclusion that certain points lie on one and the same line. This can be easily made perspicuous by a concrete figure on a piece of paper or on the blackboard.

MATH. A well-known interpretation of the word 'concrete' is: 'being in time and space', and this brings me to Comp's remark about a possible dynamical character. In these geometrical theorems, the surprising conclusion comes after a process of drawing points and lines, and in the beginning there is no indication of the direction in which it will go.

COMP. *Mutatis mutandis,* Math's exposition of his elementary theorem about Orphic triples has the same property. Who expected that Pythagorean triples would play an essential role in the development of Orphic triples?

LOG. Following the course of a proof or a derivation takes always time. The theorem itself does not contain any reference to temporal properties. But take Pascal's theorem for a conic section. I agree that the exposition of this theorem has a dynamical character. In order to explain what this theorem implies, one has first to draw attention to the six points on the conic section, and then to show how the three intersection points have arisen, and finally to pronounce that these points lie on one and the same line. In any interesting if-then theorem the consequence does not immediately follow from the antecedent, and therefore it can remain remarkable, when the antecedent has been exposed, and the consequence is formulated or is made perspicuous by means of a concrete picture.

MATH. An analogous story can be told for equations.

APP. So my $a^2 + b^2 = c^2$ was not that bad?

MATH. Can you work it out?

APP. When I first saw the proof of Pythagoras' theorem with the help of the complex plane by two applications of Euler's formula,

$$a + b\mathrm{i} = c\mathrm{e}^{\mathrm{i}\varphi}$$
$$a - b\mathrm{i} = c\mathrm{e}^{-i\varphi}$$

I was a bit angry with myself why I had never thought of factorizing $a^2 + b^2$ into $(a + b\mathrm{i})(a - b\mathrm{i})$:

$$a^2 + b^2 = (a + b\mathrm{i})(a - b\mathrm{i})$$

But I also admired the coherence of different mathematical sectors.

LOG. Don't presuppose the polar coordinates in the complex plane Pythagoras' theorem?

MATH. That is not necessary, but presupposed is the theory of similarity of triangles. It is the same with the well-known proof in which the perpendicular from C divides the right triangle ABC in two similar triangles to ABC. But App rightly emphasizes the coherence of mathematical theories.

COMP. It is remarkable that you brought Euler to the fore, App, whereas you was not yet present when we discussed the beauty of his formula.

APP. If there is any notion that dominates my work, then is it Euler's constant. We work always with exponential functions. And of course, I learned Euler's formula as a student.

MATH. I know. But is there any beauty in the formulas you work with? Even the formula of a simple function such as

$$f(x) = \frac{e^{-x^2/2}}{\sqrt{2\pi}}$$

does not satisfy my conditions for beauty. Applications of mathematics did no good to aesthetics, so to speak. Time has gone that text books and collections of exercises contained almost exclusively beautiful outcomes.

APP. Which books do you mean?

MATH. For example, Hardy's *Course of Pure Mathematics*, but also earlier works such as the *Sammlung der Aufgaben des Aufgaben-Repertoriums* from 1898. The latter book is especially interesting for the examples of analogies between algebraic and goniometric equations:

$$(a + b)(a - b) = a^2 - b^2$$
$$\sin(\alpha + \beta)\sin(\alpha - \beta) = \sin^2\alpha - \sin^2\beta$$

$$a(b - c) + b(c - a) + c(a - b) = 0$$
$$\sin\alpha\sin(\beta - \gamma) + \sin\beta\sin(\gamma - \alpha) + \sin\gamma\sin(\alpha - \beta) = 0$$

APP. These equations are new to me. I agree that it is important to give such formulas as proof exercises in order to stimulate mathematically gifted students.

MATH. I think that would be good for all students. It is clear that there are already beautiful formulas on a very elementary level.

LOG. Would it not be better to collect examples of beautiful ànd ugly formulas and proofs in order to get more grip on the rather vague conditions?

MATH. Isn't that a waste of time? We are naive mathematicians, not philosophers. It was nice discussing mathematical beauty, but we can do better and doing real mathematics.

APP. The doing itself is beautiful!

MATH. Just one last remark. I wondered if my example with the Orphic and Pythagorean triples could be generalized, or at least, extended. Suppose that I define Babylonian numbers as follows:

$$b(n) = n(n + 1)(n + 2) : 6$$

in order to get the sequence 1, 4, 10, 20, 35, 56, …, and

$$(x, y, z, t) \in B \;:=\; b(x) + b(y) + b(z) = b(t)$$

For example, $(1, 4, 5, 6) \in B$, because $1 + 20 + 35 = 56$.

Now I use the following definition of cubic quadruples

$$(x, y, z, t) \in C := x^3 + y^3 + z^3 = t^3$$

Perhaps you are familiar with this example:

$$(3, 4, 5, 6) \in C$$

COMP. Of course, this is Ramanujan's equation:

$$3^3 + 4^3 + 5^3 = 6^3$$

MATH. Here are some more:

$$(1, 6, 8, 9) \in C$$
$$(3, 10, 18, 19) \in C$$
$$(7, 14, 17, 20) \in C$$
$$(2, 17, 40, 41) \in C$$

LOG. I understand where you were going up to. You imagined that there is a theorem that says

if
$$(p, q, r, s) \in B \text{ and } (a, b, c, d) \in C$$
implies
$$(p + a, q + b, r + c, s + d) \in B$$
then
$$(p + na, q + nb, r + nc, s + nd) \in B$$

MATH. Yes, and I think that the very idea is beautiful! It illustrates my point that mathematicians can also be guided by beautiful ideas, although their dreams do not always come true. In this case the conditions are not sufficient. We have to add one more condition:

$$(p + 1)a^2 + (q + 1)b^2 + (r + 1)c^2 = (s + 1)d^2$$

COMP. Ah! A formula with a perspicuous structure!

APP. All well and good, but now we have already four conditions. Is there any chance that they can be simultaneously fulfilled? If not, then it is an illusion, and an example that you pure mathematicians live sometimes too much in the clouds with your dreams.

COMP. Then it is my task to bring them down to earth! A good deal of work on hand! I will let you know what the outcome is. See you later!

(*Hereby the discussion ends. Math, Log, Comp, and App retake their normal activities.*)

After some time, Math received the following e-mail message from Comp:

Hallo Math,

I tested all smaller solutions of *a*, *b*, *c*, and *d*, given by Wolfram, to wit:

[3,4,5,6], [1,6,8,9], [3,10,18,19],
[7,14,17,20], [4,17,22,25], [18,19,21,28],
[11,15,27,29], [2,17,40,41], [6,32,33,41],
[16,23,41,44], [3,36,37,46], [27,30,37,46],
[29,34,44,53], [12,19,53,54], [15,42,49,58],
[22,51,54,67], [36,38,61,69], [7,54,57,70],
[14,23,70,71], [34,39,65,72], [38,43,66,75],
[31,33,72,76].

Unfortunately, I didn't find any solution for *p*, *q*, *r*, and *s*, up to 1000. Maybe there is one for higher values, but that becomes too complicated.

With best wishes,

Comp.

BeNeLearn 2010

Jan Ramon, Celine Vens, Kurt Driessens, Martijn van Otterlo, and Joaquin Vanschoren
K.U.Leuven

INTRODUCTION

On May 27th-28th, the BeNeLearn 2010 conference was organized in Leuven, Belgium. BeNeLearn is the yearly event bringing together researchers in the field of machine learning from The Netherlands and Belgium.

This edition featured three invited speakers, a special session on teaching machine learning and contributed talks. In this way, it served as a forum for young machine-learning researchers to present their work, but also as an event where exciting topics, of interest to many groups, were introduced and discussed in more depth. The conference was attended by 39 participants.

INVITED TALKS

The conference program included three invited talks by renowned researchers in the field.

First, on Thursday morning Ross King (University of Wales, Aberystwyth, UK) presented his work and vision on automating biology using robot scientists. He supported his message with a report on the successes of the robot Adam which was used to automatically discover metabolic pathways and the setup of the robot Eve which is currently used in a high-throughput drug-discovery experiment targeting malaria.

On Friday morning, Francis Bach (Ecole Normale Supérieure, Paris, FR) gave a talk titled *Sparse Hierarchical Dictionary Learning*. Dictionary learning has many applications, most notably in computer vision and in image recognition. Discovered image patches can be stored in a dictionary, and sparsity can be used to make a hierarchy in the dictionary. This makes that even noisy data can be handled more easily, and the speaker showed impressive visual examples of the success of the approach.

The presentation of Saso Dzeroski (Josef-Stefan Institute, Ljubljana, Slovenia) concerned equation discovery for ecology and systems biology. State-of-the-art techniques were explained for discovering differential equations from measured data, and these were illustrated with a number of real-world applications.

