

Intelligent Systems

Petri Myllymäki
Complex Systems Computation Group
Department of Computer Science
University of Helsinki, Finland

<http://www.cs.helsinki.fi/petri.myllymaki/>

Intelligence?

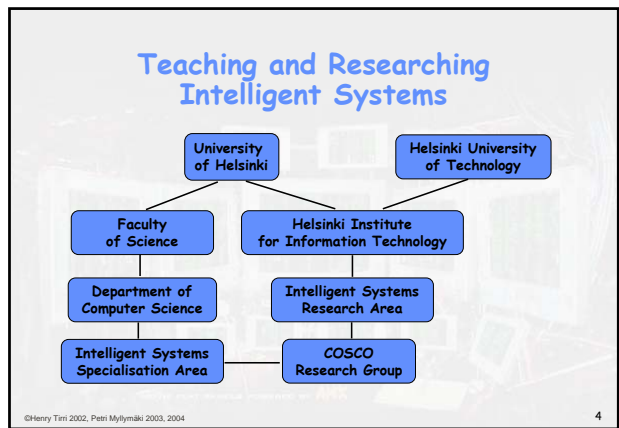
- Computer science is considering ways to **make things automated**
- Intelligent Systems studies the question **how can intelligence be automated?**
- Intelligent **behavior** can be characterized by **learning/adaptation**
- In order to learn one needs to **remember** and **generalize** (world is never repeating itself!)
- In order to generalize one needs **models**

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Name of the game?

- Artificial intelligence
- Science of uncertainty
- Adaptive and intelligent systems
- Computational intelligence
- Soft computing
- Real-world computing
- Complex systems computation
- Deep computing
- ...
- **Keywords:** knowledge representation, reasoning logic, expert systems, machine learning, data mining, Bayesian networks, neural networks, fuzzy systems, evolutionary computing, artificial life, robotics, planning, optimization...

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<http://www.cs.helsinki.fi/alykkaat/>

Main courses:

- Artificial Intelligence
- Three concepts: probability
- Three concepts: information
- Three concepts: utility
- Graphical models

Related courses:

- Machine learning
- Data mining

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Complex Systems Computation Group CoSCo

- Hannes Wietzig presents the paper "Bayesian Analysis of Online Newspaper Log Data" at the 2003 International Symposium on Applications and the Internet (Orlando, USA, January 2003) → [20.01.2003](#)
- Professor Henry Tiri gives talk "Adaptive modeling of Internet Users" at the concluding seminar of USIX technology programme → [18.01.2003](#)
- Mikko Miettinen gives talk "User Profiling and Visualization in new-based learning environments" at the concluding seminar of USIX technology programme → [18.01.2003](#)
- Professor Henry Tiri gives invited talk "Computational World" at Europe 2003 seminar, arranged by Finnish Society for Information Services
- Professor Henry Tiri gives an invited talk "Personalized Adaptive Interfaces" at Media and Everyday Life seminar arranged by StoreEnro and AlmaMedia
- Professor Henry Tiri gives talk "Individual theory - Mathematics of Personalization in Computer Networks" at Finnish Society → [12.01.2003](#)

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Our mission

- Develop intelligent solutions to hard problems found in realistic settings
- Requires both deep theoretical work and creative methodological innovations
- Complex Systems Computation Group:
 - Petri Myllymäki, Henry Tirri
 - Wray Buntine, Jorma Rissanen, Huizhen Yu (MIT)
 - around 20 researchers, mostly quite experienced
 - a rare combination of theoretical competence with top-level programming skills
 - active collaboration with
 - » UCB (Michael Jordan)
 - » CWI (Paul Vitányi, Peter Grünwald)
 - » Tsinghua University (Lizhu Zhou)



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Student: So what is it like to do research in AI?

