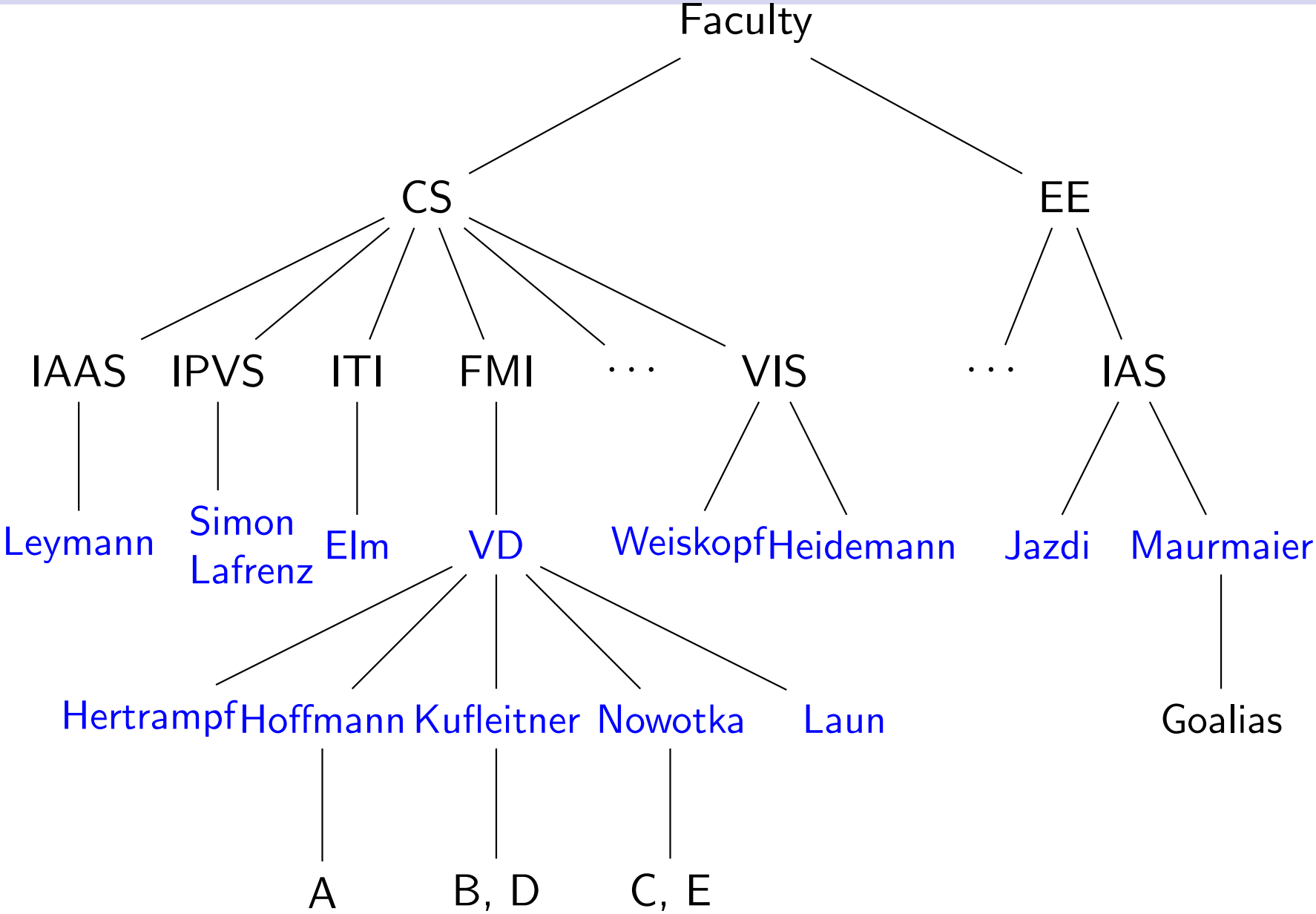
Programme of the day

Schedule	Program			Room(s)
09.10	Opening (Volker Diekert)			V38.02
09.15-09.50	Challenges in Theory and Puzzles (Volker Diekert)			
10.00-11.00	Talk: Visualization and Computer Graphics Research at Universität Stuttgart Powerwall Demonstration (Daniel Weiskopf)			
11.00-12.00	Autonomous robots playing soccer (Reinhard Lafrenz)			-1.261
12.00-13.00	Lunch at Telekom Hotel			
13.00-13.40	Presentation IAAS (Frank Leymann)			V38.03
	Group A	Group B	Group C	
13.45-14.10	Parallel Systems (Sven Simon) V38.03	Guided tour Computer Museum (Klemens Krause) 0.148	Computer Vision Lab (Gunther Heidemann) 0.345	V38.03, 0.148, 0.348
14.15-14.40	Computer Vision Lab (Gunther Heidemann) 0.345	Parallel Systems (Sven Simon) V38.03	Guided tour Computer Museum (Klemens Krause) 0.148	
	Group D	Group E		
14.45-15.15	Research Challenges in Test and Reliability (Melanie Elm) ITI 2.163	GOALIAS - le gardien de but automatique (Mathias Maurmaier) Travaux Pratiques en Développement Logiciel (Nasser Jazdi) ETI 1.161		ITI 2.163, ETI 1.161
15.20-15.50	GOALIAS - le gardien de but automatique (Mathias Maurmaier) Travaux Pratiques en Développement Logiciel (Nasser Jazdi) ETI 1.161	Research Challenges in Test and Reliability (Melanie Elm) ITI 2.163		
15.50-16.20	Coffee break at Telekom Hotel			
16.25	S-Bahn to the Airport			

Structure of the faculty . . . and the people of today:



Une vue personnelle de l'informatique théorique

Volker Diekert

FMI

January 26, 2009