TEACHING MACHINE LEARNING

Kurt Driessens chaired a session on teaching machine learning. Many of the participants of BeNeLearn are involved in teaching and are thinking on how to best improve this education. As machine learning is often in the master programmes, there is a strong interaction with the research in this area.

The session was quite successful and featured talks from different points of view. The contributions of Hendrik Blockeel and Maarten van Someren outlined the philosophy and implementation of their machine-learning courses. Arno Knobbe presented an example of how fielded applications can make machine-learning education more interesting and concrete. Kris Coolsaet presented a combination of machine learning and teaching from another point of view. Grinvin, the system his group developed, learns invariants from sets of graphs. It is used in a mathematics course to provide motivating and interesting conjectures for the students who need to learn reasoning techniques and try to prove the generated conjectures.

CONTRIBUTIONS

This year, the BeNeLearn call for papers was announced at several international mailing lists, which resulted in a large proportion (45%) of submissions from research teams outside the Benelux. Among the accepted contributions was a paper from the Riga Technical University, Latvia, and a joint paper from the University of Sunderland, UK, and the University of Hamburg, Germany.

The contributed talks were grouped in four sessions: ‘optimization’, ‘games’, ‘classification’, and ‘selected topics’, each featuring 2 to 4 talks. In order to stimulate interaction, sufficient time was provided for questions and discussion and the session chairs raised critical questions and suggestions. Abstracts and full-text PDF files are available on the conference website at http://dtai.cs.kuleuven.be/events/Benelearn2010/index.php?topic=program.

CONCLUSIONS

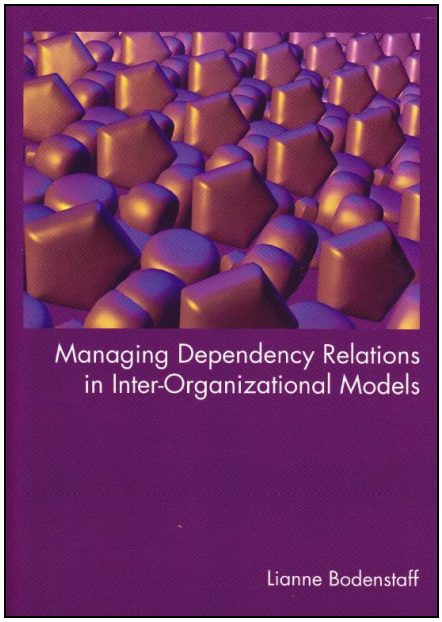
We believe that this edition was successful in offering several very interesting presentations and that the registration costs of the conference have been kept very limited (thanks to the support of a.o. FWO, SIKS, BNVKI and KULeuven). We believe also the effort to stimulate discussion was appreciated by the participants.

PH.D. THESIS ABSTRACTS

Managing Dependency Relations in Inter-Organizational Models

Ph.D. thesis abstract
Lianne Bodenstaff

Promotor: Prof.dr. R.J. Wieringa
Copromotor: Prof.dr. M.U. Reichert
Date of defense: June 17, 2010



In various fields like software development, information-systems development, and e-business development, model-based approaches allow specifying different models of which each emphasizes one specific aspect or part of the software system. In this thesis we consider particularly model-based approaches for defining inter-organizational cooperations. These cooperations are usually complex in terms of coordination, agreements, and value creation for involved partners.

At design time one should ensure that the different models are consistent with each other, i.e., that they describe the same system. At runtime we additionally have to deal with the fact that behavior of the software system might be different from that agreed upon. Such deviant behavior can, for example, be caused by partners in the cooperation that do not behave according to the agreement. Therefore, the challenges are to ensure consistency at design time as well as to monitor the system at runtime in order to detect inconsistencies with the models it relies on.

When managing complex cooperations, it is also vital to maintain the models describing them to keep an overview on the successfulness of the cooperation. Changing one model to regain consistency with the running system might result in new inconsistencies between the different models. As a consequence, this maintenance phase of the models is time consuming and grows in complexity with increasing number of models describing the system.

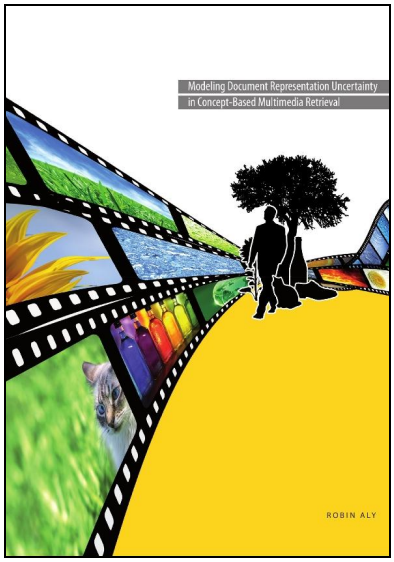
This thesis proposes a method that supports ensuring and maintaining consistency between running system and underlying models for inter-organizational cooperations. We provide a structured and model-independent approach to check and maintain consistency. Thereby, we focus on identifying and maintaining these inter-model relations.

We validate our method by conducting two case studies in two different fields of research. The first scenario deals with business and coordination models, while the second one addresses Web-service compositions. Furthermore, we provide a prototypical implementation as proof-of-concept evaluation of both scenarios. We conclude with an empirical validation of the Web-service composition scenario by an extensive and interactive survey conducted among 34 participants. This survey confirms the suitability of our proposed management solution provided for real-life use.

Modeling Document Representation Uncertainty in Concept-Based Multimedia Retrieval

Ph.D. thesis abstract
Robin Aly

Promotores: Prof.dr. P.G.M. Apers, Prof.dr. F.M.G. de Jong
Copromotor:dr.ir. D.M. Hiemstra
Date of defense: July 2, 2010



This thesis considers concept-based multimedia retrieval, where documents are represented by the occurrence of concepts (also referred to as semantic concepts or high-level features). A concept can be thought of as a kind of label, which is attached to (parts of) the multimedia documents in which it occurs. Since concept-based document representations are user, language and modality independent, using them for retrieval has great potential for improving search performance. As collections quickly grow both in volume and size, manually labeling concept occurrences becomes infeasible and the so-called concept detectors are used to decide upon the occurrence of concepts in the documents automatically.

The following fundamental problems in concept-based retrieval are identified and addressed in this thesis. First, the concept detectors frequently make mistakes while detecting concepts. Second, it is difficult for users to formulate their queries since they are unfamiliar with the concept vocabulary, and setting weights for each concept requires knowledge of the collection. Third, for supporting retrieval of longer video segments, single concept occurrences are not sufficient to differentiate relevant from non-relevant documents and some notion of the importance of a concept in a segment is needed. Finally, since current detection techniques lack performance, it is important to be able to predict what search performance retrieval engines yield, if the detection performance improves.

The main contribution of this thesis is the uncertain document-representation ranking framework (URR). Based on the Nobel-prize-winning Portfolio Selection Theory, the URR framework considers the distribution over all possible concept-based document representations of a document given the observed confidence scores of concept detectors. For a given score function, documents are ranked by the expected score plus an additional term of the variance of the score, which represents the risk attitude of the system.

User-friendly concept selection is achieved by re-using an annotated development collection. Each video shot of the development collection is transformed into a textual description which yields a collection of textual descriptions. This collection is then searched for a textual query which does not require the user's knowledge of the concept vocabulary. The ranking of the textual descriptions and the knowledge of the concept occurrences in the development collection allows a selection of useful concepts together with their weights.

The URR framework and the proposed concept-selection method are used to derive a shot and a video-segment retrieval framework. For shot retrieval, the probabilistic ranking framework for unobservable events is proposed. The framework re-uses the well-known probability of relevance score function from text retrieval. Because of the representation uncertainty, documents are ranked by their expected retrieval score given the confidence scores from the concept detectors.

For video-segment retrieval, the uncertain concept-language model is proposed for retrieving news items – a particular video-segment type. A news item is modeled as a series of shots and represented by the frequency of each selected concept. Using the parallel between concept frequencies and term frequencies, a concept-language model score function is derived from the language-modelling framework. The concept-language model score function is then used according to the URR framework and documents are ranked by the expected concept-language score plus an additional term of the score's variance.

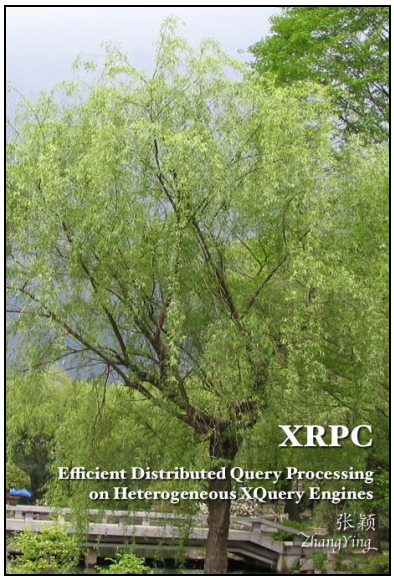
The Monte-Carlo Simulation method is used to predict the behavior of current retrieval models under improved concept-detector performance. First, a probabilistic model of concept-detector output is defined as two Gaussian distributions, one for the shots in which the concept occurs and one for the shots in which it does not. Randomly generating concept detector scores for a collection with known concept occurrences and executing a search on the generated output estimates the expected search performance given the model's parameters. By modifying the model parameters, the detector performance can be improved and the future search performance can be predicted.

