Joos, Cigaren en andere mathematische objecten

Emeritaat van Joos Vandewalle

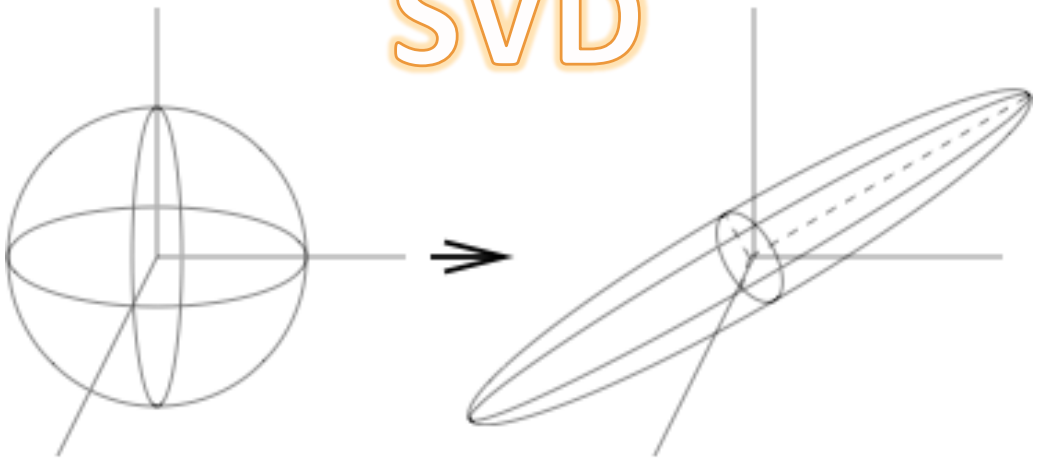
Leuven, Sept. 3, 2013

Patrick Dewilde

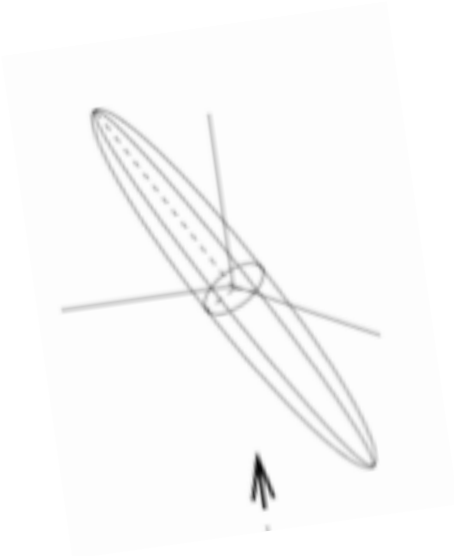


naar: Pil over Clinton

SVD

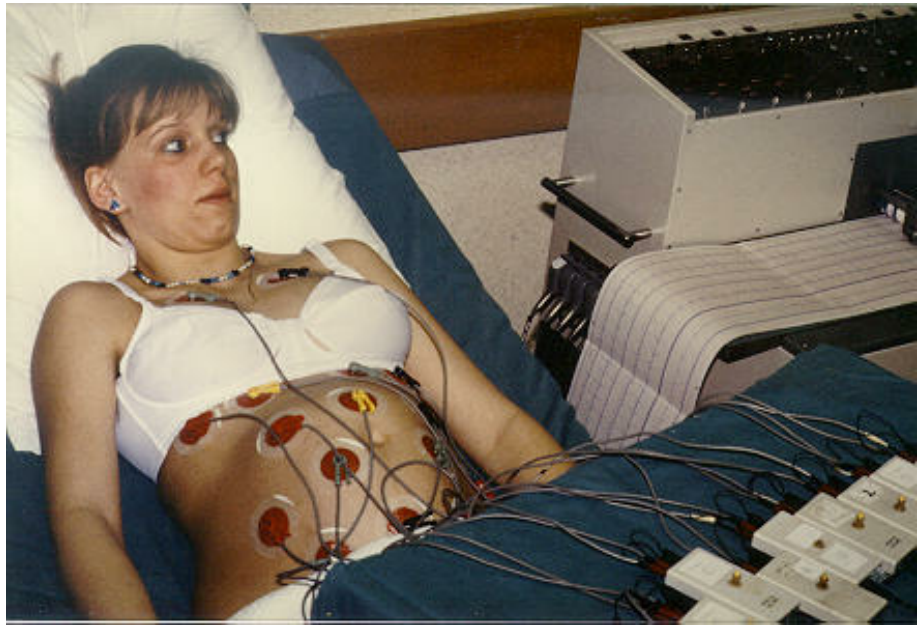


Volgens Joos is dit een cigaar:

