Deep Computing

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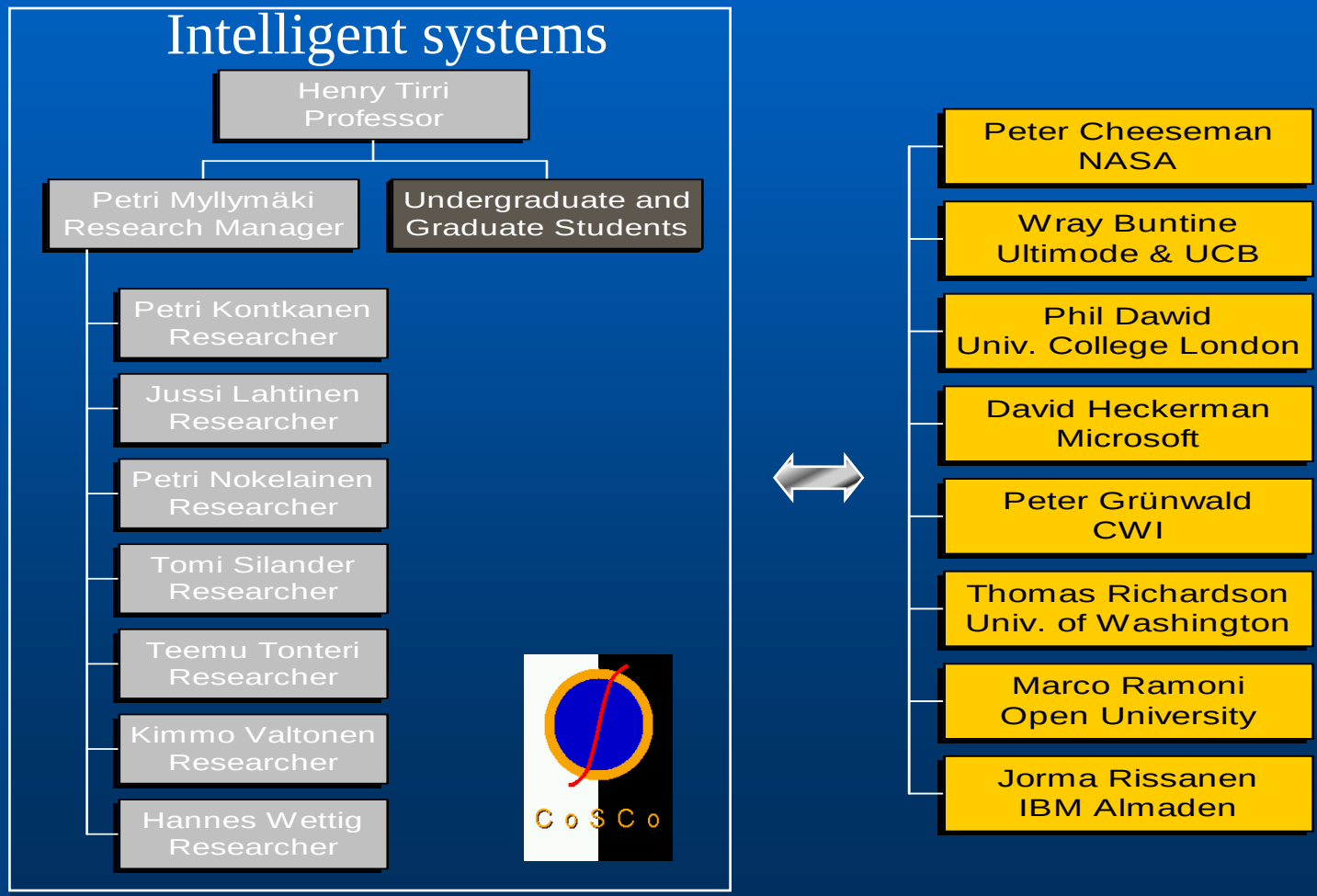
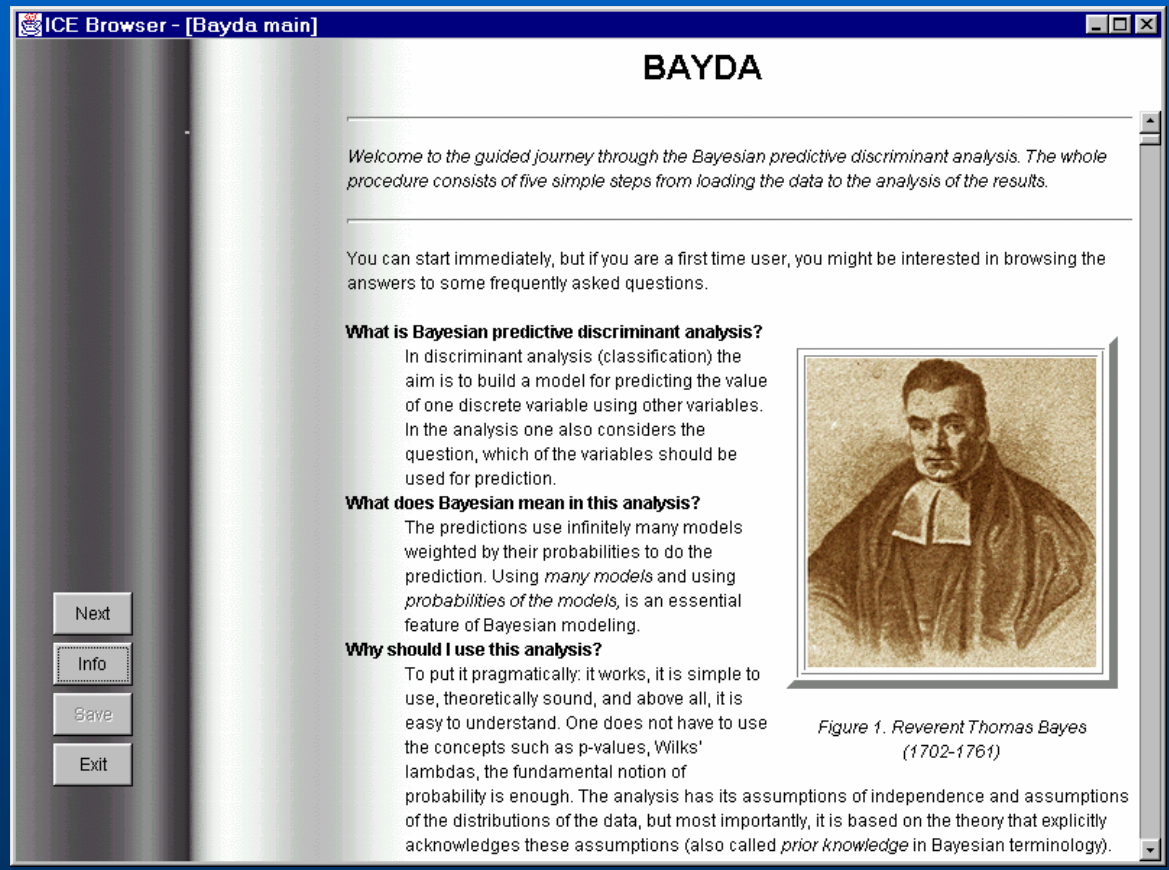