- Great fun!
- Some **hacking**
- some **math**
- Some **gaming**
- Some **technology "freaking"**
- Some **science fiction**



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"On the shoulders of Giants"



Andrey Nikolaevich Kolmogorov



Rev. Thomas Bayes

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CoSCo Research areas

- Probabilistic and information-theoretic modeling in sciences and business
 - Information-theoretic modeling approaches
 - Bayesian and Causal Networks
 - Finding the position of mobile devices
 - Personalization
 - Next generation information search
 - Tools and theory for E-learning
- Stochastic optimization in complex domains

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mdl-research.org

Minimum Description Length on the Web



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Bayes vs. MDL

Under regularity conditions $-\log P_{NML}(x^n | M) =$
 $-\log P(x^n | \hat{\theta}_i(x^n)) + \frac{k}{2} \log \frac{n}{2\pi} + \log \int \sqrt{\det I(\theta)} d\theta + o(1)$

Under regularity conditions $-\log P_{Bayes}(x^n | M) \approx$
 $-\log P(x^n | \hat{\theta}_i(x^n)) + \frac{k}{2} \log \frac{n}{2\pi} - \log w(\hat{\theta}) + \log \sqrt{\det I(\hat{\theta})} + o(1)$

If we take Jeffrey's prior

$$w(\theta) = \frac{\sqrt{\det I(\theta)}}{\int \sqrt{\det I(\theta)} d\theta} \dots \odot$$

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B-course Data Analysis Server (<http://b-course.hiit.fi>)



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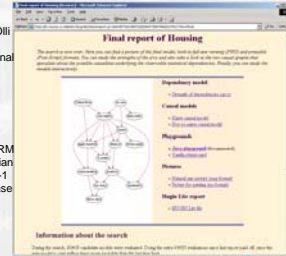
B-course Data Analysis Server (<http://b-course.hiit.fi>)

- commercial-quality ASP tool for research and teaching purposes
- 10 000 users world-wide in 2 years

Sampa Hautaniemi, Henrik Edgren, Petri Vesanen, Maja Wolf, Anna-Kaarina Jarvinen, Olli Yli-Harja, Jaakko Astola, Olli Kallioniemi and Outi Monni, A Novel Strategy for Microarray Quality Control Using Bayesian Networks. To appear in Journal of Bioinformatics.

Jarvis, Smith, Wada, Rivas, McElroy, Smulders, Caminci, Hayashizaki, Dietrich, Wu, McConnell, Yu, Wan, Hartemink, Lin, A framework for integrating the songbird brain. J Comp Physiol A (2002) 188: 961-980.

K DeForche, K Van Laethem, A Abecasis, J Snoeck, AP Carvalho, I Derdelincx, P Gomes, J Cabanas, MA Soares, RM Brindeiro, A Tanuri, R Carnacho and AM Vandanime, Bayesian Network Reveals Linkage for Mutations at Position 89 of HIV-1 Protease to other Protease Codons and Therapy with Protease Inhibitors. Proceedings of the 2nd European HIV Drug Resistance Workshop, March 11th-13th, 2004, Rome.



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Quick Summary

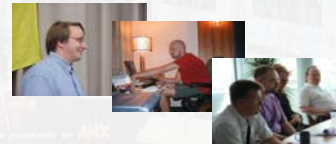
- Designed for dependency analysis with graphical models
- ASP architecture (works with most browsers)
- inference of Bayesian networks (and elementary causal networks)
- "tutorial style" user interface
- no user modifiable parameters
- interactive tool for inference
- extendible platform (v 2.0 classification)

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So what "science" was needed?

- Theory, heavy theory
- Empirical work with data sets ...
- Multidisciplinary co-operation
- Brilliant hacking (B-course had predecessors: D-Side, BAYDA)

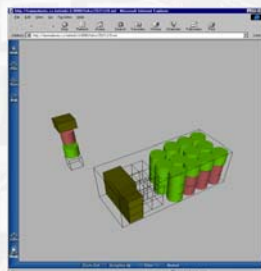


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Koptimi

- Intelligent algorithms for constrained bin-packing
- In fielded use at StoraEnso since 2000



