



# cat top $\hookrightarrow$ elegant math $\hookleftarrow$ H<sup>2</sup>

20 years cat top applications in industry

NWECS 2003

March 28 - 29, 2003

Berlin, Germany





In this talk we will give a brief overview of the last 20 years' applications of categorical and topological methods in industry. Most of them have already been presented at conferences in recent years and papers as well. In particular during this series of conferences -the North West European Category Seminar (formerly called NWDKS, NDKS and/or NWEKS)- we have shown the current "state of the art".

Concrete applications are: forecasts, scheduling, optimisation, pattern recognition, data chasing, referential integrity, data integrity, time series, artificial (i.e. computer aided) smelling, hearing, visualising, manufacturing, quality checks.

The disciplines are: energy industry, space technology, architecture, civil engineering, mechanical engineering, medicine, dental, animal farming, chemistry, biochemistry, climate research, weather forecast, reinsurance (derivatives).

The talk is given in homage to our cat top friend Horst Herrlich, "THE CATTOPologist", dedicated to his retirement.

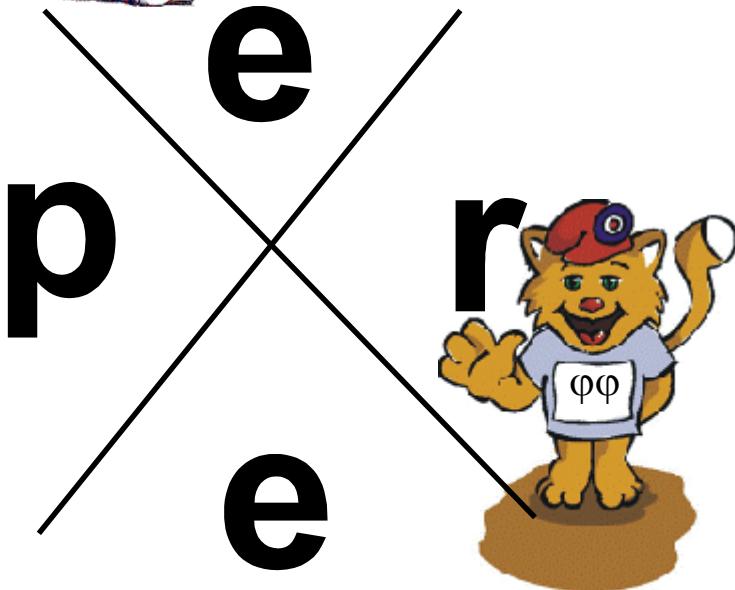
(By coincidence the date of this event are exactly the same day and place with regard to Alexander Grothendieck's 75<sup>th</sup> birthday, born 1928 in Berlin)





cat top  $\hookrightarrow$  elegant math  $\hookrightarrow \mathbb{H}^2$

## agenda



65<sup>th</sup> of Horst Herrlich



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- **H**ereditary ...
- **O**ther ways of thinking ...
- **R**ich visualisation tool
- **S**erious applications
- **t**oday's vision





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you know him ???



source: <http://www.math.fu-berlin.de/~begehr/buch/mathematicians.html>

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you know him !!!

BEB  
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source: <http://www.math.fu-berlin.de/~begehr/buch/mathematicians.html> & J. Koslowski

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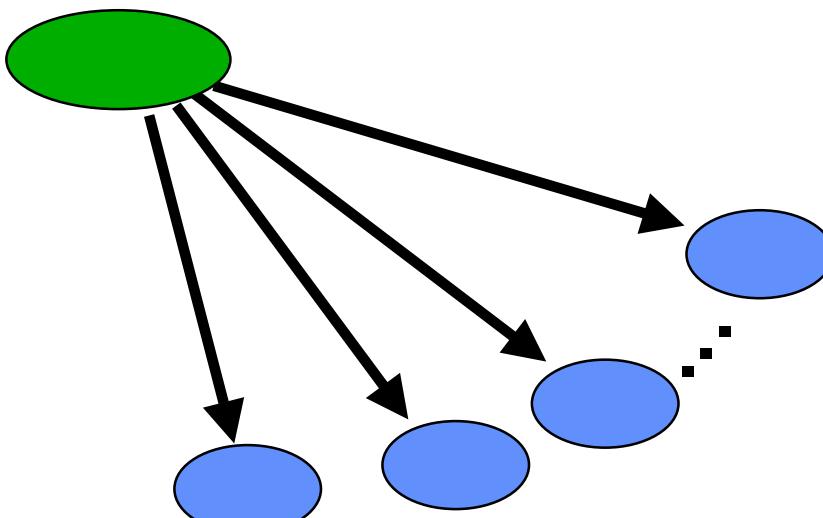




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visualisation + and -

+





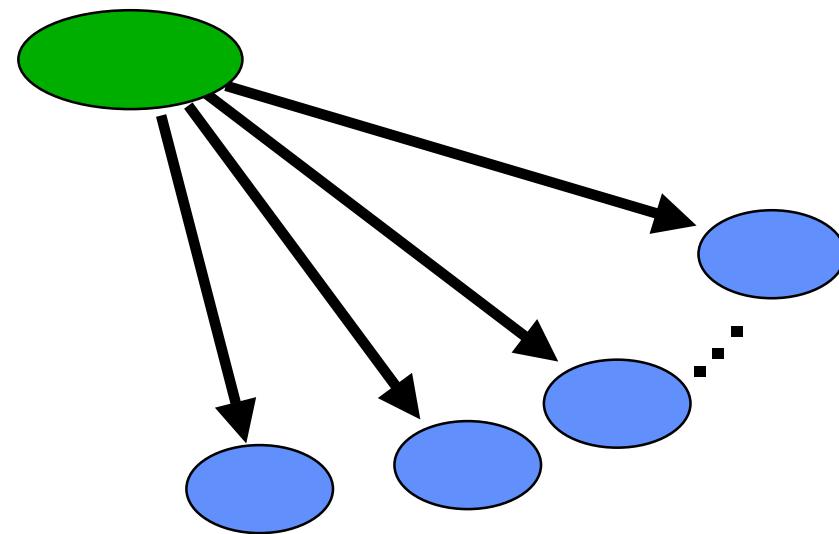
cat top  $\hookrightarrow$  elegant math  $\hookrightarrow \mathbb{H}^2$