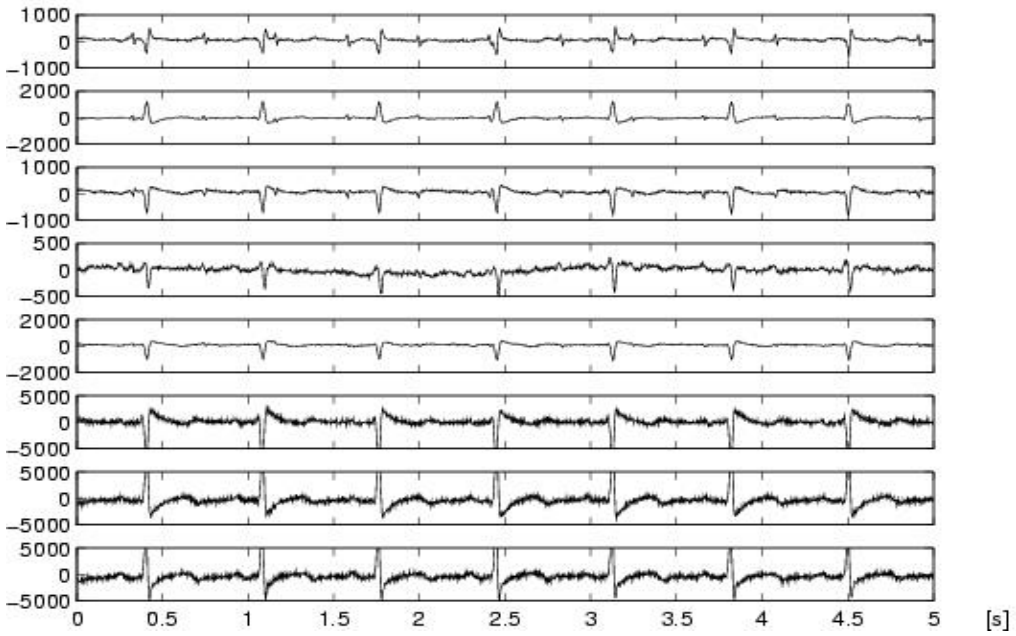


en waar dient een cigaar voor?

Juist! Om de hartslag van de baby te scheiden van die van de moeder!



NANA project



FETAL ELECTROCARDIOGRAM EXTRACTION BY SOURCE SUBSPACE SEPARATION

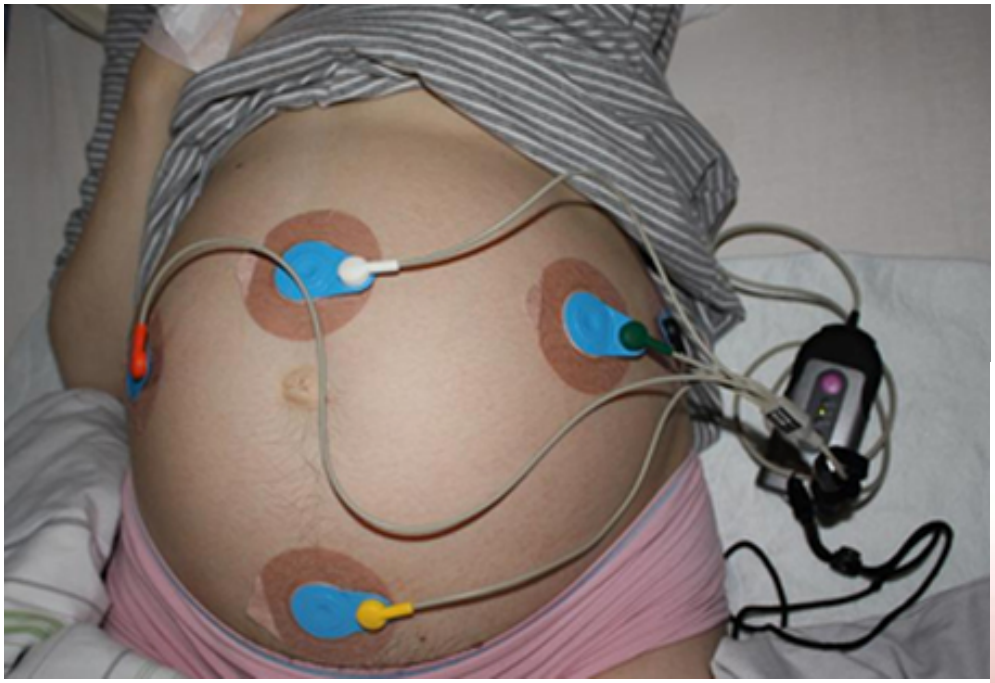
L. De Lathauwer, D. Callaerts, B. De Moor and J. Vandewalle

hoe gaat dat dan?





een elektronische cigaar!





other objects discovered by Joos

Before Cigars, what where Joos' interests?

zeros!