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BayMiner™

- Commercial ASP tool for data analysis and visualization
- HS Vaalikone



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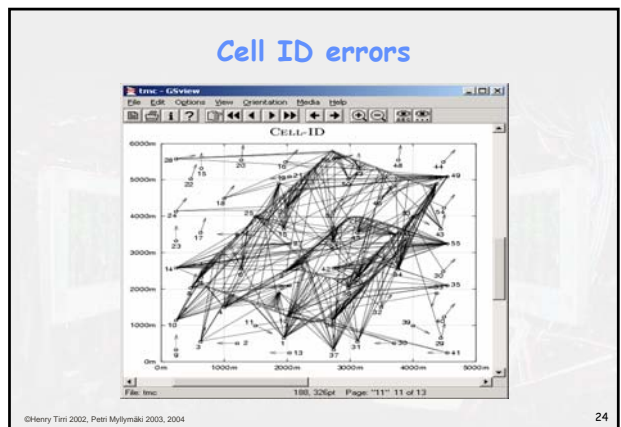
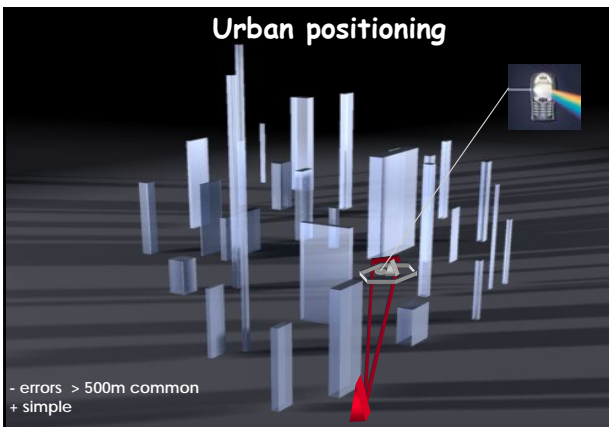
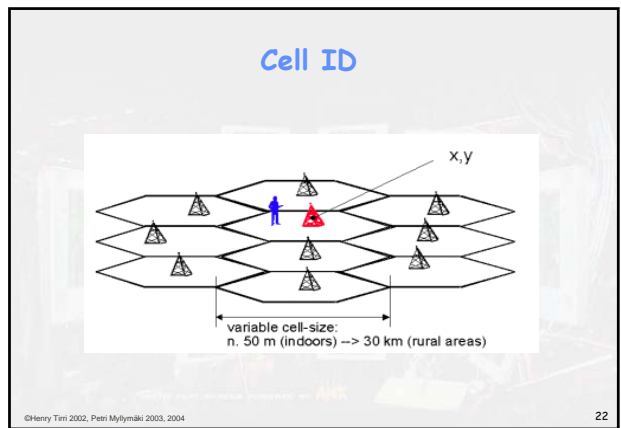
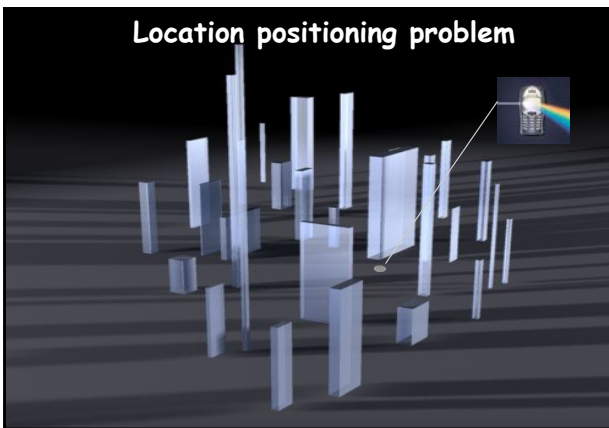
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Prima: Proactive Information Retrieval by Adaptive Models of Users' Attention and Interests

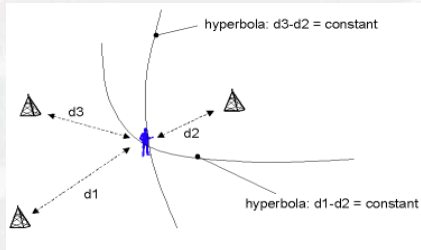
- Basic research project funded by the Academy of Finland (2003-2005)
- Joint work with the Neural Networks Research Centre (NNRC) and Center for Knowledge and Innovation Research (CKIR)
- Information retrieval enhanced with relevance data and context-sensitive information

(Note: The slide contains a list of Finnish text items, many of which are crossed out with red lines.)