visualisation + and -



## top cats - initial structures

+



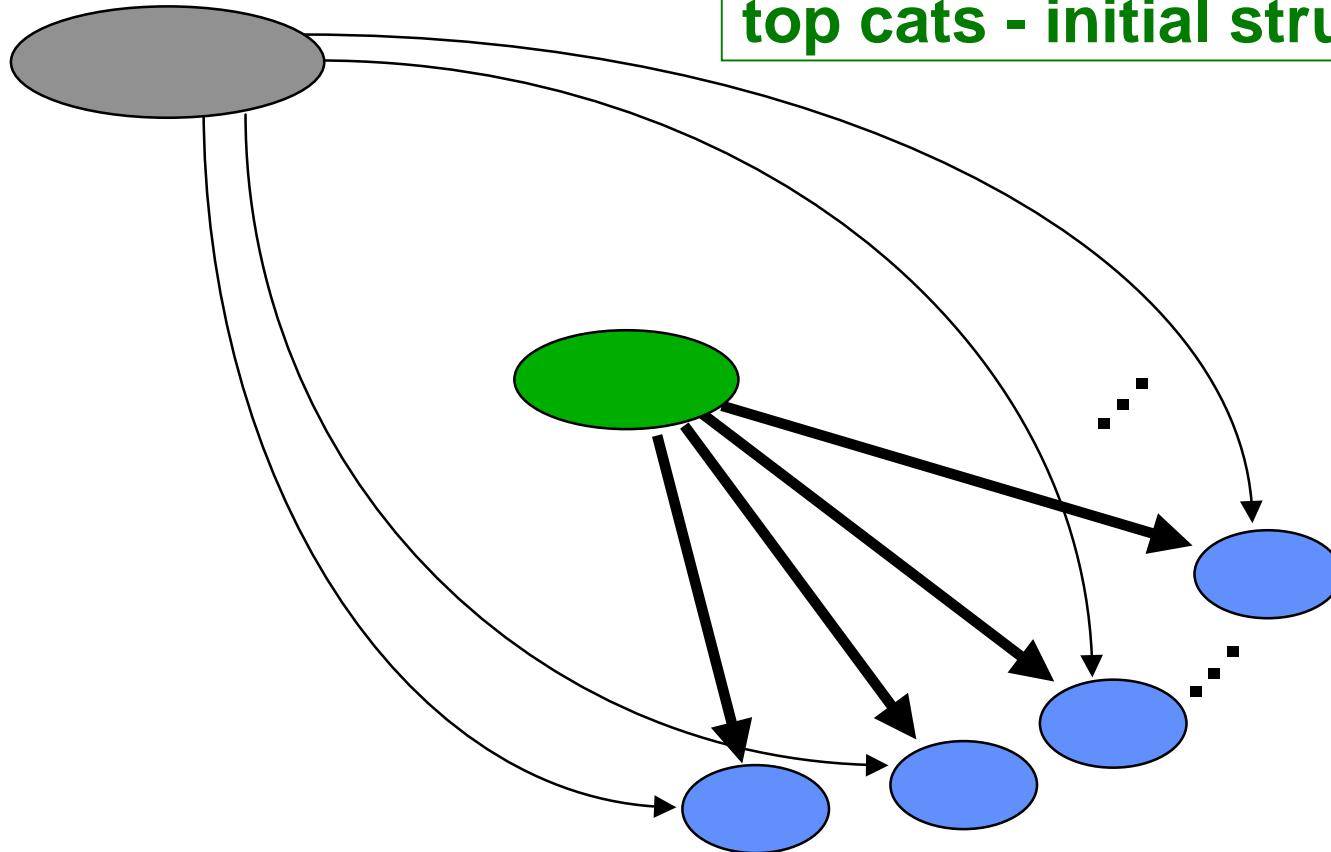


cat top  $\hookrightarrow$  elegant math  $\hookrightarrow \mathbb{H}^2$

visualisation + and -

## top cats - initial structures

+



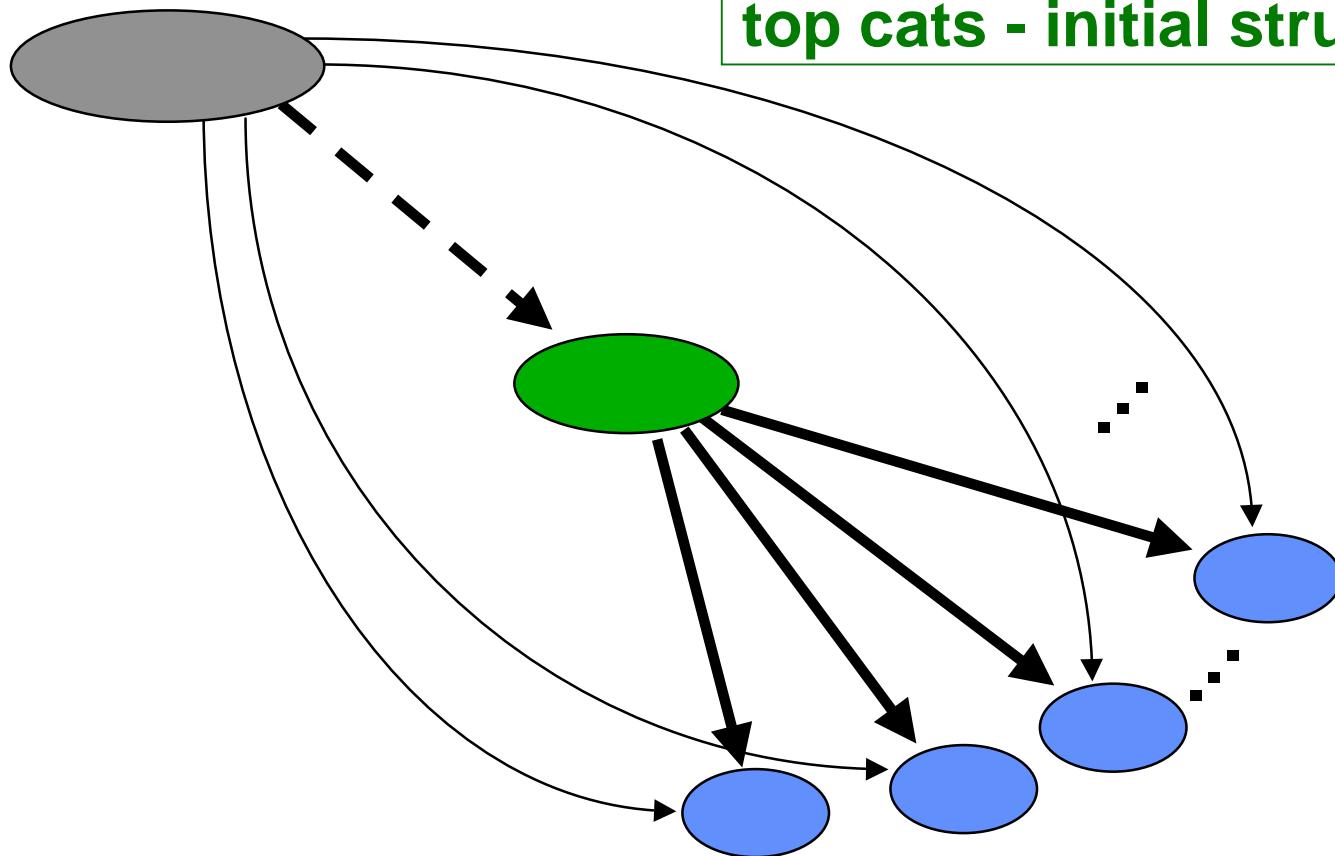


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visualisation + and -

## top cats - initial structures

+



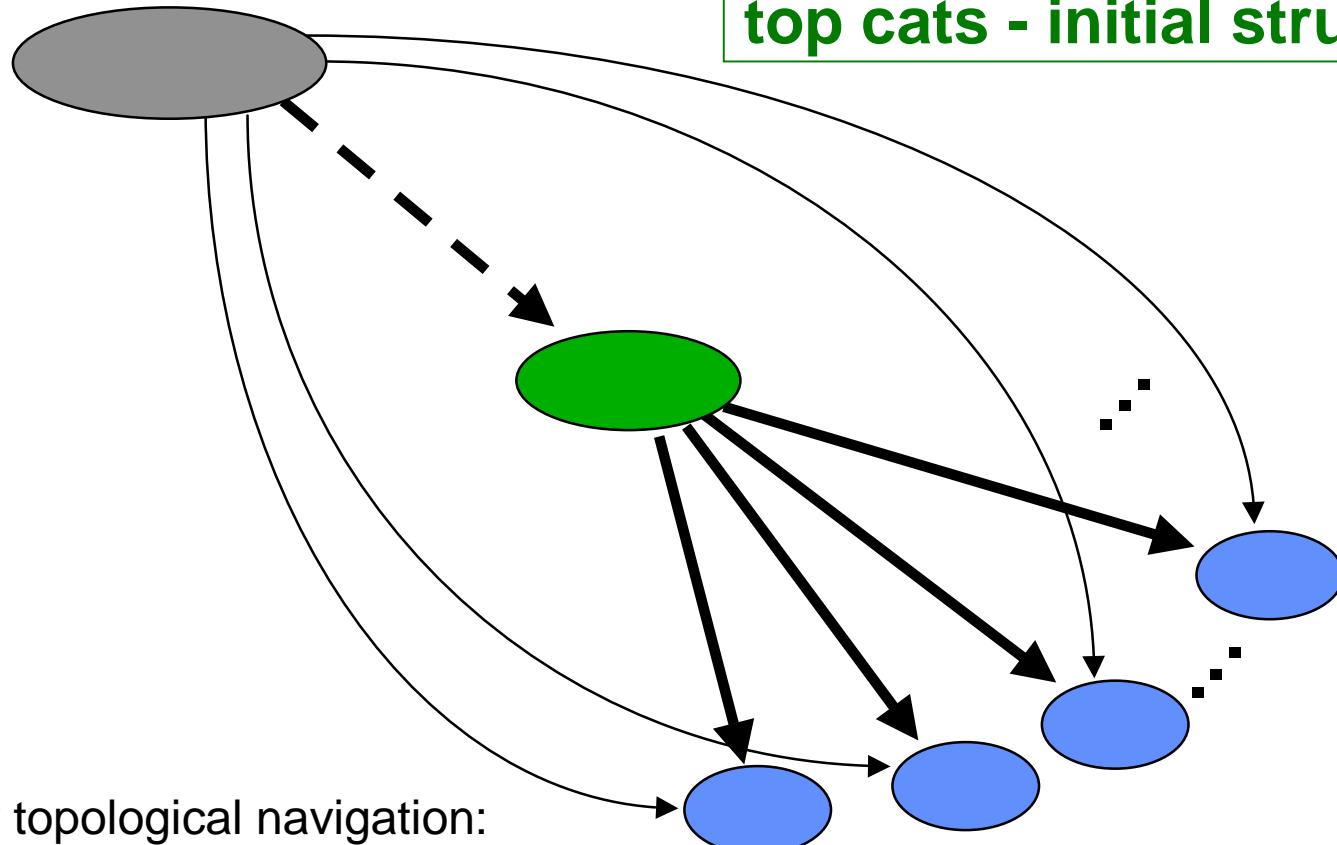


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visualisation + and -

## top cats - initial structures

+



relevant for topological navigation:

subspace ( $\curvearrowright$  easy handling, construction & views of parts of grids)

product ( $\text{hand}$  all different views easy to construct, navigate & linkable)

(and the duals quotients and coproducts)

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visualisation + and -

$$\lim_{x \rightarrow 8} \frac{8}{x - 8} = \infty$$

■

$$\lim_{x \rightarrow 5} \frac{5}{x - 5} =$$



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visualisation + and -

$$\lim_{x \rightarrow 8} \frac{8}{x - 8} = \infty$$

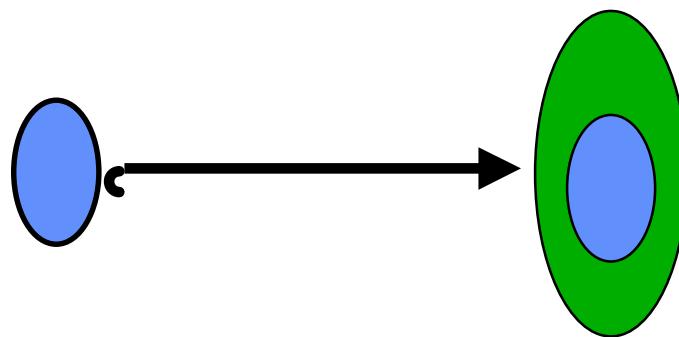
$$\lim_{x \rightarrow 5} \frac{5}{x - 5} = 5$$





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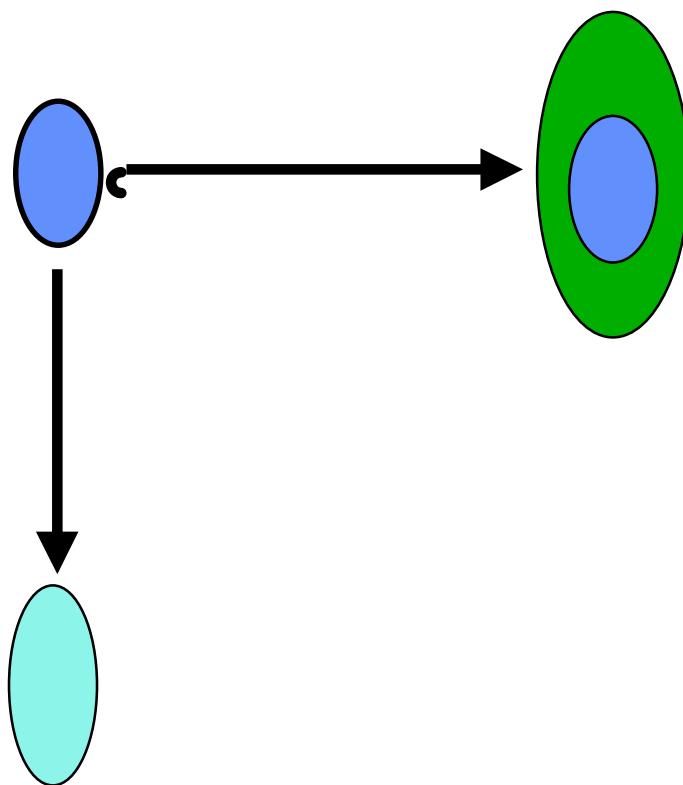
## quasitopoi - partial morphisms





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## quasitopoi - partial morphisms

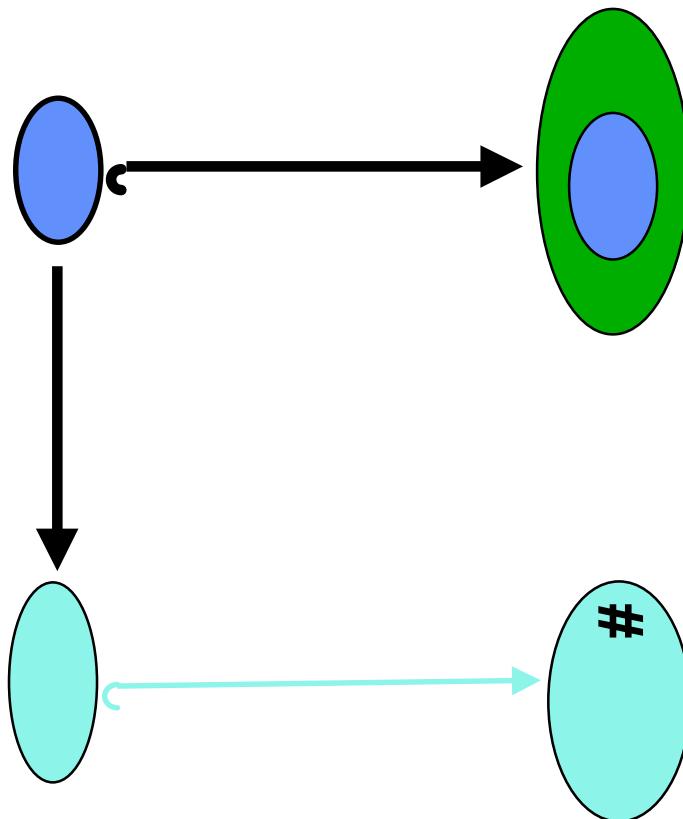




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## quasitopoi - partial morphisms

1-point-extensions ...