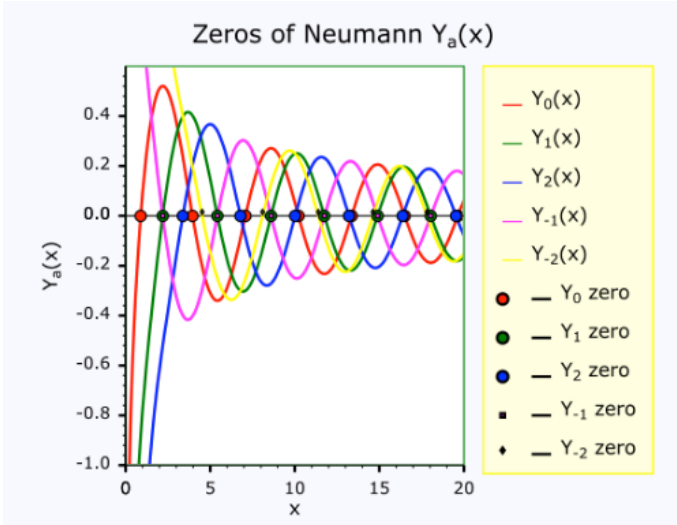
0000000000000

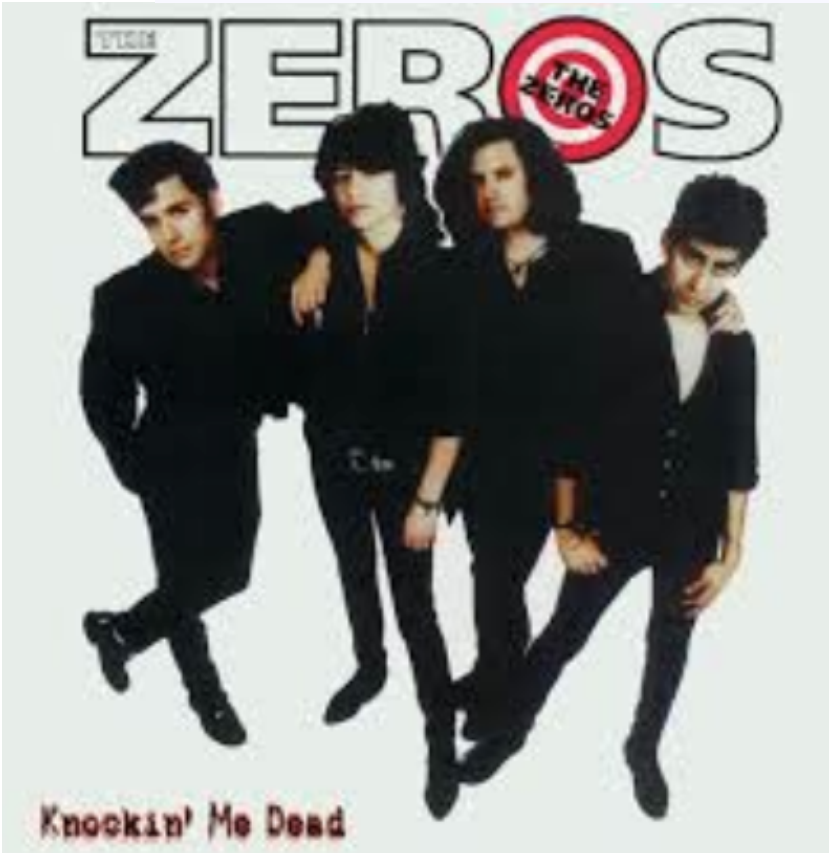
Joos' thesis: - zeros
- prime factors of rational matrix functions

zeros?


X-133


Coca-Cola
zero
REAL
Coca-Cola
TASTE
AND ZERO
CALORIES


Zeros of Neumann $Y_a(x)$
$Y_a(x)$
x
$Y_0(x)$
$Y_1(x)$
$Y_2(x)$
$Y_{-1}(x)$
$Y_{-2}(x)$
Y_0 zero
Y_1 zero
Y_2 zero
Y_{-1} zero
Y_{-2} zero


ZEROS
Knockin' Me Dead

zero caloriën?



The discovery of the zeros of a rational MIMO transfer function!

?

poles can be zeros as well!