Experiments on several collections of the TRECVid evaluation benchmark showed that the URR framework often significantly improves the search performance compared to several state-of-the-art baselines. The simulation of concept detectors yields that today's video-shot retrieval models will show an acceptable performance, once the detector performance is around 0.60 mean average precision. The simulation of video-segment retrieval suggests, that this task is easier and will sooner be applicable to real-life applications.

XRPC – Efficient Distributed Query Processing on Heterogeneous XQuery Engines

Ph.D. thesis abstract
Ying Zhang

Promotor: Prof.dr. M.L. Kersten
Copromotor: Dr. P. Boncz
Date of defense: July 8, 2010



While P2P applications that provide trivial keywords search and file-sharing features (such as Kazaa, eDonkey) have gained enormous popularity in a short time, the development of P2P applications that provide complex distributed data management and querying facilities advances only slowly. This is because the development of such applications is still a highly cumbersome task, as applications have to deal with information from different data sources. In P2P settings this set of data sources is extremely dynamic and has an enormously large scale, thus foreseeing all possible combinations of available data sources is impractical. This puts a high adaptivity burden on the shoulders of the application programmers.

To ease the development of data-intensive P2P applications, we envision a P2P XDBMS that acts as a database middle-ware system. It manages dynamic collections of heterogeneous XML data sources (i.e., peers with different software installed) and provides a uniform database abstraction to the application. The ultimate goal is to research which features such a database abstraction should offer, and how it can be realized efficiently by extending and combining existing XDBMS systems with P2P technologies.

In our quest for creating P2P XDBMS technology, we first focus on Distributed XDBMS technology, as this area also was unexplored, with an extra requirement that the to be developed technology will serve as a building block for P2P XDBMS technology. The distinction between Distributed and P2P technology is that in the former, users (i.e., application programmers) are aware of on which sites (i.e., peers) data are located. Distributed queries typically involve specific and explicit locations where data are to be queried from. In P2P systems that mainly target large environments where users cannot keep track which data is on which peer and where the group membership is highly volatile (peers enter and leave continuously and unpredictably), users are typically shielded from explicit knowledge where data is located.

In this thesis we have looked into different aspects of Distributed XDBMS including query execution, query optimisation and transaction management. The result of this work is XRPC, a minimal but orthogonal XQuery extension that enables efficient distributed querying of heterogeneous XQuery data sources. XRPC allows any XQuery expressions including the XQUF expressions to be included in a function body and executed on an arbitrary number of (remote) peers using an RPC mechanism. The main design and implementation criteria of XRPC are imposed by the targeted P2P environments: interoperability, efficiency and scalability.

First, the thesis gives a formal definition of the syntax and the semantics of XRPC including the semantics of distributed updates that follow from the use of XQUF updating functions over XRPC. This includes the definitions of two isolation levels for read-only and updating XRPC queries. The experiences in MonetDB/XQuery suggest that adding XRPC to existing XDBMS is easy, as shredding, serialisation and HTTP functionality are usually already present. The work is limited to a small parser extension and stub-code generation. Since interoperability is a major goal, XRPC also comprises a SOAP-based network-communication

protocol SOAP XRPC. Such a SOAP protocol has the additional advantage of seamless integration with web services and AJAX-based GUIs. The SOAP XRPC protocol supports the concept of Bulk RPC, i.e., the execution of multiple function calls can be handled in a single message exchange. This amortises network and parsing latencies and can make XRPC a quite efficient communication mechanism. This thesis shows that the loop-lifting technique, which is pervasively applied in the MonetDB/XQuery system for the translation of XQuery expressions to relational algebra, can easily generate such Bulk RPC requests.

Then, the thesis discusses various aspects of using XRPC in distributed XQuery processing in Chapter 4. First, it shows that XRPC can be easily adopted by different XQuery engines, such that complex P2P communication patterns can be programmed using XRPC. To enhance adoption of XRPC, an XRPC Wrapper is described that allows any XQuery data source to handle XRPC calls. The experiments on Saxon show that Bulk RPC enables set-oriented optimisations, such that Bulk RPC execution of a selection function can be handled using a join strategy. To better match the transaction semantics in databases, a deterministic update semantics for XQUF queries is defined and the SOAP XRPC protocol is extended to guarantee a deterministic order in distributed update scenarios. Atomic distributed commit is supported by using a SOAP-based 2PC protocol defined by the industry standard Web Services Atomic Transaction.

Decomposing queries to address multiple data sources is a well-studied optimisation technique in relational, object-oriented and semi-structured databases. While many of the existing techniques can be carried over, the XML data model and the XQuery language introduce a number of particular challenges not met elsewhere that revolve around XML node identities and structural (rather than value-based) relationships between nodes. In Chapter 5, the thesis elaborates a framework for distributed execution of full-fledged XQuery (i.e., including XQUF), focusing on the issue of providing deep-equal query decompositions, in the face of semantic differences when (parts of) nodes are shipped across the network in XML messages. The thesis proposes a series of decomposition techniques such as pass-by-projection and the use of a novel runtime XML projection method for serialising XML messages, that remove virtually all semantic problems and strongly improve performance. The thesis also defines the semantics of updating both local and remote documents using XQUF expressions and additional constraints that should be added to the proposed techniques to guarantee semantic equivalence for such queries. The correctness of all proposed algorithms is formally proven in Chapter 6.

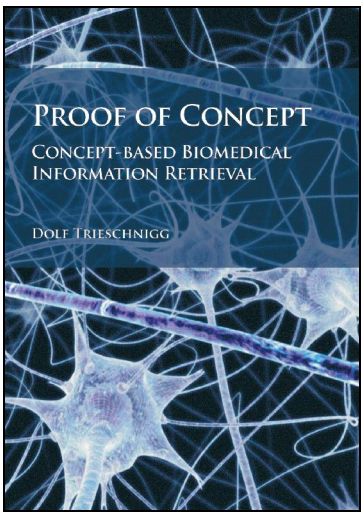
In this thesis we have also taken a first step towards creating powerful P2P XDBMS technology that preserves the full XQuery language (+XQUF) by extending it only with a single new construct, i.e., XRPC. The thesis proposes MonetDB/XQuery* in which DHTs can be integrated with XDBMS by adding support for a new “dht://” protocol in URIs. Thus no further XQuery extensions are required. The thesis discusses the semantics of two ways of coupling (loose and tight) a DHT with an XDBMS, of which the latter is more complex but powerful.

The XRPC remote function-execution mechanism and the ideas of MonetDB/XQuery* are applied in a P2P Information Retrieval application called StreetTiVo. StreetTiVo enables near real-time search in video contents by distributed and parallel execution of compute-intensive video-analysis tasks on multiple peers. Our work on the StreetTiVo application confirms the assumption that a P2P middle-ware DBMS could ease the development of data-intensive P2P applications. With XRPC the rather complex functionalities of StreetTiVo were quickly implemented using just a handful of XQuery functions which in turn are executed on the participating machines.

Proof of Concept: Concept-based Biomedical Information Retrieval

Ph.D. thesis abstract
Dolf Trieschnigg

Promotores: Prof.dr. F.M.G. de Jong, Prof.dr.ir. W. Kraaij
Date of defense: September 1, 2010



In this thesis we investigate the possibility to integrate domain-specific knowledge into biomedical information retrieval (IR). Recent decades have shown a fast growing interest in biomedical research, reflected by an exponential growth in scientific literature. Biomedical IR is concerned with the disclosure of these vast amounts of written knowledge. Biomedical IR is not only important for end-users, such as biologists, biochemists, and bioinformaticians searching directly for relevant literature but also plays an important role in more sophisticated knowledge discovery. An important problem for biomedical IR is dealing with the complex and inconsistent terminology encountered in biomedical publications.

Multiple synonymous terms can be used for single biomedical concepts, such as genes and diseases. Conversely, single terms can be ambiguous, and may refer to multiple concepts. Dealing with the terminology problem requires domain knowledge stored in terminological resources: controlled indexing vocabularies and thesauri. The integration of this knowledge in modern word-based information retrieval is, however, far from trivial. This thesis investigates the problem of handling biomedical terminology based on three research themes.