Research topics in theoretical computer science

1. The grand challenge
2. Combinatorics on words
3. Concurrency
4. Formal languages
5. Text mining
6. Data compression

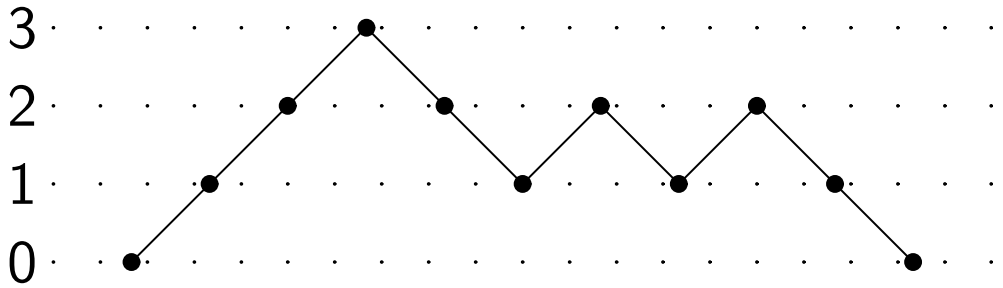
The grand challenge

The relationship between the complexity classes P and NP is an unsolved question in theoretical computer science. It is considered to be the most important problem in the field – the Clay Mathematics Institute has offered a 1 million USD prize for the first correct proof.

Let's start small

Mountains

Chomsky/Schützenberger (1963): *We define the Dyck language ...*
Dyck language D_2 is the language of correct parentheses.



Rutishauser's Klammergebirge

We know how to parse this language in parallel with threshold circuits of constant depth.

Complexity classes

$$\mathrm{AC}^0 \subsetneq \mathrm{TC}^0 \subseteq \mathrm{NC}^1 \subseteq \mathrm{LOGSPACE} \subseteq \mathrm{P} \subseteq \mathrm{NP}$$

TC^0: D_2 ($\cup$)

$\mathrm{LOGSPACE}$: D^* ($\cup$)

$$D^* = \left\{ w \in \{a, \overline{a}, b, \overline{b}\}^* \;\middle|\; w \text{ equals 1 in the free group } F_2 \right\}$$

Theorem

The Word Problem of free groups is in LOGSPACE.

Challenge: TC^0 vs NC^1

$\longrightarrow$ Complexity theory at FMI: Ulrich Hertrampf

Combinatorics on words

- Word equation $xabyx = zbaz$
- Solution: Replace variables by words such that *lhs* = *rhs*.

  $xabyx = zbaz$ has a solution: $x = a,\ y = abaaab,\ z = aaba$
- Makanin [1977]: It is decidable whether a word equation has a solution.