Vandewalle theorems:

- the degree of the pole at z_0 of

$$T(z) = \frac{A_{-k}}{(z - z_0)^k} + \cdots + \frac{A_{-1}}{(z - z_0)} + A_0 + \cdots$$

is given by the rank of

$$T_{-k,-1} := \begin{bmatrix} A_{-k} & A_{-k+1} & \cdots & A_{-1} \\ & A_{-k} & \ddots & \vdots \\ & & \ddots & A_{-k+1} \\ & & & A_{-k} \end{bmatrix}$$

what about the zero (*plus detailed structure)*?

poles and zeros

- actually, the $T_{-k,i}$ contain much more information:
  the complete polar Jordan structure plus the
  complete (Jordan) zero structure
- instrumental in the all important factorization theory
  for matrix functions
- discovery of matrix "prime factors" of any degree!

close collaboration with P. Van Dooren resulted in efficient and numerically stable algorithms

and then what?



toen brak Joos los...

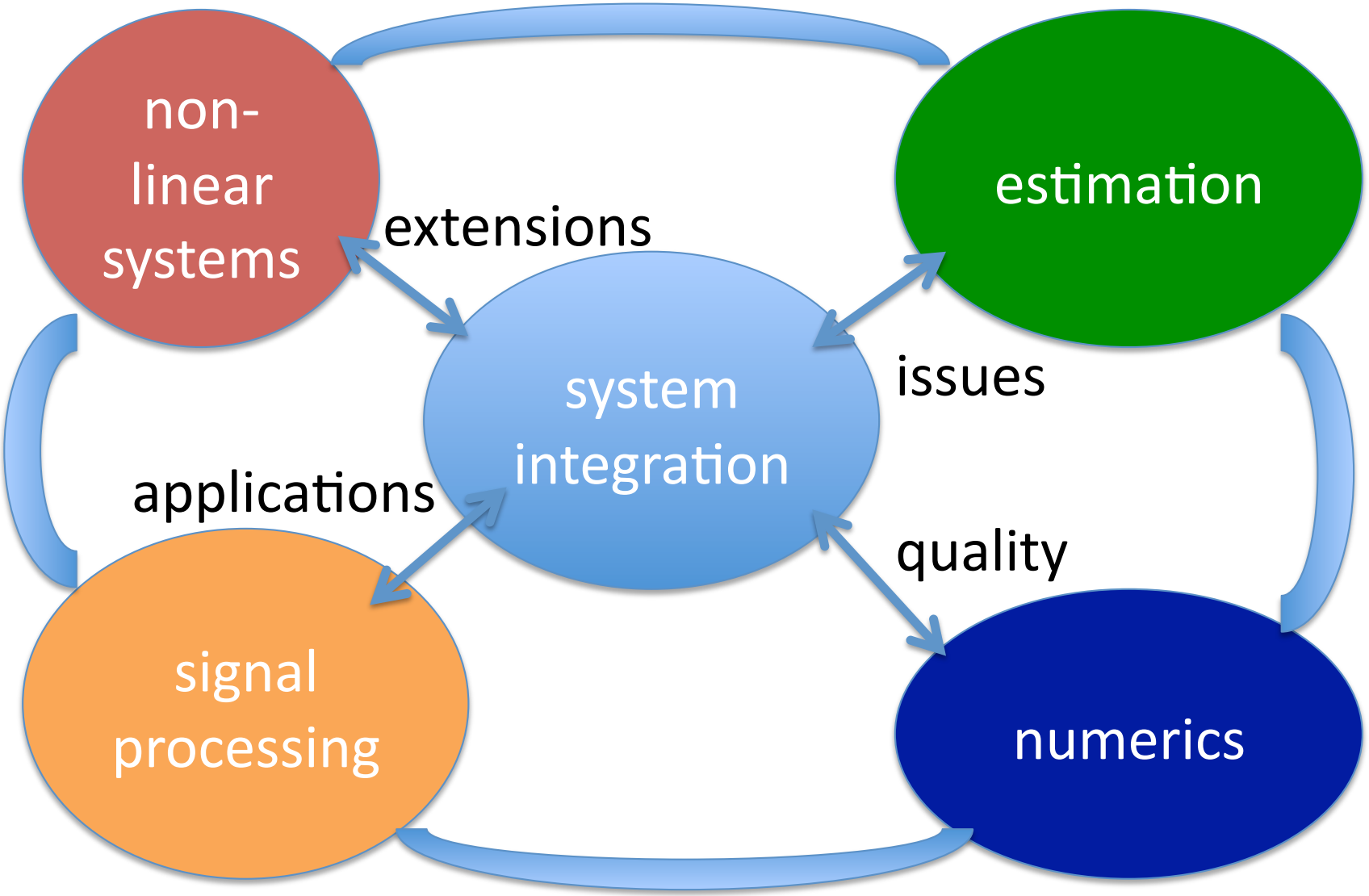
the mystery box...



unleashing zeros over the world
-the Kalman filter
-principal, independent components
-spectral factorization
-prime factors
-chaos



redefining EE...



the love of numerical algebra

Joos as didacticus: how to communicate the love of numerical algebra?

one idea: connect to applications

signal processing offers lots of opportunities...

a deeper motivation?

but there is a further and deeper motivation:

the quest for truth



the main motivation
for a "catholic" university?