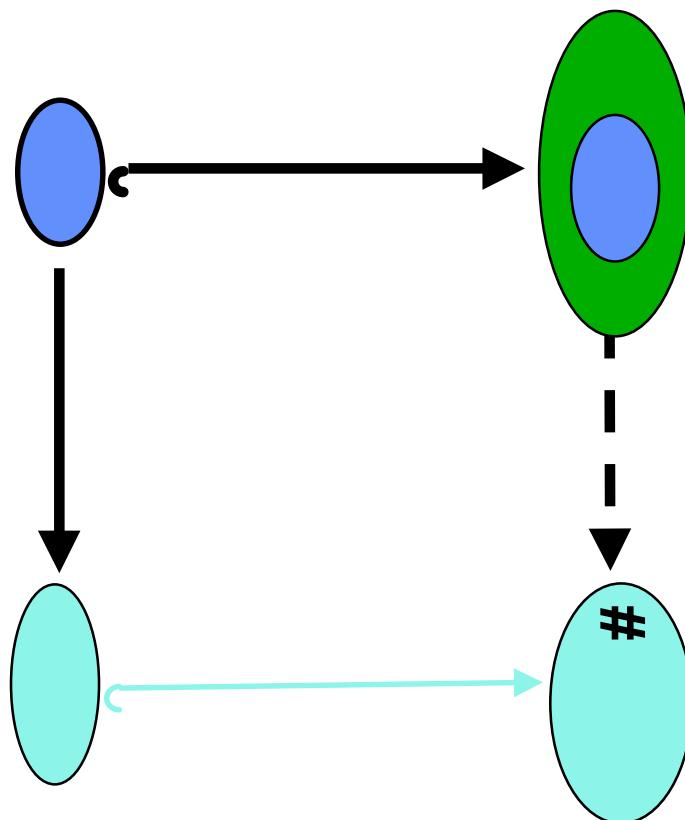




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## quasitopoi - partial morphisms

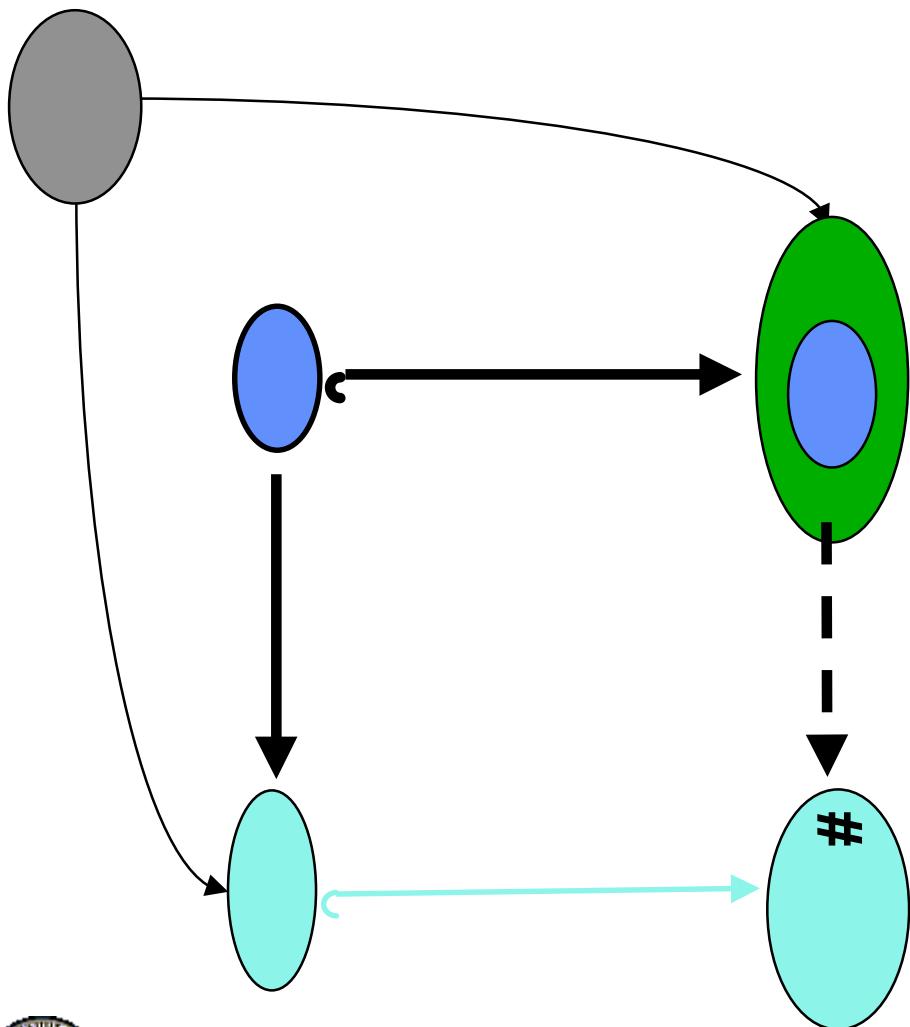
1-point-extensions ...





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## quasitopoi - partial morphisms



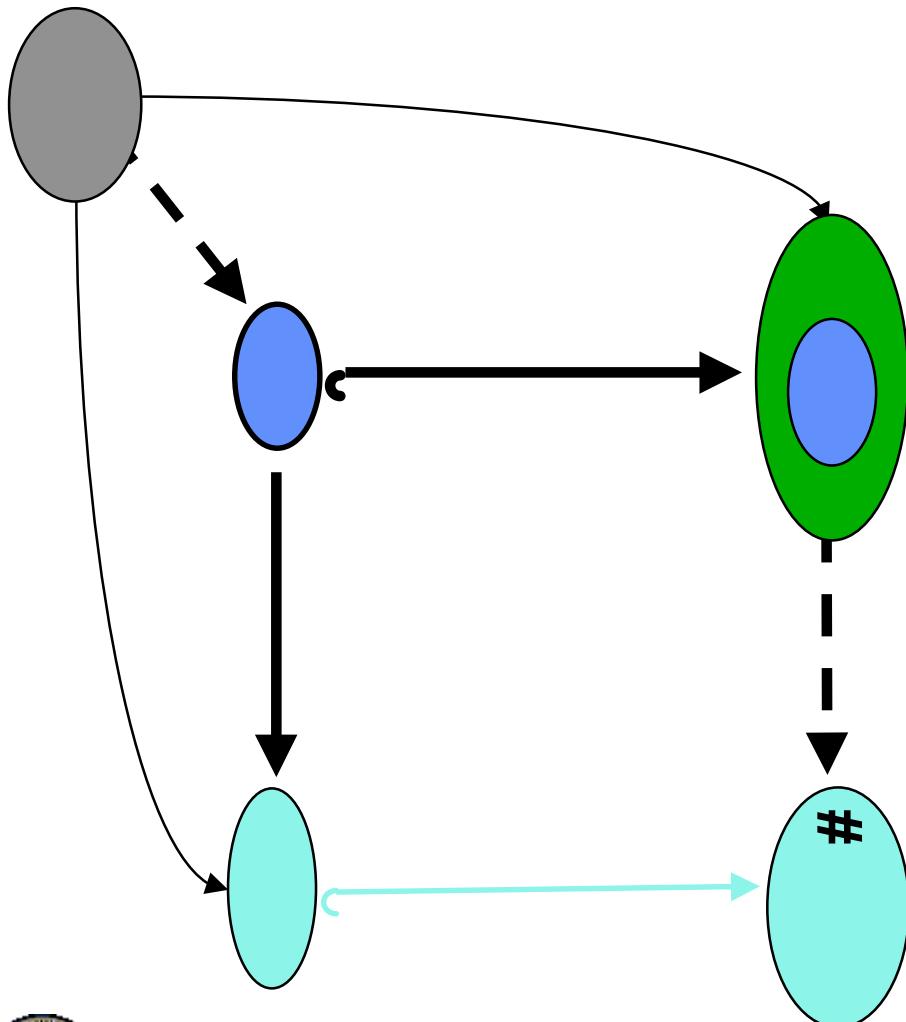
1-point-extensions ...