Challenge: What is the complexity?

Structure of solutions

- *Periodicity:* $x \in \{w\}^+$ for all $x \in X$.
- *Independence:* every proper subsystem has different set of solutions.
- *unbalanced:* $xyx = zz$ *balanced:* $xyxzz = zzyxx$
- [Harju, Nowotka 2003]:
  Every independent system of equations in three variables with non-periodic solutions is balanced.

Challenge: Conjecture [Culik II, Karhumäki 1983]: Every independent system of equations in three variables has only periodic solutions.

$\longrightarrow$ Dirk Nowotka

Another grand challenge: Concurrency

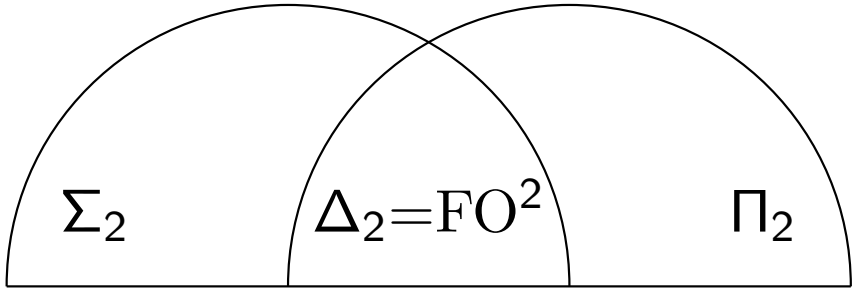
Collaboration LSV and FMI:

Algebraic tools for concurrency. Mazurkiewicz traces.

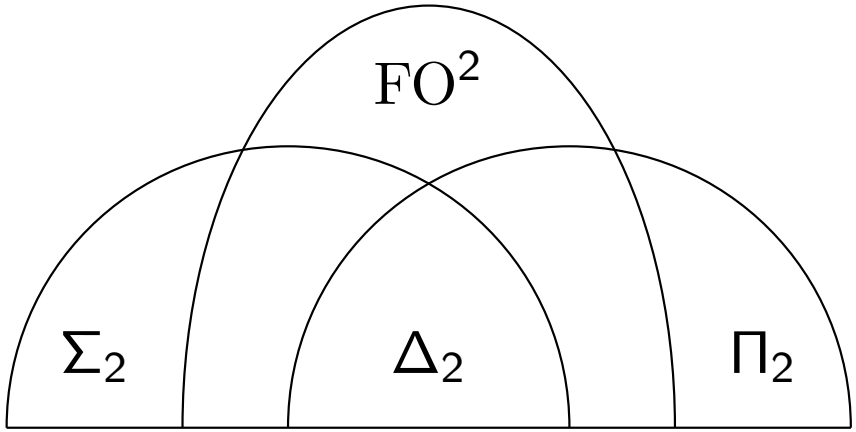
Automata theoretical approach to verification:
System = States with transitions= Finite automaton (with inherent concurrency)
Specification = Logical formula = Finite automaton (with inherent concurrency)
Verification: Test for inclusion $L(\mathrm{System}) \subseteq L(\mathrm{Specification})$.

Formal languages

- Characterization of classes of regular languages
- Unique combination of topology, algebra, and combinatorics
- Application: Properties of logical fragments and their relations
- Finite words:



- Infinite words:



Algebraic theory of automata

- A *monomial* is a language of the form $A_0^* a_1 A_1^* \cdots a_k A_k^*$ with $a_i \in \Sigma$, $A_i \subseteq \Sigma$.

Challenge: Can one decide wether a regular language $L \subseteq \Sigma^*$ is a finite Boolean combination of monomials?
Problem is open for more than 30 years.

$\longrightarrow$ Manfred Kufleitner

Text mining

The Maximal Intersection Problem:
A special case of Nearest Neighbor Search
Database $\mathcal{DB} = \{d_1, \ldots, d_n\}$ and a query set q.
Find $d \in \mathcal{DB}$ closest to q.

Applications: Text clustering/classification, near-duplicate detection, code plagiarism detection, search engines, recommendation systems, advertisement matching, ...