IOANNES PAULUS PP. II

VERITATIS SPLENDOR

Gödel and Kline

Since Gödel we know that there is no such thing like an absolute system of truth:

every system can be extended in contradictory ways

since Morris Kline we know that there is no mathematical system that does not lead to contradictions...

dealing with truth is very hazardous business!

truths?

Statistical truths: how good is an estimate?

Logical truths: when can an assertion be trusted?

Numerical truths: when is a calculation correct?

Psychological truths: can experts be trusted?

what you see is not what you get
(WYSInoWYG)

statistical truth?

the law of small numbers
Bayesian estimation: forgetting a priori's
Principal vs. independent components
Causality inference

kleine scholen scoren best/slechtst?
regression to the mean: bad to good, good to bad?
false positives, false negatives – catching a doper
cum hoc ergo propter hoc

Voorbeeld

Gegeven: 1% van de sporters gebruikt dope!

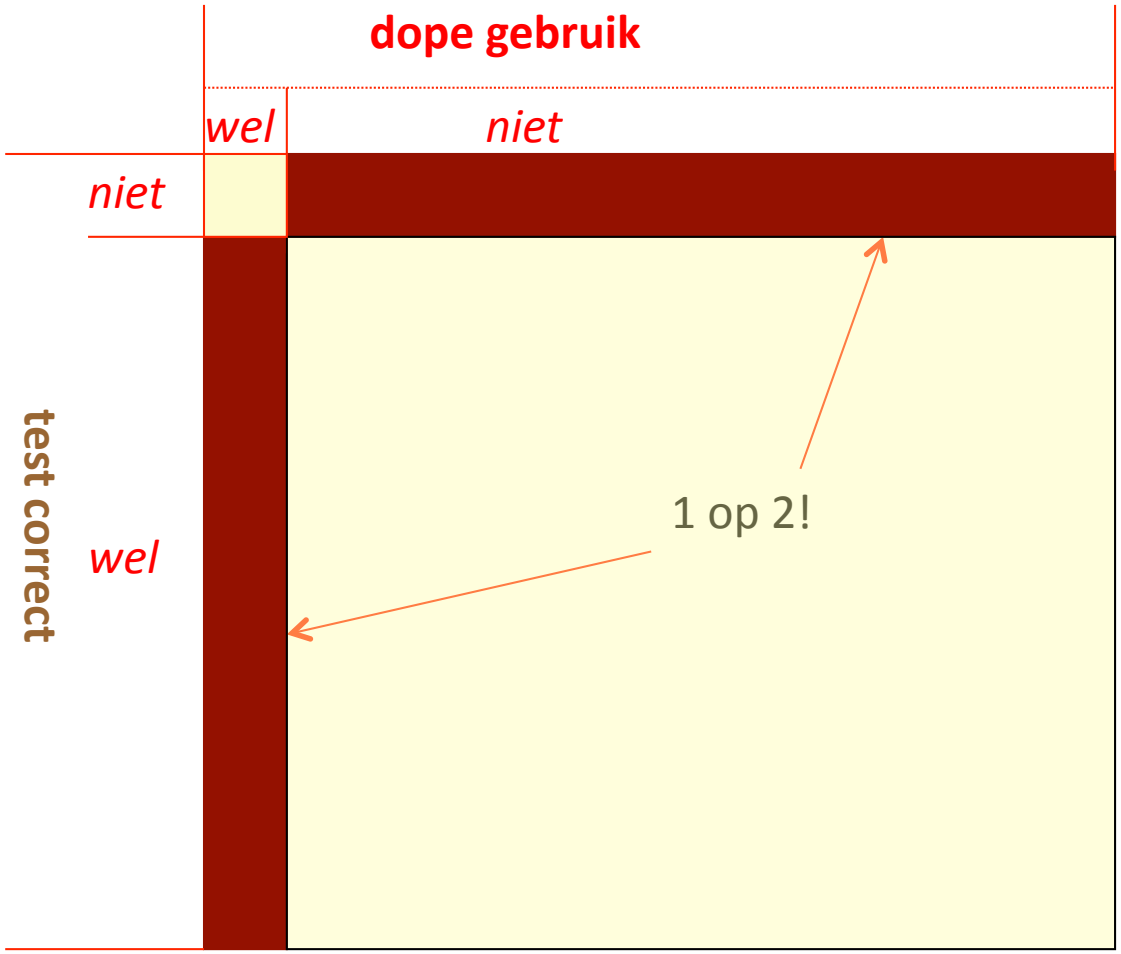
Er is een kans van 1% fout bij een doping test!