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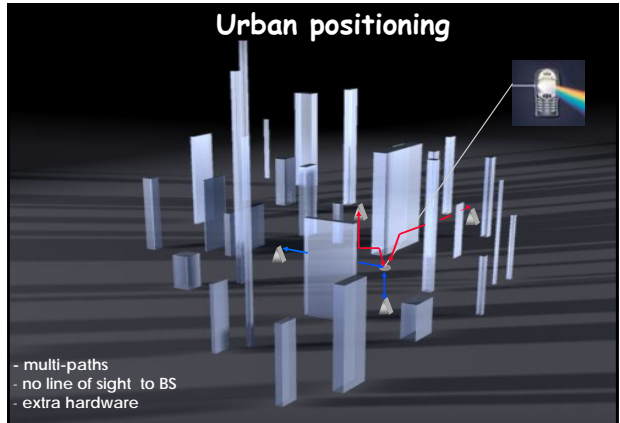
Enhanced Observed Time Difference (E-OTD)



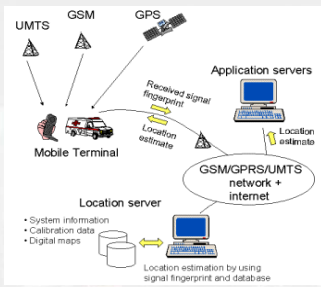
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Urban positioning



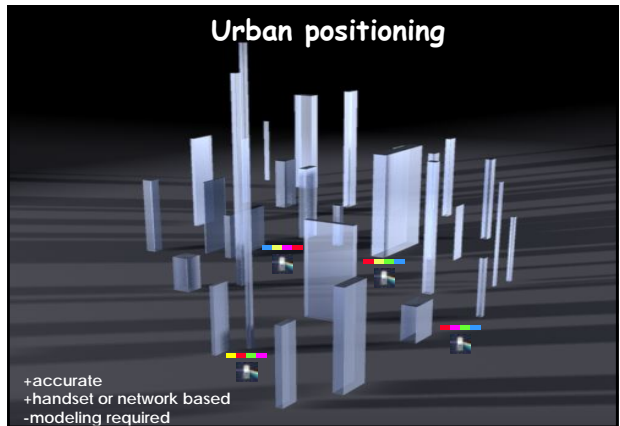
Modeling approach



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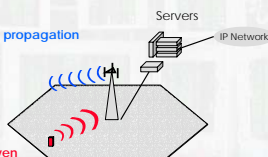
Urban positioning



Modeling alternatives

"Downlink modeling: the propagation models (GM level 1)"

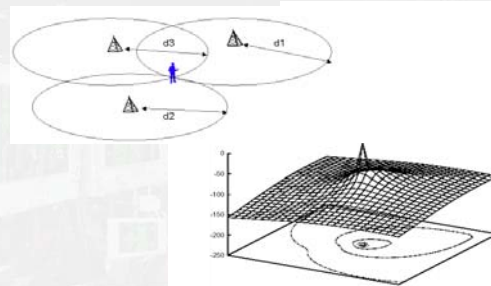
"Uplink modeling: data driven models (GM level 2)"