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## quasitopoi - partial morphisms



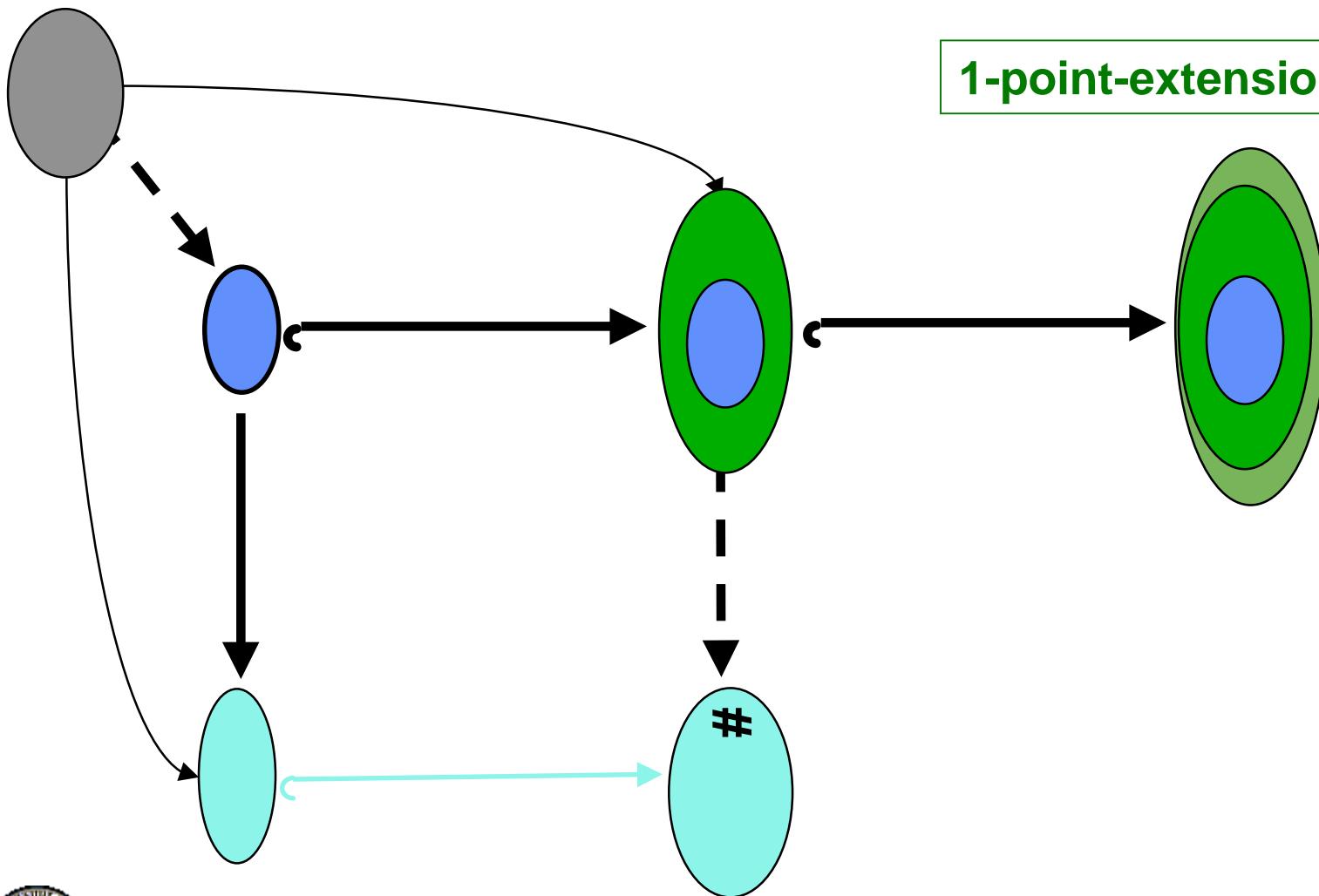
1-point-extensions ...





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## quasitopoi - partial morphisms



1-point-extensions + ...





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other than 1-point-extensions ...



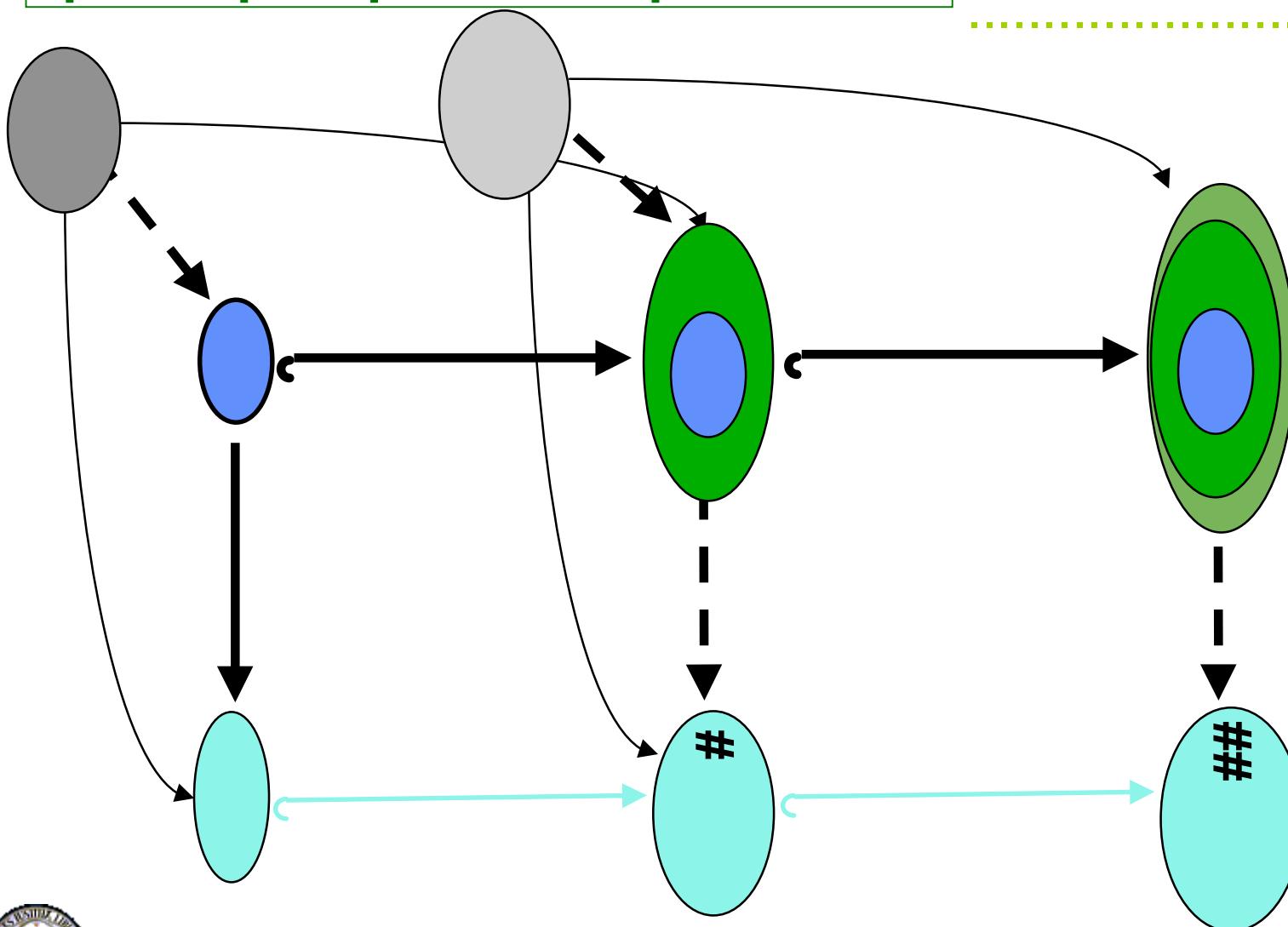
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## quasitopoi - partial morphisms

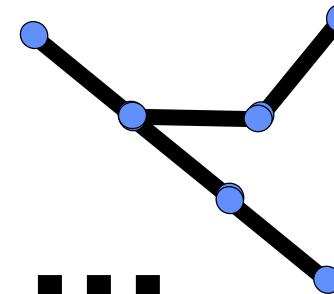
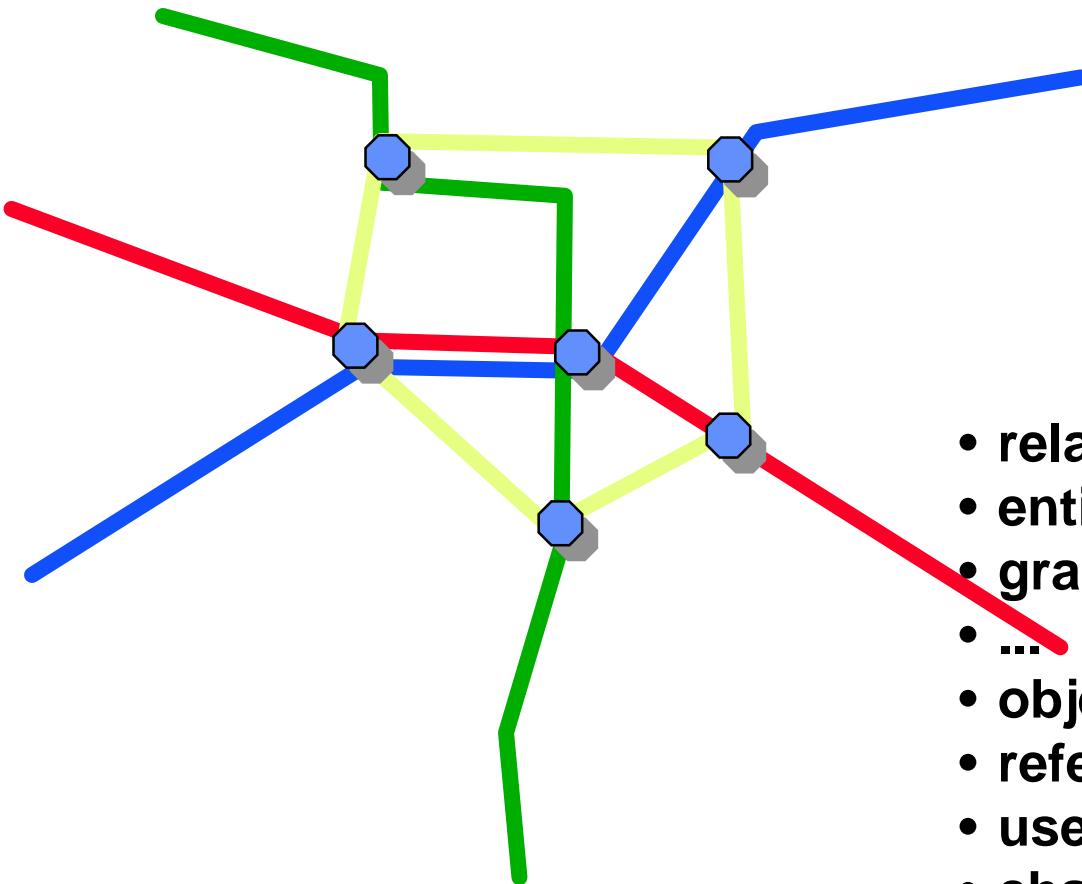


relevant for  
forecasters,  
schedulers,  
optimisers,  
pattern rec.,  
etc.