The first research theme deals with robust word-based retrieval. Effective retrieval models commonly use a word-based representation for retrieval. As so many spelling variations are present in biomedical text, the way in which these word-based representations are obtained affect retrieval effectiveness. We investigated the effect of choices in document-preprocessing heuristics on retrieval effectiveness. This investigation included stop-word removal, stemming, different approaches to breakpoint identification and normalisation, and character n-gramming. In particular breakpoint identification and normalisation (that is determining word parts in biomedical compounds) showed a strong effect on retrieval performance. A combination of effective preprocessing heuristics was identified and used to obtain word-based representations from text for the remainder of this thesis.

The second research theme deals with concept-based retrieval. We investigated two representation vocabularies for concept-based indexing, one based on the Medical Subject Headings thesaurus, the other based on the Unified Medical Language System metathesaurus extended with a number of gene and protein dictionaries. We investigated the following five topics.

1. How documents are represented in a concept-based representation.
2. To what extent such a document representation can be obtained automatically.
3. To what extent a text-based query can be automatically mapped onto a concept-based representation and how this affects retrieval performance.
4. To what extent a concept-based representation is effective in representing information needs.
5. How the relationship between text and concepts can be used to determine the relatedness of concepts.

We compared different classification systems to obtain concept-based document and query representations automatically. We proposed two classification methods based on statistical language models, one based on K-Nearest Neighbours (KNN) and one based on Concept Language Models (CLM).

For a selection of classification systems we carried out a document-classification experiment in which we investigated to what extent automatic classification could reproduce manual classification. The proposed KNN system performed well in comparison to the out-of-the-box systems. Manual analysis indicated the improved exhaustiveness of automatic classification over manual classification. Retrieval based on only concepts was demonstrated to be significantly less effective than word-based retrieval. This deteriorated performance could be explained by errors in the classification process, limitations of the concept vocabularies and limited exhaustiveness of the concept-based document representations. Retrieval based on a combination of word-based and automatically obtained concept-based query representations did significantly improve word-only retrieval. In an artificial setting, we compared the optimal retrieval performance which could be obtained with word-based and concept-based representations. Contrary to our intuition, on average a single word-based query performed better than a single concept-based representation, even when the best concept term precisely represented part of the information need.

We investigated to what extent the relatedness between pairs of concepts as indicated by human judgements could be automatically reproduced. Results on a small test set indicated that a method based on comparing concept-language models performed particularly well in comparison to systems based on taxonomy structure, information content and (document) association.

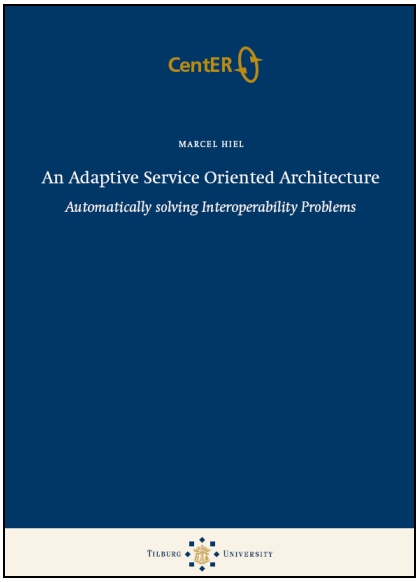
In the third and last research theme of this thesis we propose a framework for concept-based retrieval. We approached the integration of domain knowledge in monolingual information retrieval as a cross-lingual information-retrieval (CLIR) problem. Two languages were identified in this monolingual setting: a word-based representation language based on free text, and a concept-based representation language based on a terminological resource. Similar to what is common in traditional CLIR, queries and documents are translated into the same representation language and matched. The cross-lingual perspective gives us the opportunity to adopt a large set of established CLIR methods and techniques for this domain. In analogy to established CLIR practise, we investigated translation models based on a parallel corpus containing documents in multiple representations and translation models based on a thesaurus. Surprisingly, even the integration of very basic translation models showed improvements in retrieval effectiveness over word-only retrieval. A translation model based on pseudo-feedback translation was shown to perform particularly well. We proposed three extensions to a basic cross-lingual retrieval model which, similar to previous approaches in established CLIR, improved retrieval effectiveness by combining multiple translation models. Experimental results indicate that, even when using very basic translation models, monolingual biomedical IR can benefit from a cross-lingual approach to integrate domain knowledge.

Directions for future work are using these concepts for communication between user and retrieval system, extending upon the translation models and extending CLIR-enhanced concept-based retrieval outside the biomedical domain.

An Adaptive Service Oriented Architecture: Automatically solving Interoperability Problems

Ph.D. thesis abstract
Marcel Hiel

Promotor: Prof.dr. W.J.A.M. van den Heuvel
Copromotor: dr. H. Weigand
Date of defense: September 7, 2010



Organizations desire to be able to easily cooperate with other companies and still be flexible. The IT infrastructure used by these companies should facilitate these wishes. Service-Oriented Architecture (SOA) and Autonomic Computing (AC) were introduced in order to realize such an infrastructure, however both have their shortcomings and do not fulfill these wishes.

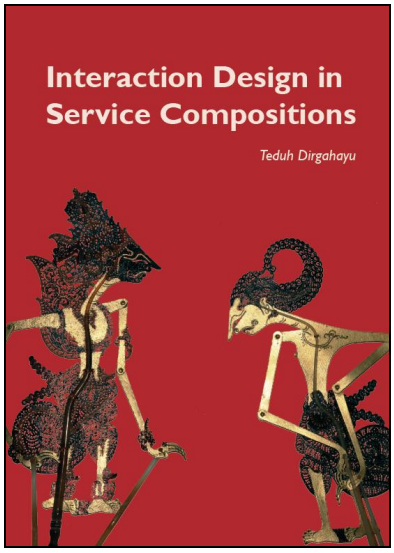
This dissertation addresses these shortcomings and presents an approach for incorporating (self-) adaptive behavior in (Web) services. A conceptual foundation of adaptation is provided and SOA is extended to incorporate adaptive behavior, called Adaptive Service Oriented Architecture (ASOA).

To demonstrate our conceptual framework, we implement it to address a crucial aspect of distributed systems, namely interoperability. In particular, we study the situation of a service orchestrator adapting itself to evolving service providers.

Interaction Design in Service Compositions

Ph.D. thesis abstract
Teduh Dirgahayu

Promotor: Prof.dr.ir. C.A. Vissers
Assistant-promotores: Dr. M.J. van Sinderen, dr.ir. D.A.C. Quartel
Date of defense: September 10, 2010



This thesis proposes a concept and transformations for designing interactions in a service composition at related abstraction levels. The concept and transformations are aimed at helping designers to bridge the conceptual gap between the business and software domains. In this way, the complexity of an interaction design can be managed adequately.

A service composition is specified as one or more interactions between application components. Interaction design is therefore the central activity in the design of a service composition. Interaction design at related abstraction level requires an interaction concept that can model interactions at a higher abstraction level (called *abstract interactions*) and interactions at a lower abstraction level (called *concrete interactions*), in order to avoid any conceptual gap between abstraction levels.

An *interaction* is defined as a unit of activity that is performed by multiple entities or participants in cooperation to establish a common result. Different participants can have different views on the established result. The possible results of an interaction are specified using contribution constraints and distribution constraints. Contribution constraints model the responsibility of the participants in the establishment of the interaction result. Distribution constraints model the relation between the participants' views. An interaction provides mutual synchronisation or time dependency between the participants. This interaction concept can model abstract and concrete interactions. A designer can hence use a single interaction design concept during a design process.

Two design transformations are defined, namely *interaction refinement* and *interaction abstraction*. Interaction refinement replaces an abstract-interaction with a concrete-interaction structure. Interaction abstraction replaces a concrete-interaction structure with an abstract-interaction structure. A set of conformance requirements and a conformance assessment method are defined to check the conformance between an abstract-interaction and concrete-interaction structure.

In an interaction design process, a designer first represents a service composition as an abstract interaction that specifies the desired result. This abstract interaction is then refined into a concrete-interaction structure that specifies how to establish that result. Interaction refinement can be done recursively until it results in a concrete-interaction structure that can be mapped onto available interaction mechanisms. Every refinement is followed by conformance assessment.

To facilitate the development process of a service composition, this thesis provides

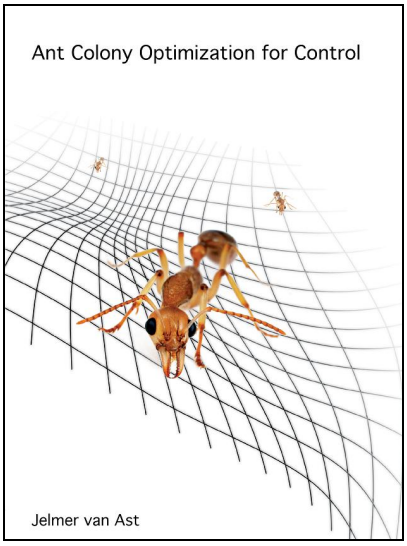
– patterns for interaction refinement, which serve as guidelines on possible refinements of an abstract interaction;
– abstract representations of interaction mechanisms, which allow interaction mechanisms to be included in an interaction design at a higher abstraction level; and
– a transformation tool to transform an interaction design at an implementation level to an executable implementation.