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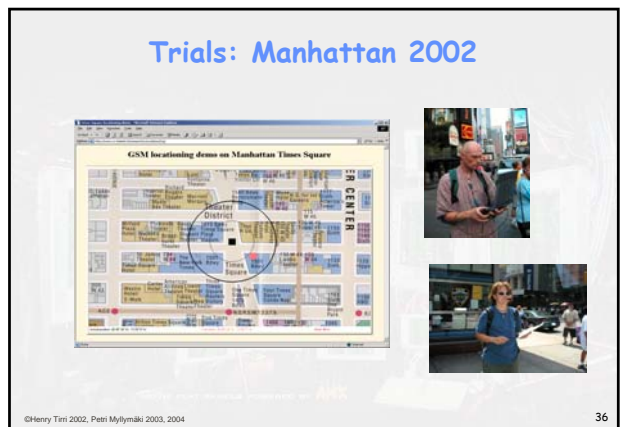
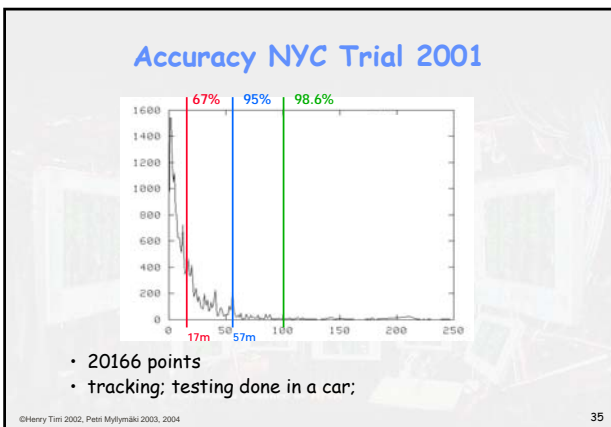
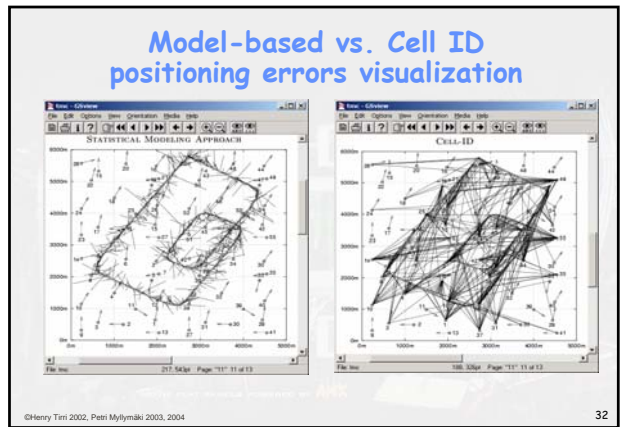
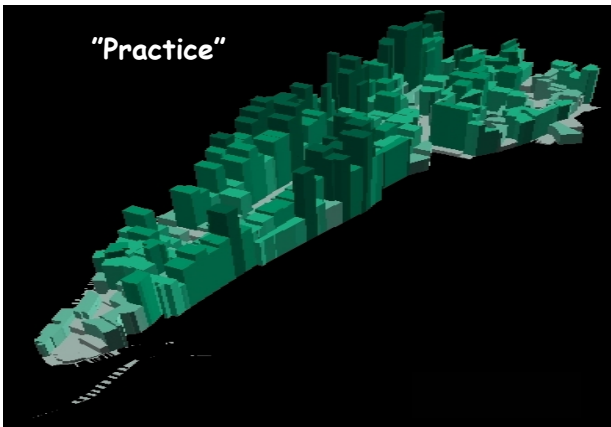
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"Theory"

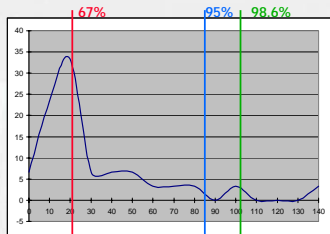


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Accuracy NYC Trial 2002

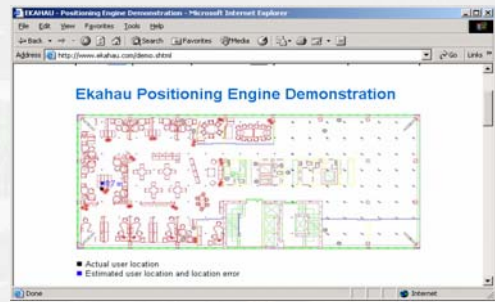


- 30 points
- static; testing done by walking;

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Generalization: WLAN



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Ekahau Positioning Engine™

- Software for locating devices in Wi-Fi networks
 - European Union: The European Information Society Technology Prize 2002.
 - Technology Marketing Corporation (TMC): Best product of the year 2002.
 - Planet PDA, the Global Summit on Enterprise & Custom Volume Handheld Computing: Best of show.
 - Software Industry Summit: Best commercialized innovation in Finland in 2002.
 - SearchNetworking.com: Bronze medal, best product of the year 2003 (enterprise wireless applications and systems).
 - Wi-Fi Planet 2004: Best of Show.



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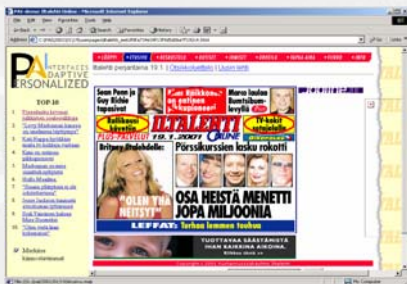
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Personal WEB