Een sporter test **positief** bij een doping test!

Wat is de kans dat hij schuldig is?

99:1?
1:2?
iets anders?

Analyse



= test positief

(oppervlak = aantallen)

Moraal: test altijd de tegengestelde hypothese!

logical truth?

are trees green?
when does a sculpture exist?
what is mass, charge, spin?
what is the smallest number that needs more than
    1000 characters to describe it?





Is the world deterministic?

Newtonian mechanics: the state of the world determines all future evolution
Quantum mechanics: the evolution of the wavefunction is deterministic
Neurophysiology: before you know you anticipate

Conclusion: there is no free will (Jan Verplaetse)
hence: there can be no responsibility...

Where is the mistake?

numerical truths?

Mysterious matrices: let *A, Y* be positive definite,
what about *AY*+*YA*? (scalar example: 2*3+3*2)

Example: $\begin{bmatrix}10 & 3\\ 3 & 1\end{bmatrix}\begin{bmatrix}1 & \\ & 10\end{bmatrix}+\begin{bmatrix}1 & \\ & 10\end{bmatrix}\begin{bmatrix}10 & 3\\ 3 & 1\end{bmatrix}=\begin{bmatrix}20 & 33\\ 33 & 20\end{bmatrix}$

is non positive definite (det = -689)!

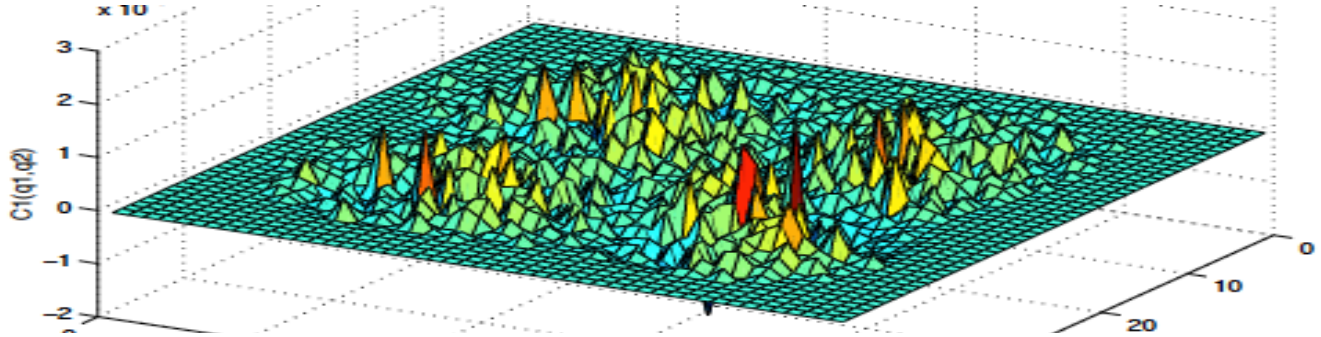
Other example: ill conditioning of $\begin{bmatrix}1 & 1 & \cdots & 1\\ & 1 & \ddots & 1\\ & & \ddots & \vdots\\ & & & 1\end{bmatrix}$