The use of the interaction concept, design transformations, patterns for interaction refinement, abstract representations of interaction mechanisms, and transformation tool are illustrated with two case studies. In the first case study, we design a travel-reservation application as a service composition using a top-down design approach. The services and application components that are involved in the service composition have to be developed. In the second case study, we design enterprise-application integration for an order management that composes existing services and applications. We follow an integration approach and use our interaction concept during the design process. The obtained integration solution is then transformed to an executable implementation using our transformation tool.

Ant Colony Optimization for Control

Ph.D. thesis abstract
Jelmer van Ast

Promotores: Prof.dr. R. Babuška, Prof.dr.ir. B. De Schutter
Date of defense: September 14, 2010



The very basis of this research is the collective behavior of ants in colonies. Ants are an excellent example of how rather simple behavior on a local level can lead to complex behavior on a global level that is beneficial for the individuals. The key in the self-organization of ants is communication through pheromones. When an ant forages for food, it is biased to search along trails of stronger pheromone concentrations. The moment it finds food, it will walk back to the nest while depositing pheromones and thereby contributing to the reinforcement of a successful trail.

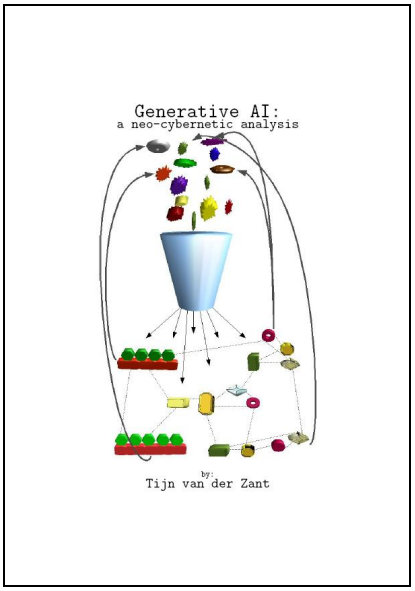
In this research, we take these principles to the domain of control-policy learning. A control policy is a mapping from states to actions and our objective is to develop methods to learn the optimal control policy for a given dynamic system by interacting with it. We call our methods Ant Colony Learning (ACL). The power of ACL lies in the fact that there is a set of ants, from which each ant interacts with the system and influences the other ants through updating pheromone levels associated with the visited state-action pairs. We observe that increasing the number of ants in the algorithm results in a decrease of the number of trials required for convergence to the optimal policy.

We also study the generalization of the ACL framework to control problems with continuous state spaces. In order to capture a continuous space with a finite number of elements, we study two ways of partitioning the state space. In the first way, the state space is partitioned using bins. Each state measurement is assigned to exactly one bin, which leads to the introduction of discretization noise, rendering an originally deterministic system non-deterministic and restricting the performance of the algorithm. We find that a better way of partitioning the state space is by using fuzzy triangular membership functions. The continuous-state measurement then belongs to multiple membership functions to a certain degree. With fuzzy partitioning, the continuity of the state variables is preserved and no non-determinism is introduced. The optimal control policy can then be learned using much fewer ants in much fewer trials.

Generative AI: A neo-cybernetic analysis

Ph.D. thesis abstract
Tijn van der Zant

Promotor: Prof.dr. L.R.B. Schomaker
Date of defense: September 24, 2010



The intelligence of machines is still created by humans. As long as machines are not capable of developing their own intelligence, they are merely displaying the cleverness of the designers. The involvement of humans for the scaffolding of subjectiveness in machines hampers the development and autonomy of machine intelligence in profound ways. The mind-body problem should be stated as the mind-body-scaffolding problem, but no general theory of this scaffolding principle exists. If machines are to scaffold their own minds, then they require generative mechanisms to construct and test their mental machinery. This thesis is about the abstract mechanisms behind the automated scaffolding of the intelligence of machines. In order to develop this theory, two notoriously difficult technological problems will be explored, i.e., the automatic recognition of historical cursive script as well as the development of home-robotics applications.

Most of the technologies used in the field of Artificial Intelligence are analytic or manually designed. These are undesired properties for the development of intelligent machines. If the machine only analyzes, it will never create a new level of interaction with the environment but will only be capable of solving the problem at hand. If the machine intelligence requires the manual labor of humans it will not be able to learn new capabilities autonomously. To get out of this conundrum a new methodology or paradigm has to be developed, which should be concerned with the automated scaffolding of the mental structures of machines. The required methodology has to be generative, not only analytic, and has to function autonomously.

Generative Artificial Intelligence, as proposed in the first chapter, is a theory that pushes the use of generative methodologies of Artificial Intelligence to the extreme. Instead of limiting the amount of data being processed in the machines, it proposes to increase the amount of data. Most, if not all, problems addressed in contemporary Artificial Intelligence can be classified as toy problems. Toy problems generate toy solutions. The "Input → Transform → Output" paradigm of contemporary Artificial Intelligence is suited for these toy problems, but has not lead to machines with a form of general intelligence.

Generative Artificial Intelligence abstracts away from the generative processes found in some other scientific disciplines, such as quantum mechanics, biology, neurology and sociology. The abstract machinery developed in this thesis consists of generative procedures in flux, sorting machines that operate on the generators and meshworks of generators that can form higher-order organizational structures of processing. The abstract machinery is recursive and generative. The abstract machine is applied to the development of the brains of humans, to demonstrate the power of the model and to show that the developed abstract machinery can be used to generate intelligence in biological organisms.

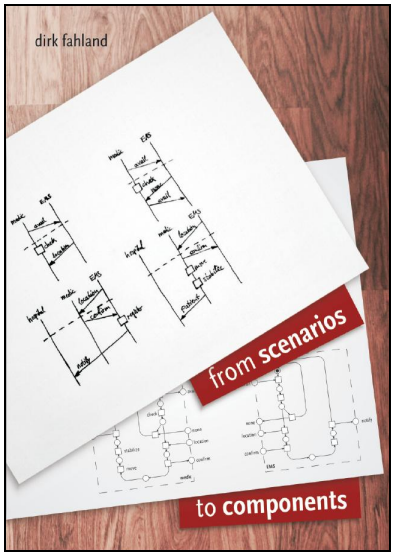
Subsequent chapters form the battlefield of the new theory regarding contemporary Artificial Intelligence. Previous research in the form of articles are treated from the perspective of Generative Artificial Intelligence. It is shown in this thesis that all basic mechanisms, that are required according to Generative Artificial Intelligence, are already available in contemporary Artificial Intelligence. These mechanisms only have to be used in different manners and in different contexts to unlock their full potential.

In chapter 2 research on interactive evolutionary computation demonstrates the power of using humans as a steering mechanism for the development of machine intelligence. The pareto front of possible solutions should be treated differently than with an artificial fitness criterion. Chapter 3 of the thesis continues with new developments in computing hardware and infrastructures which allow scientists to think radically different about the ways to perform computations. Embarrassingly parallel computations can be used for generative processes needed for the scaffolding of machine intelligence. In chapter 4 research on handwriting recognition demonstrates the power of a complete abstract machine which is implemented. The model shows a very good performance by means of feedback processes. The machine applies an implementation of the primate visual cortex in order to explore biologically inspired solutions. The last chapter discusses the generative ideas with respect to a world-wide research initiative for the development of domestic service robots called ROBOCUP@HOME. The procedures applied to the creation of intelligence can also be used to steer research and for generative science in general.

From Scenarios to Components

Ph.D. thesis abstract
Dirk Fahland

Promotores: Prof.dr. W.M.P. van der Aalst, Prof.dr. W. Reisig
Copromotor: Prof.dr. K. Wolf
Date of defense: September 27, 2010



Scenario-based modeling has evolved as an accepted paradigm for developing complex systems

of various kinds. Its main purpose is to ensure that a system provides desired behavior to its users. A *scenario* is generally understood as a behavioral *requirement*, denoting a course of actions that shall *occur* in the system. A typical notation of a scenario is a Message Sequence Chart or, more general, a finite partial order of actions. A *specification* is a set of scenarios. Intuitively, a system *implements* a specification if all scenarios of the specification can occur in the system. The main challenge in this approach is to systematically *synthesize* from a given scenario-based specification state-based components which together implement the specification; preferably to be achieved automatically. A further challenge is to *analyze* scenarios to avoid erroneous specifications.

Existing scenario-based techniques exhibit a conceptual and formal gap between a scenario-based specification on the one hand and a state-based implementation on the other hand. This gap often renders synthesis surprisingly complex, and obscures the relationship between a specification and its implementation. Additionally, existing techniques for analyzing implementations cannot immediately be reused for analyzing specifications, and vice versa.