Personalization and Intelligent Search



Personalized, adaptive interfaces

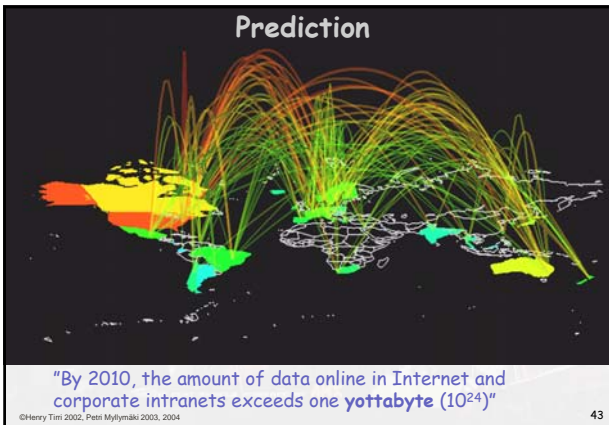


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Future of Search



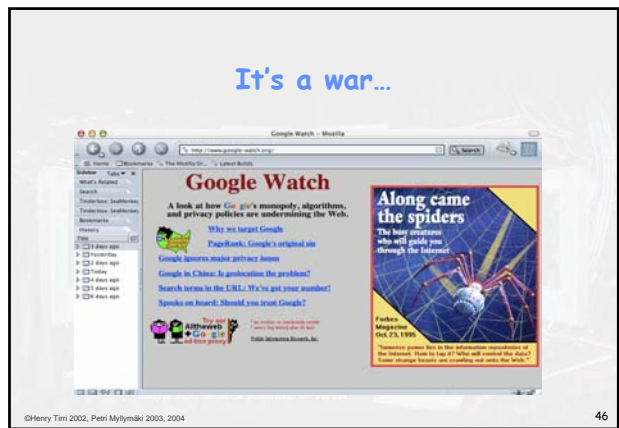


Knowledge workers spend 35% of their productive time searching for information online, while 40% of the corporate users report they cannot find the information they need to do their jobs on the intranet.

--Working council of CIOs, Business Wire, February 2001

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- ### Problems with Google
- Google's immortal cookie (2038)
 - Google records all they can
 - Google retains all data indefinitely
 - Google ignores privacy policy questions
 - Google hires spooks (NSA)
 - Google's toolbar is spyware
 - Google's cache is problematic
 - Google's database as a data mining resource (150 million searches/day)
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Next Generation Information Management Research

Collaborative search

Search-ina-Box

YDIN

Mobile search

Topic-specific search

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Emerging key technologies

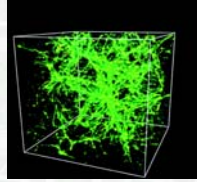
"Chelsea Football Club",
"Clinton DeLeon" and
"Chelsea Clinton"

- language processing
- (probabilistic) statistical modeling
- personalization
- collaborative filtering

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What is NOT there

- no major search engine performs any sophisticated language processing (scalability)
- no open source engines provide language processing
- non-interfering and (search) integrated personalization
- no quality corporate-wide intranet search systems (several sites)



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Related projects

Scalable Probabilistic Methods for the Next Generation Search Engine (PROSE)



Search-In-a-BOX



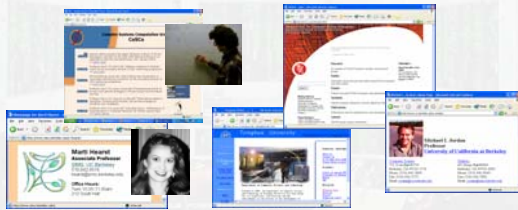
ALVIS (FP6 STREP)

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SIB research core competencies

- probabilistic modeling for embedded language models, automatic content analysis and personalization
- advanced user interface design



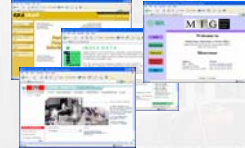
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Superpeer Semantic Search (ALVIS)



ALVIS (FP6 STREP)



- HIIT
- MIG-INRA (France)
- EPFL (Switzerland)
- Lund University (Sweden)
- JSI (Slovenia)
- Index Data (Denmark)
- Exalead (France)
- DTV (Denmark)
- Université Paris Nord

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モウラチェウ search

- Open Source
- Advanced language model (hidden from user)
- Probabilistic query models
- Integrated personalization
- Superpeer architecture