Challenge: Short query time

Our approach

Assume that the input behaves according to some predefined distribution (e.g. *Zipf's law for natural language texts*) and construct efficient algorithms based on this assumption.

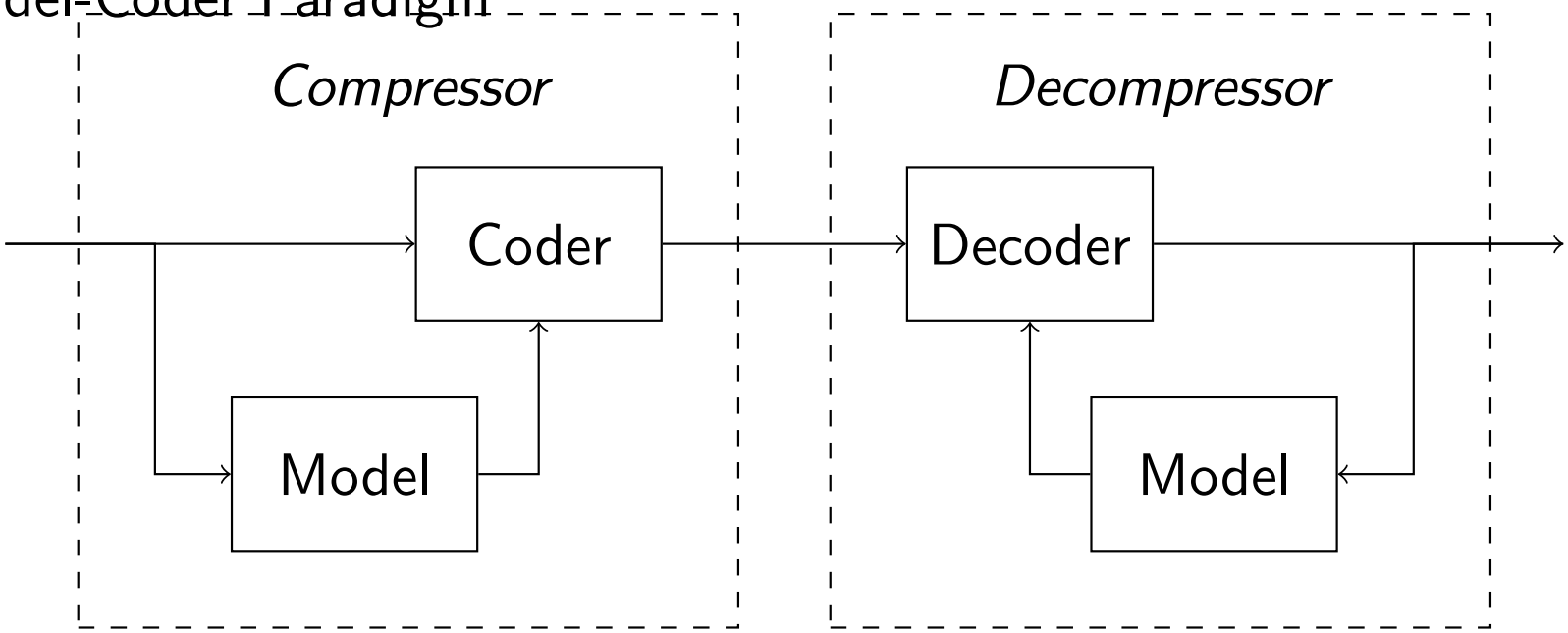
Theoretical results: CSR 2007 and TOCS (To appear)

$\longrightarrow$ Benjamin Hoffmann et al.

Practical implementation: Ongoing work with real world data and promising experimental results.

Data Compression

- Model-Coder Paradigm



- Coder/Decoder: Arithmetic coding
- Model: New algorithm developed at our department
- At the moment: Implementation and optimization

Challenge: Win Hutter prize `http://prize.hutter1.net/`

$\longrightarrow$ Manfred Kufleitner

Have a good day

with

- Daniel Weiskopf
- Reinard Lafrenz
- Sven Simon
- Klemens Krause
- Gunther Heidemann
- Melanie Elm
- Nasser Jazdi
- Mathias Maurmeier

and from FMI by Benjamin Hoffmann, Manfred Kufleitner, and Dirk Nowotka

Thank you

⟶ Volker Diekert