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## points vs relations



- relational DBs
  - entity relationship models
  - graph theory in comp. sc.
  - ...
  - object orientation (oop)
  - referential integrity
  - user's view
  - chaos in big info systems
- need of cat top assistance**



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## SCADA / ConCADA

### SCADA\*):

- Topology
- Theory of Graphs

### ConCADA\*\*):

- Category Theory
- Pretopologies

\*) Supervisory Control And Data Acquisition

\*\*) Contract Control And Data Acquisition





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where we have to go ... ?

my 5-point-”edit”-program: computer assistance for

- ≈ better isos e.g. automation for offset optimiser for visualisation, ...
- ≈ part of grid (subgrids)
- ≈ gluing together of grids (coproducts)
- ≈ simplifying grids (quotients)
- ≈ product of grids (products)



my 5-point-”navigator”-program: computer assistance for

- ≈ “topology” of configuration (ref. integrity)
- ≈ arbitrary relation (or point/object) “on course” (traction)
- ≈ neighbourhoods stepwise via setoidal automorphisms)
- ≈ alternative info (“fuzzy”, “messiness”)
- ≈ “pattern” recognition (quick reconstruction/reuse of path)



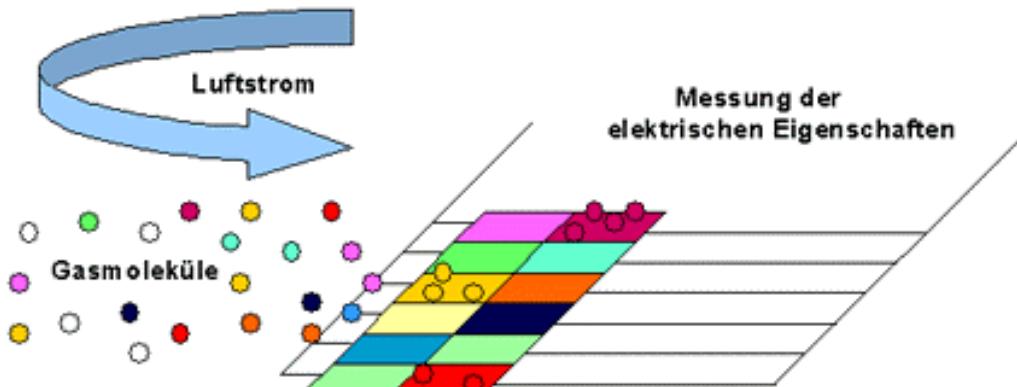
=> now topological features required !!!





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## Human Interface Supervision System

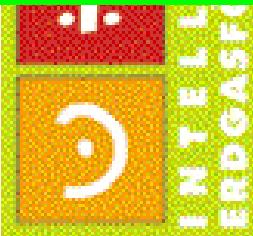


Dotierte Trägerplättchen

Intelligente  
Erdgasförderung



<http://www.beb.de/hiss>

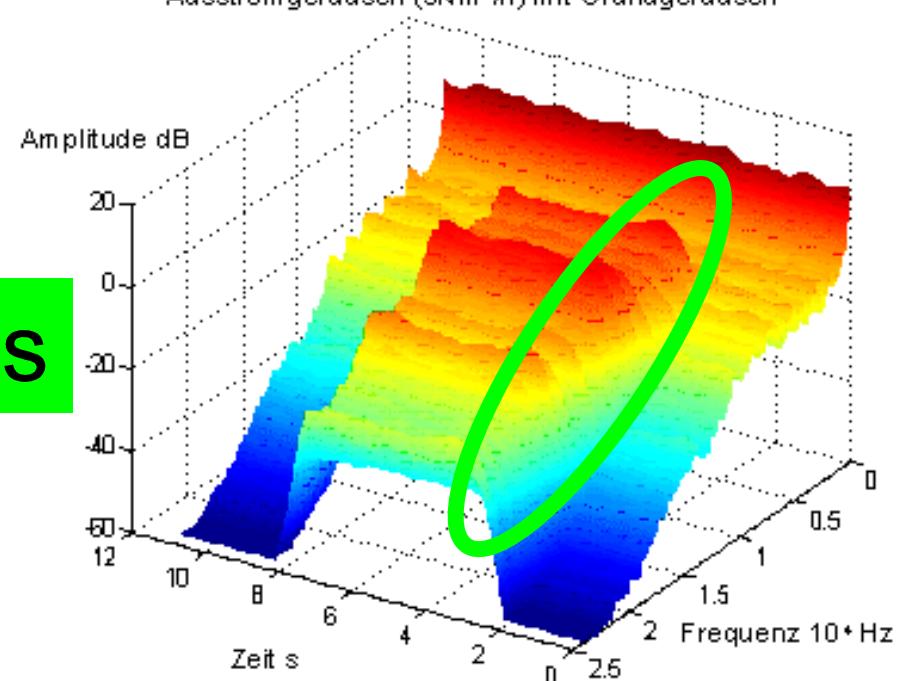


EXPO2000  
HANNOVER

Registriertes Projekt:  
der Weltausstellung

pattern recognition:  
fuzzy logic & neural nets  
better => PreTOPs

Ausströmeräusch ( $5 \text{ Nm}^3/\text{h}$ ) mit Grundgeräusch

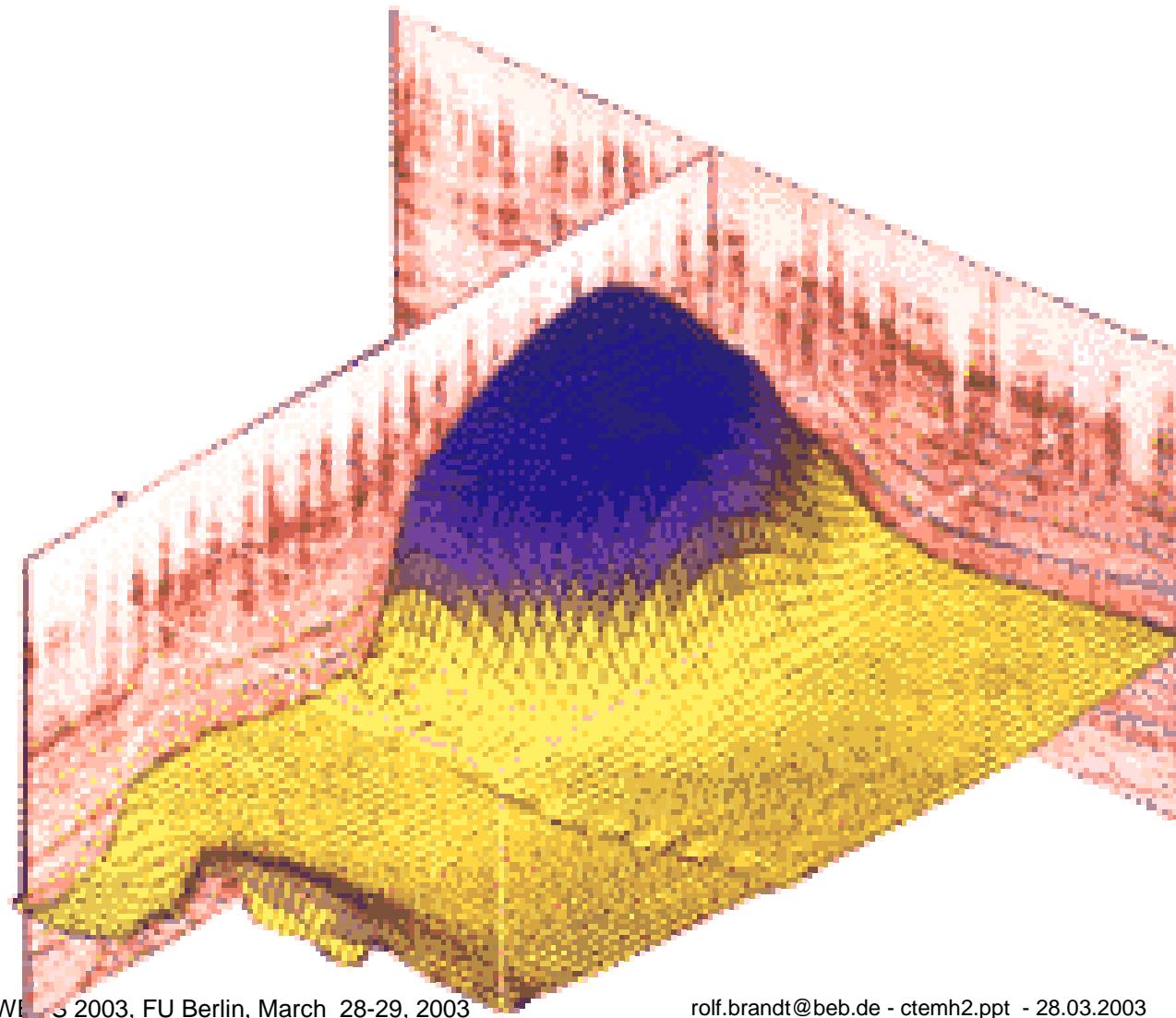


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number crunching ...



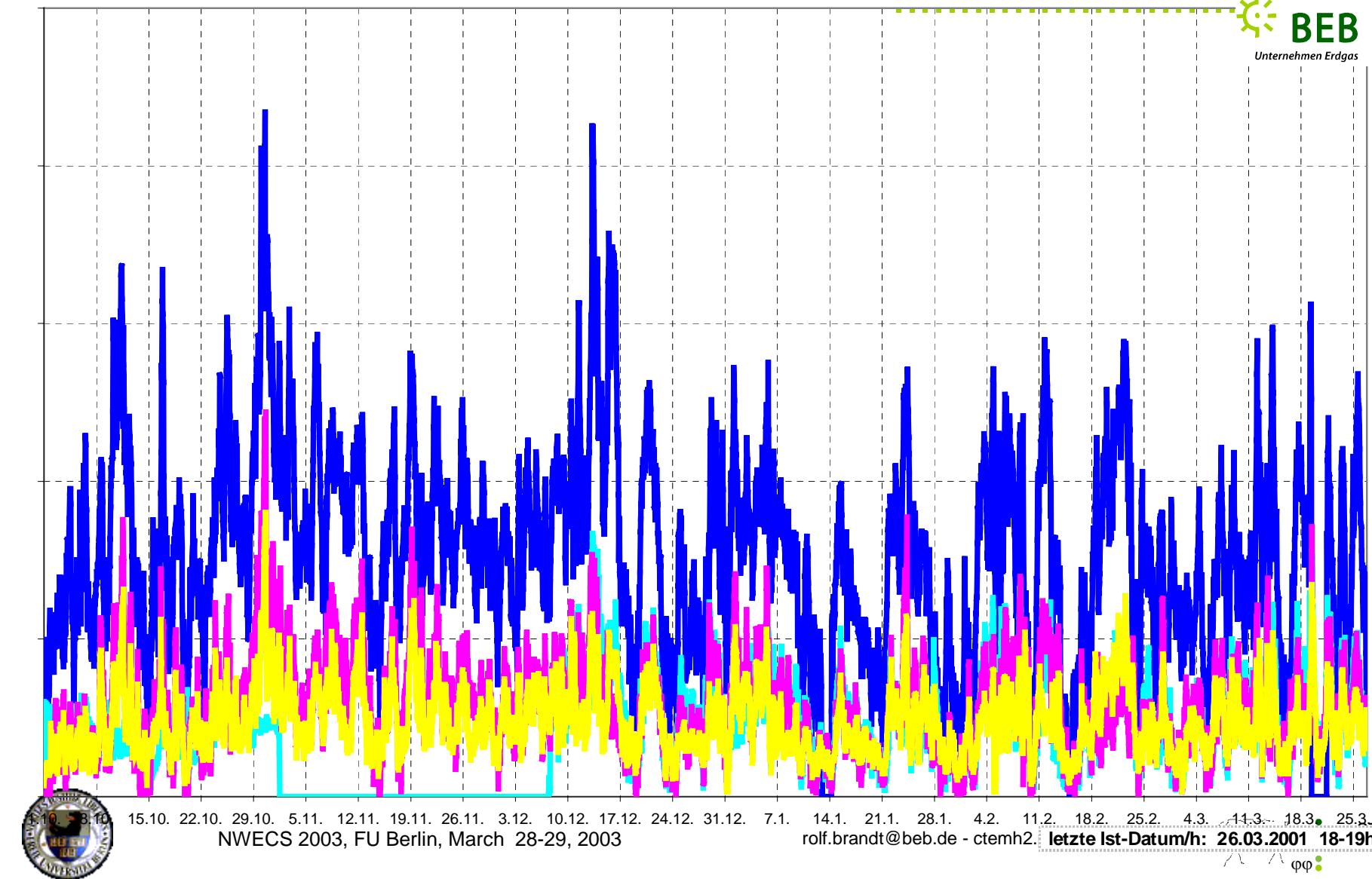
relevant for  
forecasters,  
schedulers,  
simulators,  
optimisers,  
pattern rec.,  
etc.