In this thesis, we introduce a semantic model for scenarios that seamlessly integrates scenario-based specifications and state-based implementations. We focus on modeling and analyzing the *control-flow* of systems. Technically, we use Petri nets together with the well-established notion of *distributed runs* for (1) describing the semantics of scenarios, for (2) systematically constructing and analyzing a specification, and for (3) synthesizing an implementation from a given specification.

Our first contribution is to identify a minimal set of notions to specify the behavior of distributed systems with scenarios. We formalize these notions in a novel semantic model for scenarios, called *oclets*. Oclets combine formal notions from Petri-net theory with formal notions from scenario-based techniques in a unified way. We define a classical *declarative semantics* for scenario-based specifications, which defines when a given set of runs *satisfies* a given specification. These semantics are *compositional*: a set of runs satisfies a composition of two specifications if and only if it satisfies each of the specifications. We then provide *composition* and *decomposition operators* on oclets and relations for comparing oclets. Using these notions, we systematically derive for each scenario-based specification *S* the behavior exhibited by a *minimal implementation* of *S*.

The second contribution of this thesis aims at bridging the conceptual and methodological gap between scenario-based specifications and state-based system models. In our approach, the semantics of scenarios and the semantics of systems both employ the same notions from Petri nets. We provide *operational semantics* for scenario-based specifications. On the basis of these operational semantics, we consider the problems of *analyzing* behavioral properties of a specification and of *synthesizing* components that implement the specification. We show that these problems are undecidable in general and present a sufficient property for the decidable case. Based on this property, we present algorithms for analysis and synthesis. Our results generalize existing techniques from Petri nets to the domain of scenario-based specifications.

We implemented our algorithms for simulating, analyzing, and synthesizing from scenario-based specifications in our tool Greta. An industrial case study shows the feasibility of our techniques.

Continuous Progress

H. Jaap van den Herik
TiCC, UvT, Tilburg

Education, Art, Science, and Belief are best characterised as four distinct ways of life. Moreover, they have a special relation to the economic welfare. For instance, a living out of Art is possible if money is flooding around. In times of financial and economic stand still, clever people make estimations and calculations on their future expectations and are willing to dedicate an important part of their life to Science, to do research and to achieve the doctor's title. Education is of all times and does not seem to have a direct relation with the fluctuations in the financial world. Some believe that bad times are a source of inspiration for believers. If true, then Belief can be seen as context dependent. These four superficial opinions may lead to the claim that Science and Belief are more related than at first blush. Here, I would like to remark that this claim calls for a closer investigation.

In the wide area of Artificial Intelligence, we see many research disciplines assembled. In each of the disciplines there is certainly continuous progress. However, the use of computers (compute power), storage (capacities), and intelligent tools emphasises the continuous progress and brings the results to a higher level, and, in particular, makes them fit for applications.

The titles of the Ph.D. theses that are announced below are a joy to read. They include concept, contents, and context; services, emotions, and vocabularies, as well as learning, adaptivity, and interaction. Admittedly, some titles are exceeding my guideline of five words only. My favourite of this list is Dirk Fahland's "From Scenarios to Components", with Teduh Dirgahayu's "Interaction Design in Service Compositions" as a well-deserved second. The other titles are long, too long for properly catching the attention in half a jiffy. An exception is here the first part of Mark van Staalduinen's title "Content-based paper retrieval. Towards reconstruction of art history". Congratulations are due to all Ph.D. thesis defenders, and also to the supervisors. Special congratulations are given to Lambert Schomaker, who will act three times as supervisor in the months to come. The best advice to all of us is: keep up the good work!

Robin Aly (UT) (July 2, 2010). *Modeling Document Representation Uncertainty in Concept-Based Multimedia Retrieval.* University of Twente. Promotores: Prof.dr. P.G.M. Apers (UT), Prof.dr. F.M.G. de Jong (UT). Copromotor: Dr.ir. D. Hiemstra (UT).

Dolf Trieschnigg (UT) (September 1, 2010). *Proof of Concept: Concept-Based Biomedical Information Retrieval.* University of Twente. Promotores: Prof.dr. F.M.G. de Jong, (UT), Prof.dr.ir. W. Kraaij (RUN).

Marcel Hiel (UvT) (September 7, 2010). *An Adaptive Service Oriented Architecture: Automatically solving Interoperability Problems***.** Tilburg University. Promotor: Prof.dr. W.J.A.M van den Heuvel (UvT). Copromotor: Dr. H. Weigand (UvT).

Teduh Dirgahayu (UT) (September 10, 2010). *Interaction Design in Service Compositions*. University of Twente. Promotor: Prof.dr.ir. C.A. Vissers (UT). Assistant-promotores: Dr. M.J. van Sinderen (UT), Dr.ir. D.A.C. Quartel (Novay).

Jelmer van Ast (TUD) (September 14, 2010). *Ant Colony Optimization for Control.* Delft University of Technology. Promotores: Prof.dr. R. Babuška (TUD), Prof.dr.ir. B. De Schutter (TUD).

Jose Janssen (OU) (September 17, 2010). *Paving the Way for Lifelong Learning; Facilitating competence development through a learning path specification.* Open University. Promotor: Prof.dr. E.J.R. Koper (OU). Copromotor: Dr. A. Berlanga (OU).

Tijn van der Zant (RUG) (September 24, 2010). *Generative AI: a neo-cybernetic analysis.* University of Groningen. Promotor: Prof.dr. L.R.B. Schomaker (RUG).

Dirk Fahland (TU/e) (September 27, 2010). *From Scenarios to Components*. University of Technology Eindhoven. Promotores: Prof.dr. W.M.P. van der Aalst (TU/e), Prof.dr. W. Reisig (Humboldt University Berlin). Copromotor: Prof.dr. K. Wolf (University of Rostock).

Niels Lohmann (TU/e) (September 27, 2010). *Correctness of Services and their Composition*. University of Technology Eindhoven. Promotores: Prof.dr. W.M.P. van der Aalst (TU/e), Prof.dr. K. Wolf (University of Rostock). Copromotor: Dr. N. Sidorova (TU/e).

Ghazanfar Farooq Siddiqui (VU). (September 28, 2010). VU University Amsterdam. *Integrative Modeling of Emotions in Virtual Agents*. Promotores: Prof.dr. J. Treur (VU). Copromotores: Dr. T. Bosse (VU), Dr. J.F. Hoorn (VU).

Victor de Boer (UvA) (September 30, 2010). University of Amsterdam. *Ontology Enrichment from Heterogeneous Sources on the Web*. Promotor: Prof.dr. B.J. Wielinga (UvA). Copromotor: Dr. M. van Someren (UvA).

Guillome Chaslot (UM) (September 30, 2010). *Monte-Carlo Tree Search*. Maastricht University. Promotor: Prof.dr. G. Weiss (UM). Copromotores: Dr.ir. J.W.H.M. Uiterwijk (UM), dr. M.H.M. Winands (UM), Dr. B. Bouzy (Université Paris Descartes).

Mark van Assem (VU) (October 1, 2010). VU University Amsterdam. *Converting and Integrating Vocabularies for the Semantic Web*. Promotor: Prof.dr. A.Th. Schreiber (VU). Copromotor: Dr. J.R. van Ossenbruggen (CWI/VU).

Peter van Kranenburg (UU) (October 4, 2010). *A Computational Approach to Content-Based Retrieval of Folk Song Melodies.* Utrecht University. Promotores: Prof.dr. R.C. Veltkamp (UU), Prof.dr. L.P. Grijp (UU). Copromotor: Dr. F. Wiering (UU).

Ralph Niels (RUG) (October 4, 2010). *Allograph Based Writer Identification, Handwriting Analysis and Character Recognition.* University of Groningen. Promotor: Prof.dr. L.R.B. Schomaker (RUG). Copromotor: Dr. L.G. Vuurpijl (RUN).

Mark van Staalduinen (TUD) (October 7, 2010). *Content-Based Paper Retrieval. Towards*

reconstruction of art history. Delft University of Technology. Promotor: Prof.dr.ir. J. Biemond (TUD). Copromotor: Dr.ir. J.C.A. van den Lubbe (TUD).

Matthijs Amelink (TUD) (October 18, 2010). *Ecological Interface Design, Extending Work Domain Analysis.* Delft University of Technology. Promotores: Prof.dr.ir. M. Mulder (TUD), Prof.dr.ir. B. Mulder (TUD). Copromotor: Dr.ir. R. van Paassen (TUD).

Maria Niessen (RUG) (October 22, 2010). *Context-Based Sound Event Recognition.* University of Groningen. Promotor: Prof.dr. L.R.B. Schomaker (RUG). Copromotor: Dr. T.C. Andringa (RUG).