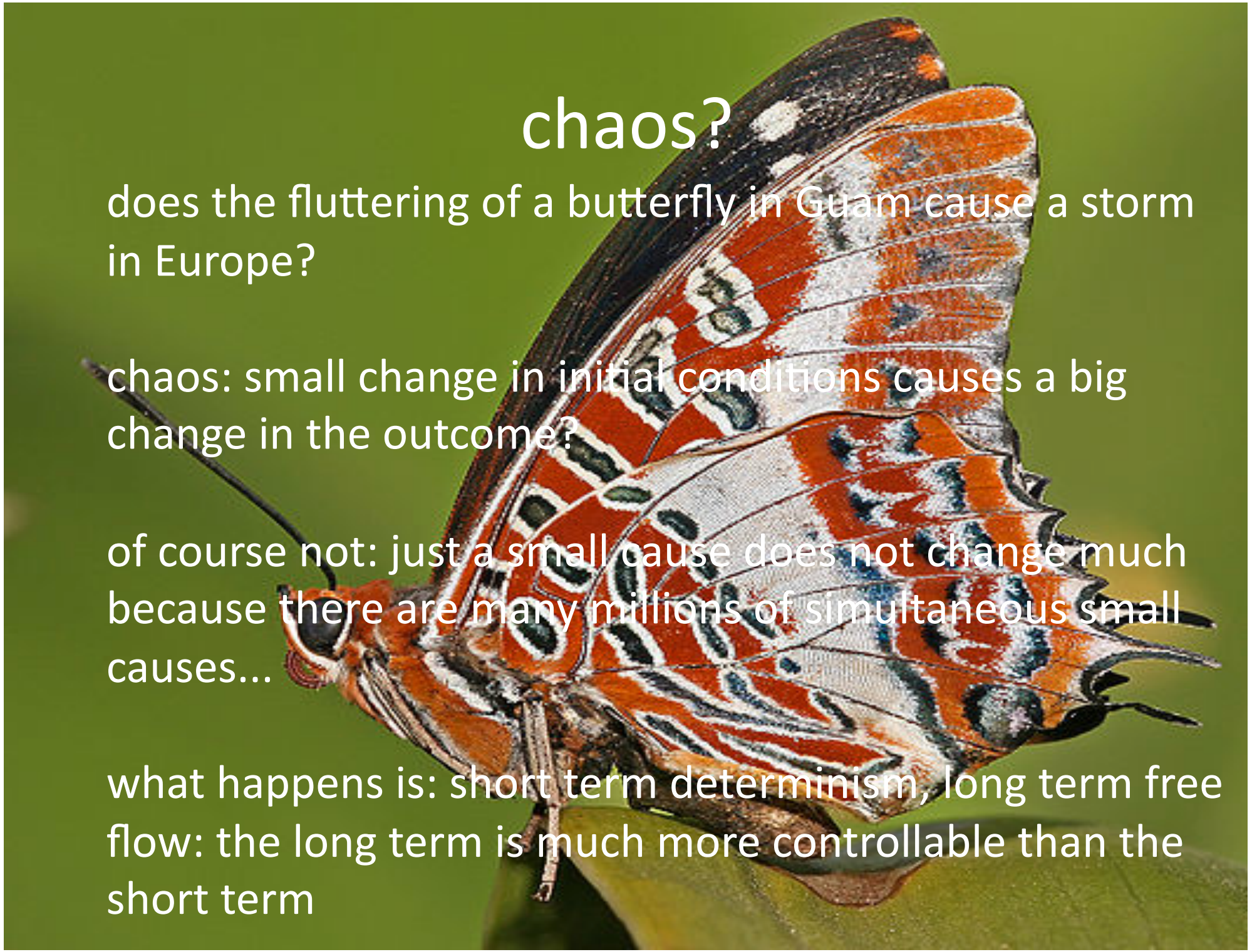
chaos

no wonder Joos got interested in chaos

Artificial Neural Nets easily run into chaos, but they can also do very interesting things such as providing good system approximations and support learning

Example of chaotic optimization: the time it takes to reach point B from point A with public transportation





chaos?

does the fluttering of a butterfly in Guam cause a storm in Europe?

chaos: small change in initial conditions causes a big change in the outcome?

of course not: just a small cause does not change much because there are many millions of simultaneous small causes...

what happens is: short term determinism, long term free flow: the long term is much more controllable than the short term

Joos and chaos

The same Artificial Neural Net produces chaos and good numerical approximations of non-linear functions!
[e.g. kernel-based mutivariate approximations]

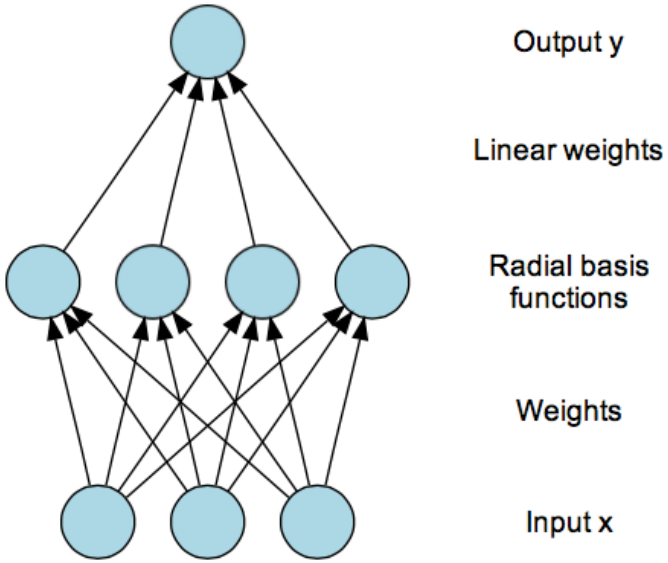
Chaos is unavoidable, but may lead to order

Examples: - the boiling pot
- learning and classification strategies

A contribution of Joos...