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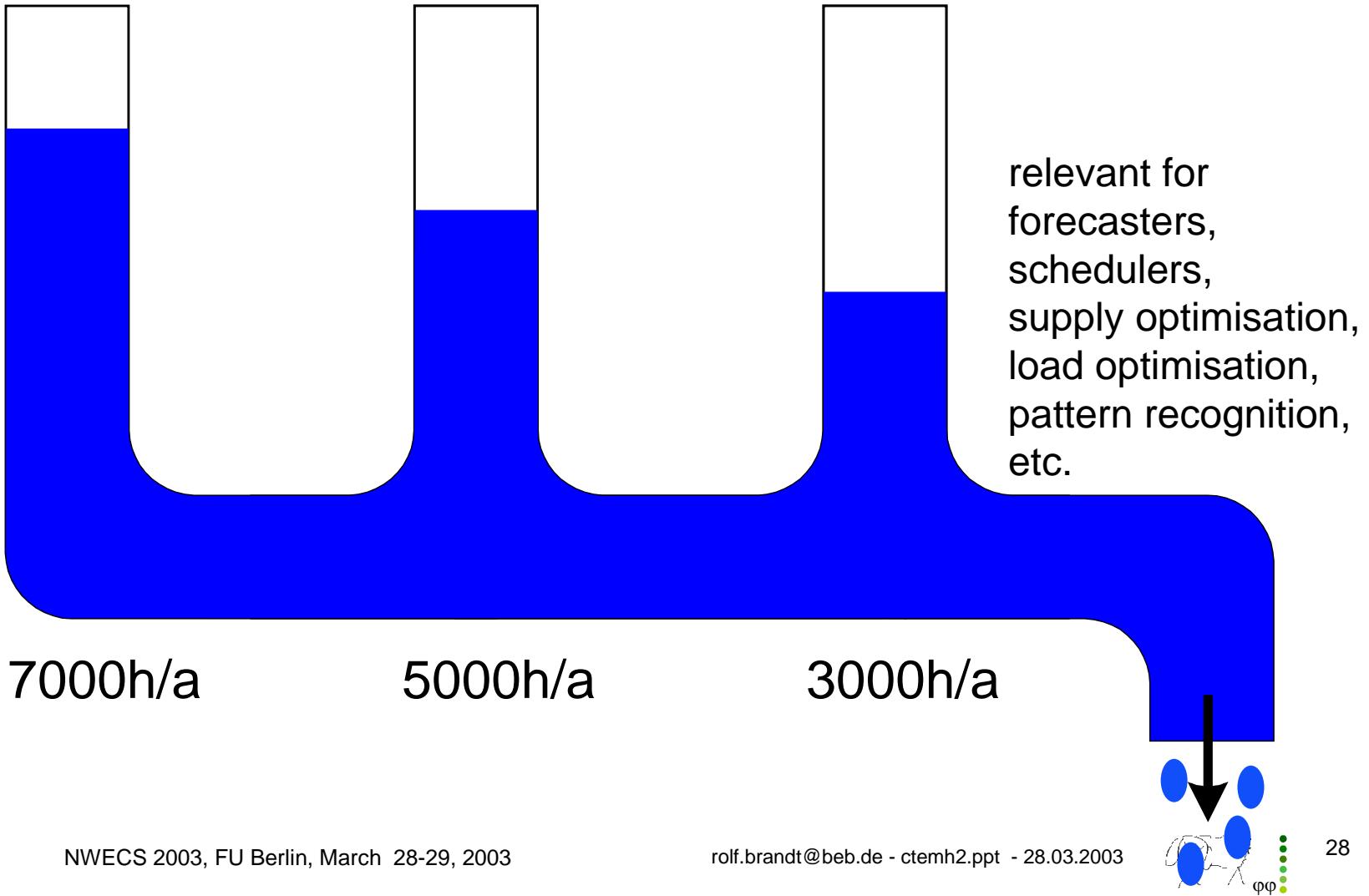
## errors in time series





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communicating tubes = bin packing

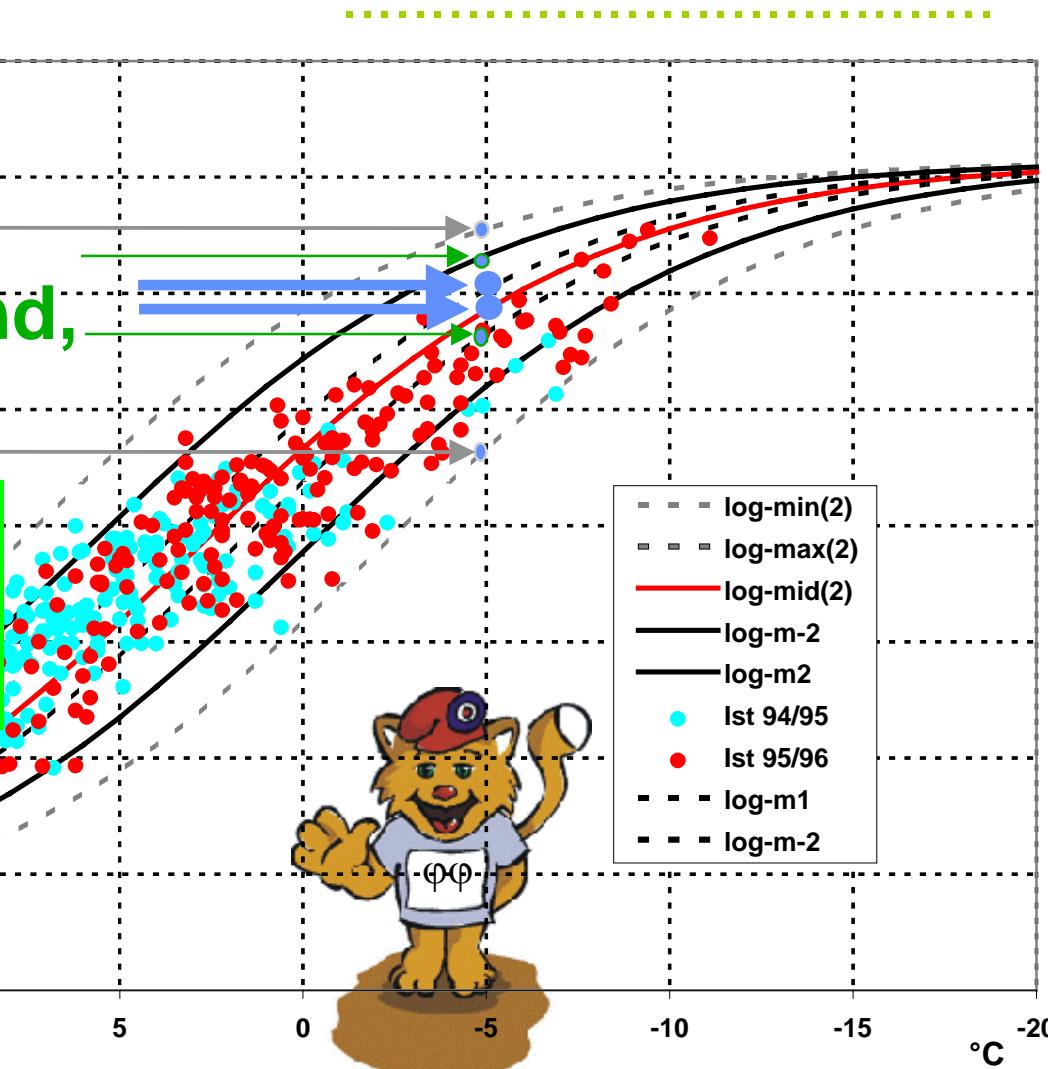




m<sup>3</sup>/d

next information ...  
(e.g. temperature, wind,  
cloud, history, ...)