Alin Gavril Chitu (TUD) (November 2, 2010). *Towards Robust Visual Speech Recognition.* Delft University of Technology. Promotores: Prof.dr. C.M. Jonker (TUD), Prof.drs.dr. L.J.M.Rothkrantz (TUD).

Siska Fitrianie (TUD) (November 8, 2010). *Human Handheld-Device Interaction: An Adaptive User Interface*. Delft University of Technology. Promotores: Prof.dr. H. Koppelaar (TUD), Prof.drs.dr. L.J.M. Rothkrantz (TUD).

INAUGURAL ADDRESSES

With much pleasure we announce the following three inaugural addresses.

Dr.ir. J.G. Slootweg (September 10, 2010). *Smart Grids – Fundament voor de toekomstige energievoorziening.* Technische Universiteit Eindhoven.

Dr. J.P.J. Verkruijsse RE RA (October 15, 2010). *Bestuurlijke Informatieverzorging: na het **singularity point** een nieuwe glanzende toekomst?* Tilburg University.

Drs.dr. L.J.M. Rothkrantz (October 20, 2010). *Digital Guardian Angels.* NLDA Den Helder.

AI & Industry

Section Editor
Koen Hindriks

No Form, No Brain

Anne van Rossum, Alfons Salden
Almende, Rotterdam

"We do not keep the outward form of order, where there is deep disorder in the mind." – Shakespeare

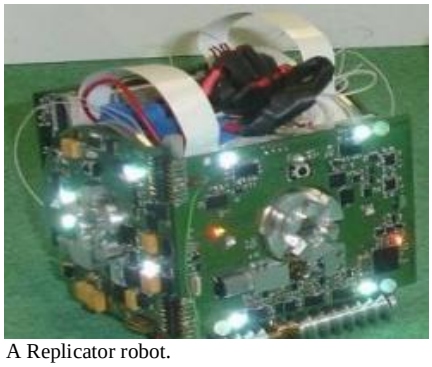
Each pattern recognized is a pattern formed – a pattern formed outside in the world, and a pattern formed in the mind of the observer. There is no pattern recognition without pattern formation. The art of pattern formation has been described in ancient scriptures; the separation of the waters from the earth, the scattered stars through the sky, and the molding of human beings. Moreover, the art of pattern formation is still very vividly alive in the form of beautiful fractals used to render realistic natural scenes with trees, water, and sand beaches in modern games.

In the fifties, Turing described a model that could explain the patterns, the spots and stripes, on animal skin. It is a so-called reaction-diffusion model which explicates how local phenomena in the form of protein exchange between cells can generate intricate patterns. It is one of the first attempts to model morphogenesis – the creation of form – using anonymous messages, which he coined "morphogens". It is a study of self-organization before anyone knew of synergetics (Haken), punctuated equilibrium (Gould), the edge of chaos (Kauffman), or self-organized criticality (Bak).

In the FP7 project Replicator the creation of form has materialized in the form of self-reconfigurable robots. The robots can partake in a diversity of body shapes by disconnecting and connecting in specific configurations. Moreover, in contrast with other types of modular robots, the Replicator robots are equipped with a plethora of sensors and can move autonomously using screw drives. The robots are meant to operate in conditions where wheeled robots with fixed body layouts will not measure up to the demands of the environment. A collapsed mine requires a robot to adopt, i.e., a snake shape to crawl through a narrow passages, move aside a certain rock fragment, and detect a victim in distress.

Almende, a research company specialized in self-organization, based in Rotterdam, studies within Replicator two aspects of self-organization. Both aspects have to do with the influence of the environment. The first aspect might be loosely defined under the umbrella term "epigenetic robotics": the direct influence of the environment on the transcription of an artificial genome. The second

aspect is concerned with integration of sensor data in its (environmental) context: "cognitive sensor fusion".

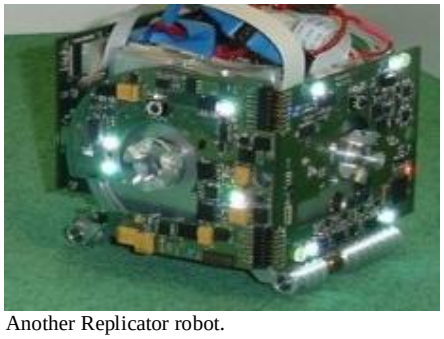


A Replicator robot.

Epigenetic robotics. The ability to partake in a diversity of body shapes and morph from one shape to another is solved by *evolving* reaction-diffusion models. In the literature such models are called gene regulatory networks. Depending on the task at hand, such as moving a certain distance, overcoming an obstacle, or more general, awarding the mere existence of a shape change depending on light conditions, causes the population to evolve towards the desired behavior. The swarm of robots might disperse during the night and assemble to larger structures during the day.

Cognitive sensor fusion. A robot organism observes an entity in the outside world, like a power outlet, using its battery level detectors, distance sensors, microphones, and cameras. After a preprocessing stage, the sensory data is associated across aforementioned sensor modalities using *adaptive resonance theory* (Grossberg). Adaptive resonance theory has been developed to solve the stability-plasticity dilemma. It provides a self-organized method that allows the network to overwrite old memories, but not to forget them all. It restructures itself depending on its state of vigilance (wakefulness).

Pattern recognition exists by the virtue of pattern formation. That the new century will reveal many secrets for artificial intelligence thanks to the study of form!



Another Replicator robot.

Section Editor
Richard Starmans

SIKS Masterclass on "Design Science Methodology: Principles and Practice"

INTRODUCTION

On October 15, 2010, the School for Information and Knowledge Systems (SIKS) organizes a masterclass on "Design Science Methodology: Principles and Practice." The location will be Conference Centre Hoog Brabant in Utrecht. The class is scheduled from 10.00-17.00 hours. The event is primarily intended for SIKS-Ph.D. students, but also SIKS research fellows and SIKS alumni are cordially invited to participate. Although this masterclass is primarily intended for SIKS-Ph.D. students, other participants are not excluded. However, their number of passes will be restricted and depends on the number of SIKS-members taking the class. This masterclass is part of the Advanced Components stage of SIKS' educational program.

The engineering of information and knowledge systems is a design science, in which artefact design alternates with validation and evaluation research. This is methodologically complex because it involves a mutual nesting of design problems and research questions, as well as a balancing between abstract generalization and concrete applicability for stakeholders. This masterclass provides guidelines for the practicing IKS researcher to deal with this complexity.

We will use the engineering cycle as the top-level methodological framework for design science. Within this framework, we first treat typical engineering research questions such as the validation question what effects will be produced by the interaction between a designed artifact and a problem domain, what the valuation of these effects with respect to stakeholder goals is, what trade-offs are involved and how sensitive this is to changes in the problem domain. Next, we discuss the large range of research methods available to the IKS researcher when validating artifact designs, from lab experiments to simulations and field research.

Thirdly, we will discuss the role of theories of practice in balancing abstraction with applicability, and fourthly we will provide a structure for practical design theories and show how this can be linked to the practical problems that IKS research aims to solve. Many examples from IKS research are given to illustrate the points made in the tutorial. The masterclass is summarized in the form of a set of guidelines for practicing IKS researchers.

SCIENTIFIC DIRECTOR

Prof.dr. R.J. Wieringa (UT)

PROGRAM

The final program is not known yet, but the outline is as follows:

Block 1: Introduction; Design Science; Knowledge questions and practical problems
Block 2: The engineering cycle
Block 3: The research cycle
Block 4: Mutually nested engineering and research cycles
Block 5: Structure and content of design theories; Discussion

REGISTRATION

Participation, lunch included, is free for all SIKS-members and SIKS alumni. However, an early registration is required. For participation, please fill in the registration form at the SIKS website.

SIKS-TBM Seminar in Delft

We would like to invite you to the first of a seminar series on agent models and simulation that the Faculty Technology Policy and Management (TBM) organises in cooperation with the School for Information and Knowledge Systems (SIKS).

Date: Thursday October 21, from 16.00 - 17.00
Location: Faculty TBM, TU Delft, Jaffalaan 5, Delft, room A1.370 (boardroom).

The presentation will be given by Emile Chappin.

Title: Agent-based Model of Transitions in Consumer Lighting.

Abstract: To understand the consequences of the EU ban on incandescent lamps, an agent-based model is developed in which consumers are simulated in their lamps-purchase behaviour. Consumers are modelled based on heterogeneous preferences and develop opinions on lamps (memory and perceptions), and share these in a social-network structure. Lighting technology is modelled using many different lamps of different technology types. The results indicate that the ban on bulbs will be effective in realising an energy efficient sector, albeit at significant expense to consumers. An alternative policy, introducing a tax on incandescent lamps, would also be effective given a sufficient level of taxation. Next to these results, we also intend to present new results that show the evolution of consumer lighting from 1980 using a slightly adapted version of the model.