Establishing the relation between neural networks, numerical approximation and learning

feature maps through function approximations using a neural network



What would be the most motivating research topic for SP Valley?

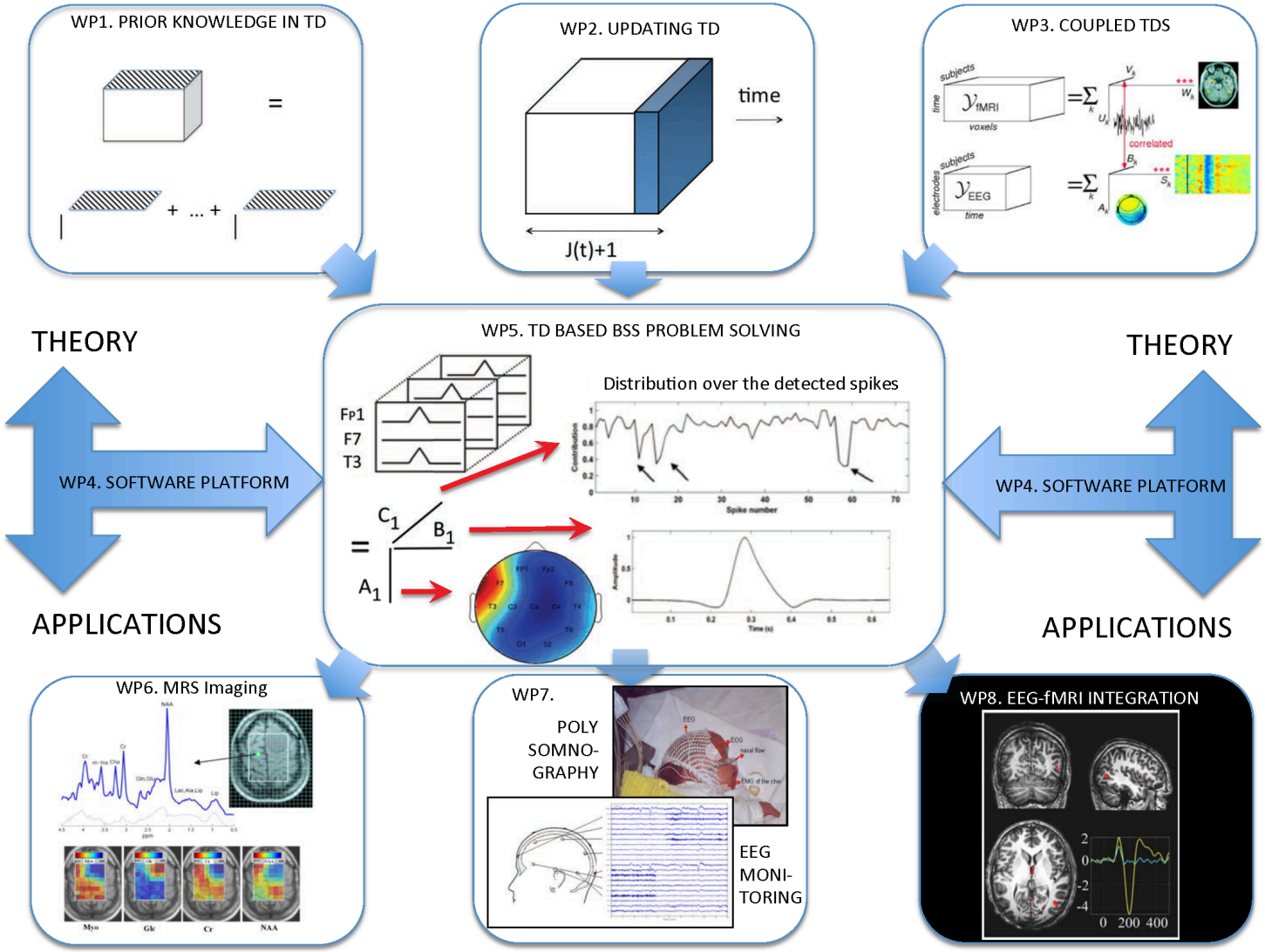
Switched Capacitor Filters?

Cellular Neural Nets?

Multivariate Analysis? YES YES YES!

Cryptography? YES YES YES!

Multi-multi Variate analysis: the search for truth



hiding the truth

So, from searching for truth, let us try to hide it!

cryptography



finally a way
to clinch the NSA!

Joos, a lot of thanks!

for:

- being such a dedicated student
- being so curious and enterprising
- being so concerned about teaching and students
- creating one of the best groups in SP in the world
- many scientific results
- motivating so many people
- being a great co-organizer of events
- enduring and engaging friendship
- making wonderful sculptures

and now: back to shaping the future...



to



ad multos annos...