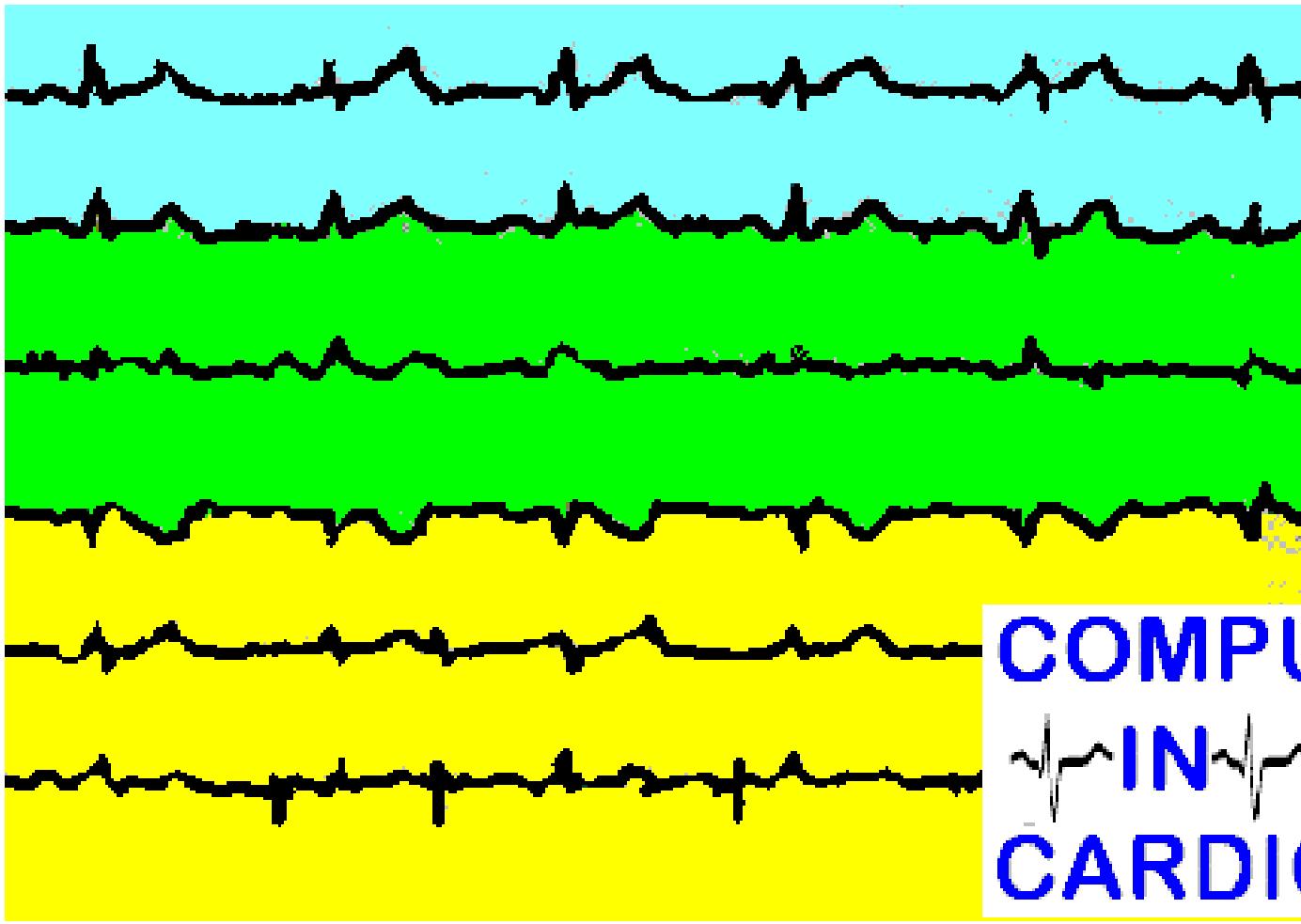
models for climate:  
„Wetter Michel“  
„felt temperature“, ...





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ECGs



**COMPUTERS  
IN  
CARDIOLOGY**





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natural algorithms ...



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Mandala-Dach

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tradition

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## Mathematiker in Berlin (17.-20. Jahrhundert)

Ordnung: Geburtsjahr nach Jahrhunderten; dann alphabetisch nach Nachnamen.

### Mathematiker in Berlin - 17. Jahrhundert

 <p>Leibniz Gottfried Wilhelm 1646-1716</p>	 <p>Leibniz Gottfried Wilhelm 1646-1716</p>
	

Fertig Internet

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<b>Timpe</b> Anton Aloys 1882-1959	<b>Vahlen</b> Theodor 1869-1945	<b>Weber</b> Heinrich 1842-1913	<b>Weierstraß</b> Karl Theodor Wilhelm 1815-1897	<b>Weierstraß</b> Karl Theodor Wilhelm 1815-1897	<b>Weingarten</b> Julius 1836-1910
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Das älteste Vereinsbild des Mathematischen Vereins aus dem Jahre 1863.  
Obere Reihe (v.l.n.r.): Theume, **H. A. Schwarz**, Kallius, Steinbart.  
Untere Reihe: Berner, Karl Otto Emil Lampe, Deite, Schwaibe.

## Mathematiker in Berlin - 20. Jahrhundert

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Ahmed Abou *1938	Sigurd *1935	Walter *1931	Karl-Heinz *1938	Gerhard *1938	Fritz-Joachim *1927	Gerhard *1941
Geppert Harald 1902-1945	Grell Heinrich 1903-1974	Grottemeyer Karl Peter *1927	Haack Wolfgang Siegfried 1902-1994	Habetha Klaus *1932	Hellwig Günter *1926	Herrlich Horst *1937

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$\mathbb{H}^2$  1975



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Mannheim 1975



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Murten 1984

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Louvain La Neuve 1987

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L'Aquila 1994

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Antwerp 1998

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Antwerp 1998

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Antwerp 1998

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NDKS 2000 Dötlingen



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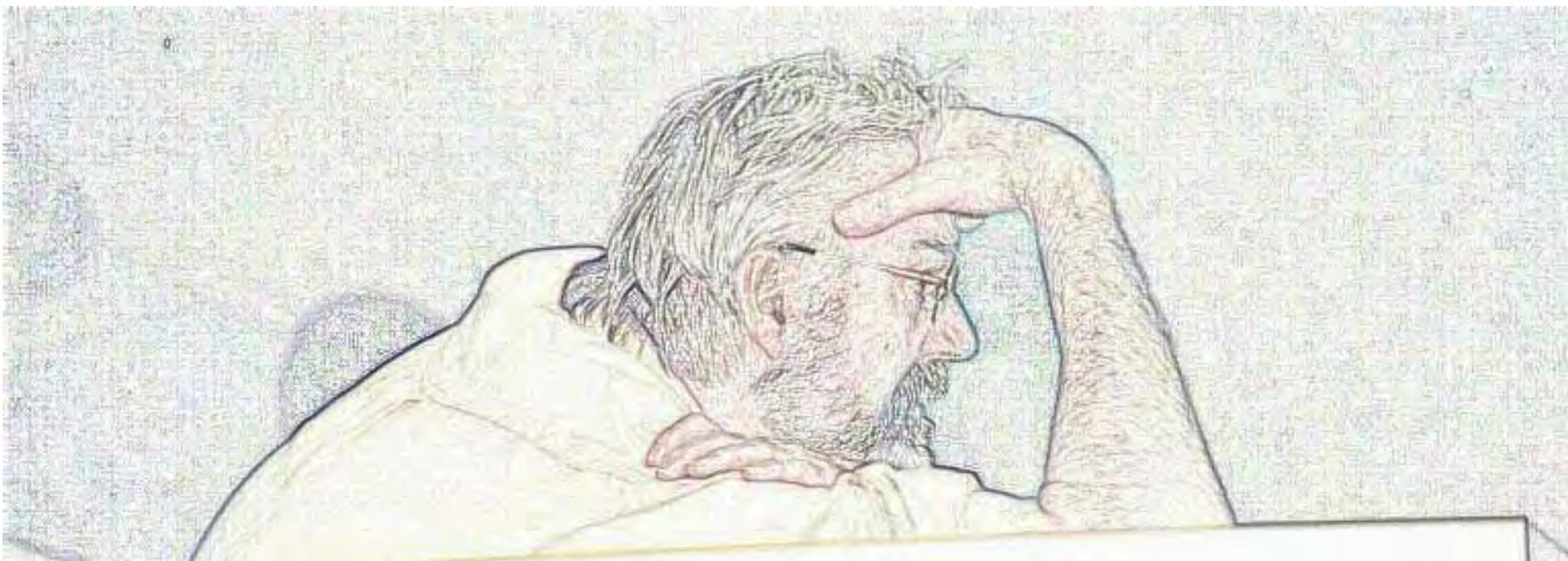
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Bremen 2000

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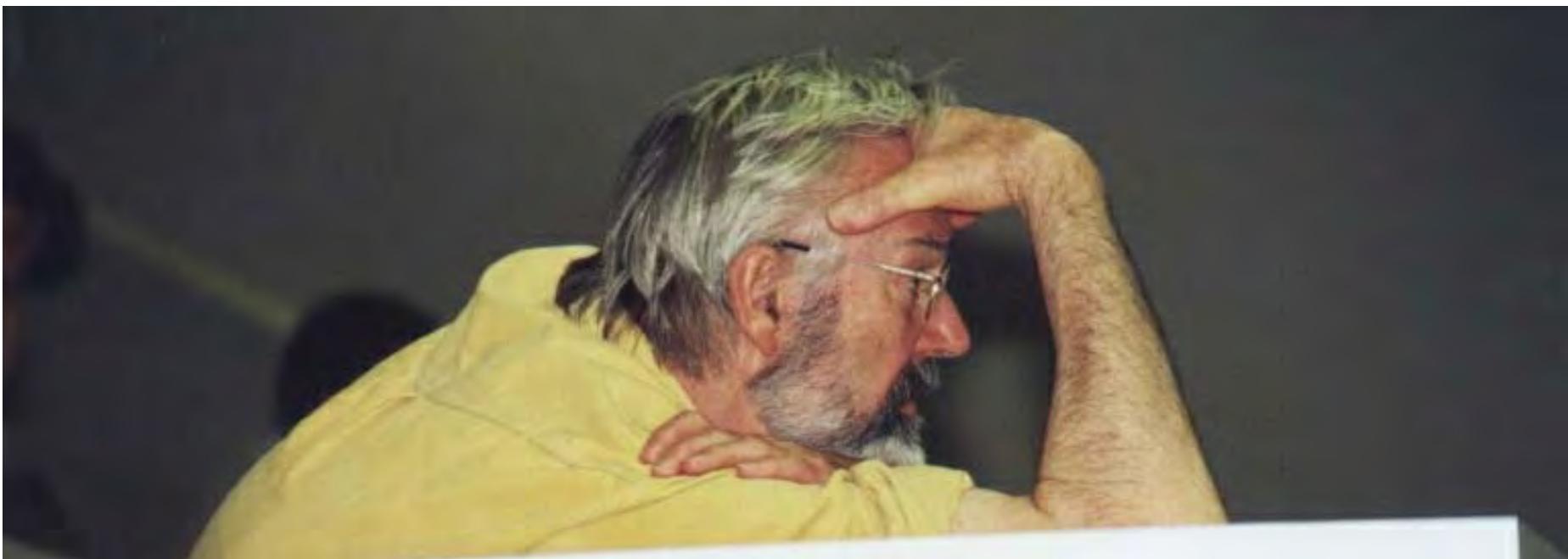
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Bremen 2000