SIKS-Day 2010 in Veldhoven

INTRODUCTION

On November 2, 2010, the School for Information and Knowledge Systems (SIKS) organizes its annual SIKS-day. The location will be NH Conference Hotel Koningshof in Veldhoven. This year the SIKS-day will be part of a three-day national event, entirely dedicated to the Computing and Information Sciences. This event involves a cooperation with IPA, ASCI, NOW, and STW. More details will be made available shortly.

The main aim of the SIKS-day is to give SIKS-members, participating in research groups all over the country, the opportunity to meet each other in an informal setting and to inform them about current developments and some new activities and plans for the coming year. A small scientific symposium will be organized at the SIKS-day as well. Four invited speakers have agreed to perform:

- John-Jules Meyer (UU)
- Djoerd Hiemstra (UT)
- Hans Akkermans (VU)
- Antal van den Bosch (UvT)

By inviting these researchers we hope to have selected the right ingredients for a memorable day. All members of our research school (research fellows, associated members and Ph.D. students) as well as the members of SIKS' Advisory Board and our alumni are invited to participate.

REGISTRATION

For registration, please visit the website of the event.

5th SIKS/Benais Conference on "Enterprise Information Systems"

For the fifth time, the Dutch Research School SIKS organizes a Dutch/Belgian Conference on Enterprise Information Systems (EIS). The purpose of EIS is to bring together Dutch/Belgian researchers interested in the advances in and the business applications of information systems. This broad field includes topics such as: Management Information Systems,

E-Business, IS Analysis and Design, Requirements Engineering, Business Innovation, Knowledge Management, Business Process Management, Product Software Development, Coordination and Communication, Collaborative Information Systems, Business/IT Alignment, Enterprise Engineering, Architectures for IKS, Business Process Intelligence, Business Process Compliance, Process Mining, Service Government, Agile Service Networks, and many others.

EIS 2010 is organized by SIKS (School for Information and Knowledge Systems) in cooperation with LOIS (strategic initiative for Logistics, Operations and Information Systems), BENAIS (Benelux Chapter of the Association for Information Systems) and NIRICT (Netherlands Institute for Research on ICT). The conference offers a unique opportunity for research groups from both the Computer Science-side and the Management-side to report on research, meet and interact. We also welcome practitioners with an interest in research and innovation, as well as doctoral students in the early stages of their careers. The event will take place in Eindhoven, at the campus of Eindhoven University of Technology. Participation in this event is free of charge, but registration is compulsory.

IMPORTANT DATES

September 6:	Submission deadline for Alpha papers
September 13:	Submission deadline for Beta papers
October 5:	Notification of acceptance
November 16:	EIS 2010, Eindhoven, the Netherlands

CONFERENCE ORGANIZATION

Organization Chair:	Wil van der Aalst
PC Co-chairs:	Hajo Reijers, Boudewijn van Dongen
Publicity chair:	Jan Martijn van der Werf
Demo chair:	Pieter van Gorp
Secretariat:	Ine van der Ligt

SIKS Basic Course "Research Methods and Methodology for IKS"

INTRODUCTION

On November 24, 25, and 26, 2010, the School for Information and Knowledge Systems (SIKS) organizes the annual three-day course "Research Methods and Methodology for IKS". The location will be Conference centre Woudschoten in Zeist. The course will be given in English and is part of the educational Program for SIKS-Ph.D. students. Although the course is primarily intended for SIKS-Ph.D. students, other participants are not excluded. However, their number of passes will be restricted and depends on the number of SIKS-Ph.D. students taking the course.

"Research Methods and Methodology for IKS" is relevant for all SIKS-Ph.D. students (whether working in computer science or in information science). The primary goal of this hands-on course is to enable these Ph.D. students to make a good research design for their own research project. To this end, it provides an interactive training in various elements of research design, such as the conceptual design and the research planning. But the course also contains a general introduction to the philosophy of science (and particularly to the philosophy of mathematics, computer science and AI). And, it addresses such divergent topics as "the case-study method", "elementary research methodology for the empirical sciences" and "empirical methods for computer science".

"Research Methods and Methodology for IKS" is an intense and interactive course. First, all students enrolling for this course are asked to read some pre-course reading material, comprising some papers that address key problems in IKS-methodology. These papers will be sent to the participants immediately after registration. Secondly, all participants are expected to give a brief characterization of their own research project/ proposal, by answering a set of questions, formulated by the course directors, and based on the aforementioned literature. We believe that this approach results in a more efficient and effective course; it will help you to prepare yourself for the course and this will increase the value that you will get from it.

COURSE COORDINATORS

Hans Weigand (UvT), Roel Wieringa (UT), John-Jules Meyer (UU), Hans Akkermans (VU), and Richard Starmans (UU)

PROGRAM

More details on the program will be made available in due course.

REGISTRATION

In the conference centre there is a limited number of places and there is interest from other groups in the topic as well. Therefore, an early registration is required. For registration you are kindly requested to fill in the registration form at the SIKS website.

Arrangement 1 includes single room, all meals, and course material. Arrangement 2 includes only lunch, dinner and course material. So no stay in the hotel and no breakfast.

Deadline for registration for SIKS-Ph.D. students: November 1, 2010. After that date, applications to participate will be honoured in a first-come first-serve manner. Of course, applications to participate from other interested groups are welcome already. They will receive a notification whether they can participate as soon as possible.

Information for non-SIKS-Ph.D. students: SIKS needs a confirmation from your supervisor/office that they agree with the arrangement and paying conditions.

SIKS Basic Courses "Mathematical Methods for IKS" and "Knowledge Modeling"

INTRODUCTION

From December 7-10, 2010, the School for Information and Knowledge Systems (SIKS) organizes two basic courses "Mathematical Methods for IKS" and "Knowledge Modeling". Both courses will be given in English and are part of the obligatory Basic Course Program for SIKS-Ph.D. students. Although these courses are primarily intended for SIKS-Ph.D. students, other participants are not excluded. However, their number of passes will be restricted and depends on the number of SIKS-Ph.D. students taking the course.

Location: Landgoed Huize Bergen, Vught
Date: December 7-10, 2010

SCIENTIFIC DIRECTORS

- Prof.dr. Eric Postma (UvT), Mathematical Methods for IKS
- Prof.dr. Tom Heskes (RUN), Mathematical Methods for IKS
- Dr. Bert Bredeweg (UvA), Knowledge Modeling

PROGRAM

The program is not available yet, but may include the following topics:

Mathematical Methods for IKS

- Basic formalisms relevant to modern intelligent knowledge systems
- Automatically acquired knowledge representations
- Inductive Learning
- Bayesian Statistics
- Entropy and Information Theory
- Computer intensive techniques
- Minimum Description Length Methods

Knowledge Modeling

- Ontologies, Epistemology and Models
- Modeling with Description Logics
- Methodology for Ontology engineering
- KADS
- OWL: Ontology Language for the Web
- Ontology patterns, Re-use of information

REGISTRATION

In the conference centre there is a limited number of places and there is interest from other groups in the topic as well. Therefore, an early registration is required.

Deadline for registration for SIKS-Ph.D. students: **November 30, 2010.** After that date, applications to participate will be honoured in a first-come first-serve manner. Of course, applications to participate from other interested groups are welcome already. They will receive a notification whether they can participate as soon as possible.

For registration you are kindly requested to fill in the registration form at the SIKS website.

Arrangement 1 includes single room, all meals, and course material. Arrangement 2 includes two lunches, one dinner and course material. So no stay in the hotel and no breakfast.

HOW TO SUBSCRIBE

The BNVKI-AIABN Newsletter is a direct benefit of membership of the BNVKI-AIABN: Benelux Association for Artificial Intelligence. Membership dues are € 40 for regular members; € 25 for doctoral students (AIO's); and € 20 for students. In addition, members will receive access to the electronic version of the European journal *AI Communications*. The Newsletter appears bimonthly and contains information about conferences, research projects, job opportunities, funding opportunities, etc., provided enough information is supplied. Therefore, all members are encouraged to send news and items they consider worthwhile to the editorial office of the BNVKI/AIABN Newsletter. Subscription is done by payment of the membership due to Postbank no. 3102697 in The Netherlands (IBAN: NL 74 PSTB 0003 1026 97; BIC: PSTBNL21). Specify *BNVKI/AIABN* as the recipient, and please do not forget to mention your name and address. Sending of the BNVKI/AIABN Newsletter will only commence after your payment has been received. If you wish to conclude your membership, please send a written notification to the editorial office before December 1, 2010.

COPY

The editorial board welcomes product announcements, book reviews, product reviews, overviews of AI education, AI research in business, and interviews. Contributions stating controversial opinions or otherwise stimulating discussions are highly encouraged. Please send your submission by E-mail (MS Word or text) to newsletter@maastrichtuniversity.nl.

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CHANGE OF ADDRESS

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