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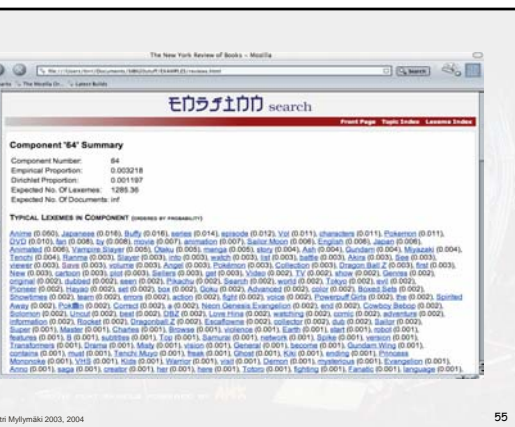
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モウラチェウ search



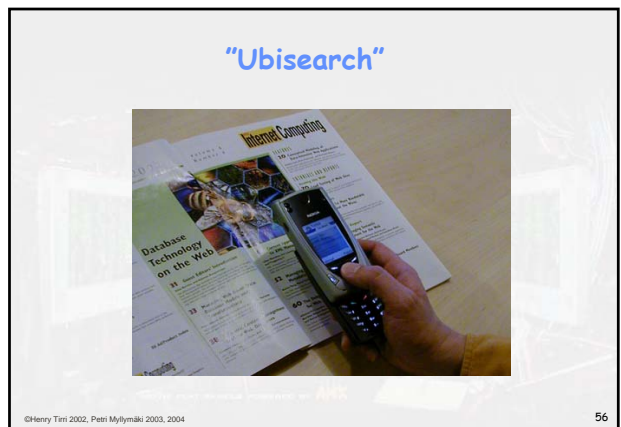
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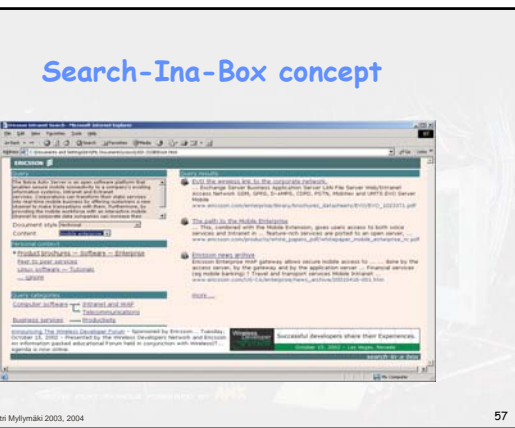
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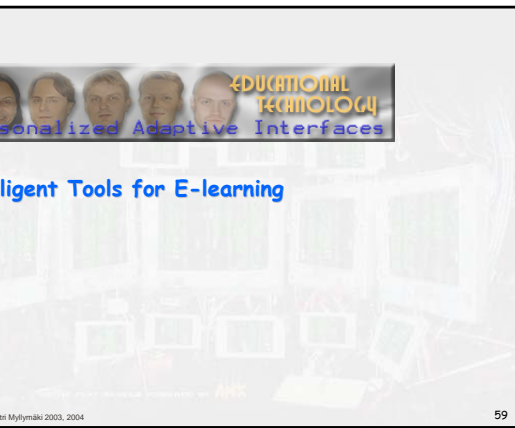
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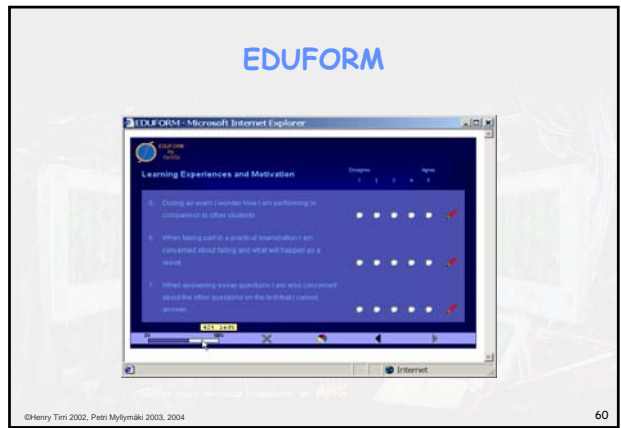
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EDUCO

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OurWeb

File	Author	Date
Evolutionary game theory	John K. Sargent	03/11/04
Evolutionary game theory	John K. Sargent	03/11/04
Evolutionary game theory	John K. Sargent	03/11/04
Evolutionary game theory	John K. Sargent	03/11/04
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Evolutionary game theory	John K. Sargent	03/11/04

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and other things 😊

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