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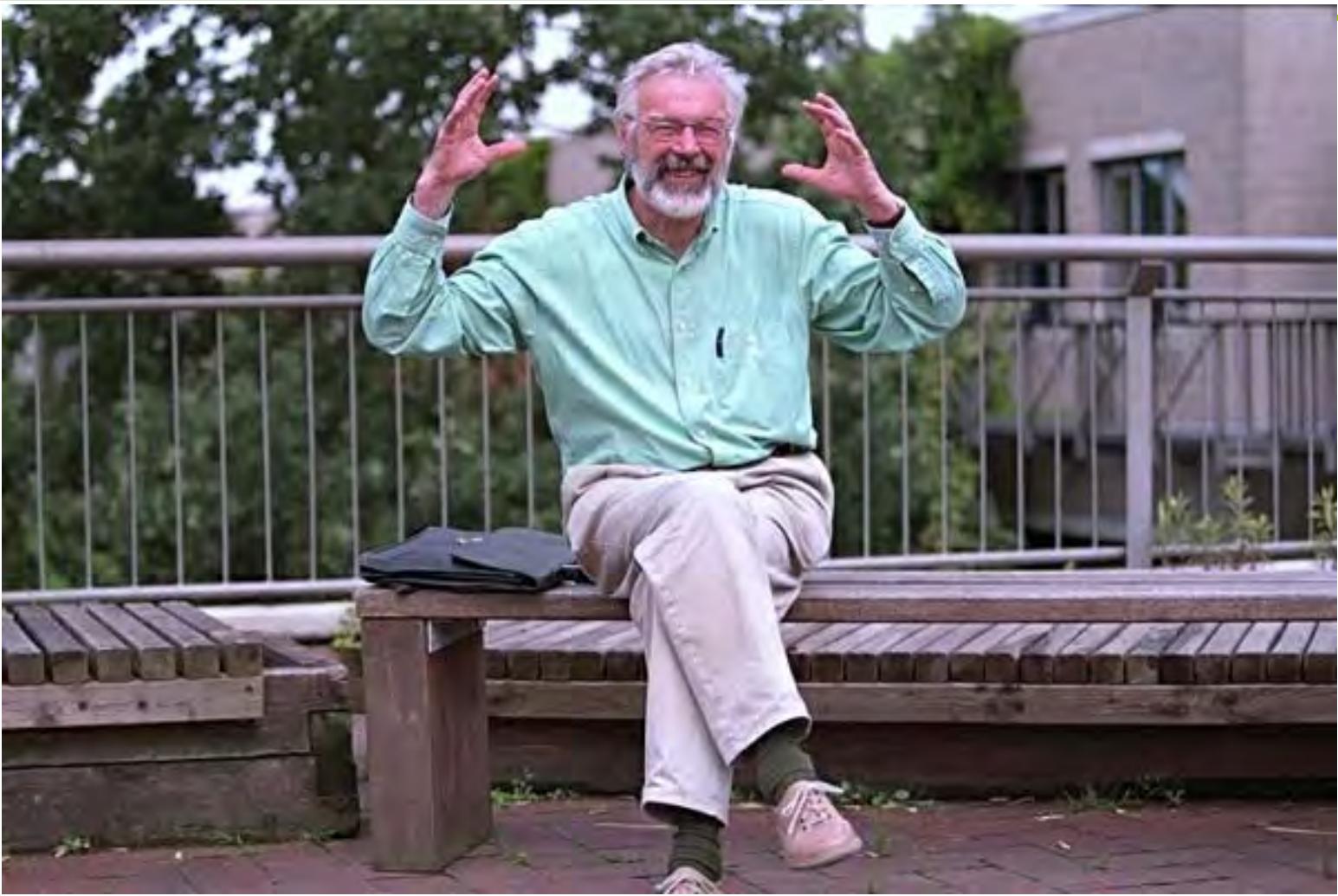


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Bremen 2000



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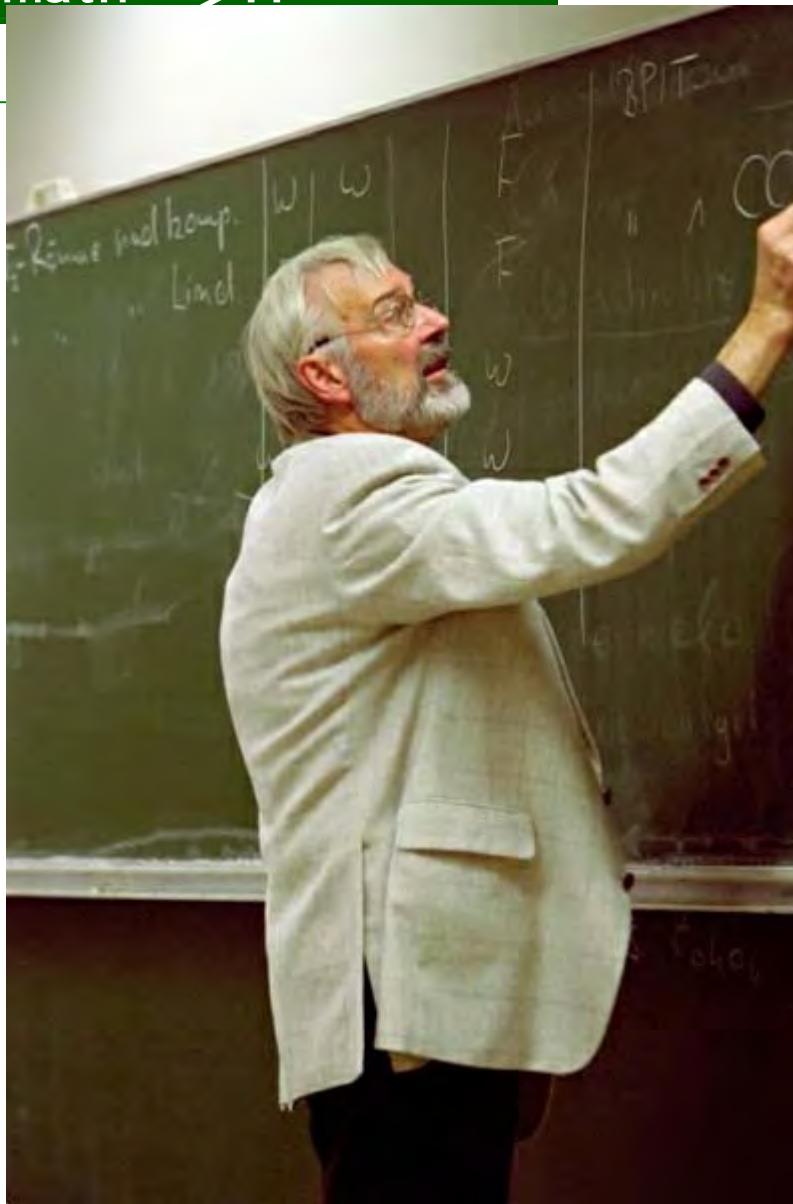




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Bremen 2002

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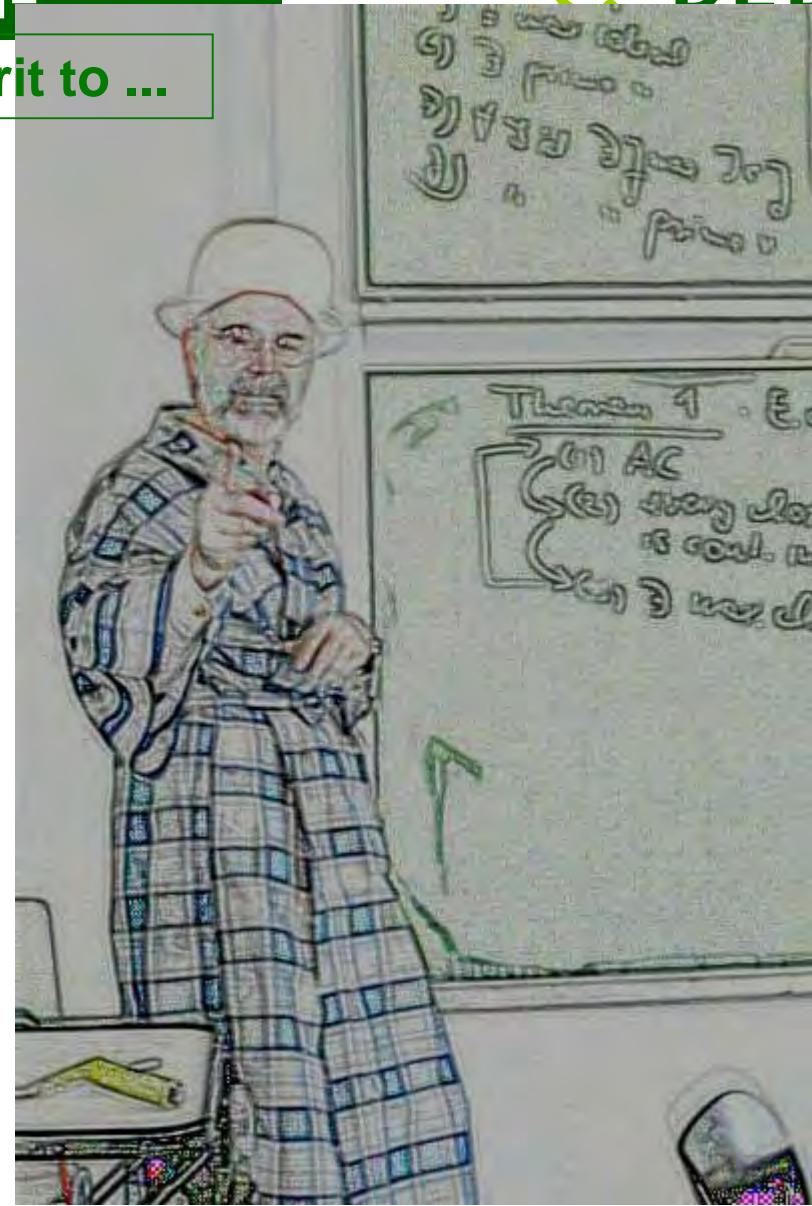


cat top  $\hookrightarrow$  elegant math  $\hookrightarrow \mathbb{H}^2$

from Spreephantom via Weserspirit to ...



source: e-mail from KatMAT group Bremen





cat top  $\hookrightarrow$  elegant math  $\hookrightarrow$   $H^2$



## Y.T. Rhineghost

source: e-mail from KatMAT group Bremen



**5 years ago:**  
**(to 70<sup>th</sup> / 60<sup>th</sup> ...)**



# Topology & GMS

"Topology versus Algebra für Gas Management Systeme"  
Untertitel: Angewandte kategorische Topologie für Netze

**Alexander Grothendieck**  
(\*1928 in Berlin)



**Horst Herrlich**  
(\*1937 in Berlin)





cat top  $\hookrightarrow$  elegant math  $\hookrightarrow \mathbb{H}^2$

ciao Horst ...



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**Yours Jürgen and Rolli**



source: KatMAT group Bremen



... thank you  
for your  
kind  
attention ...