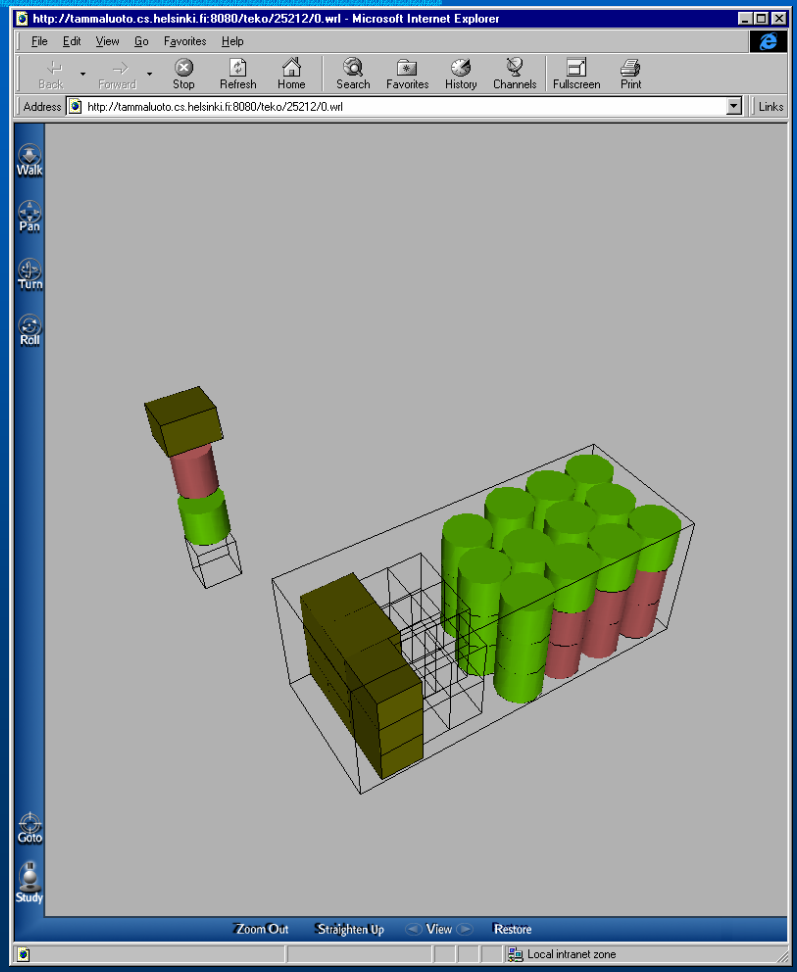
Example problem I
General tools for probabilistic modeling



http://www.cs.Helsinki.fi/research/cosco/

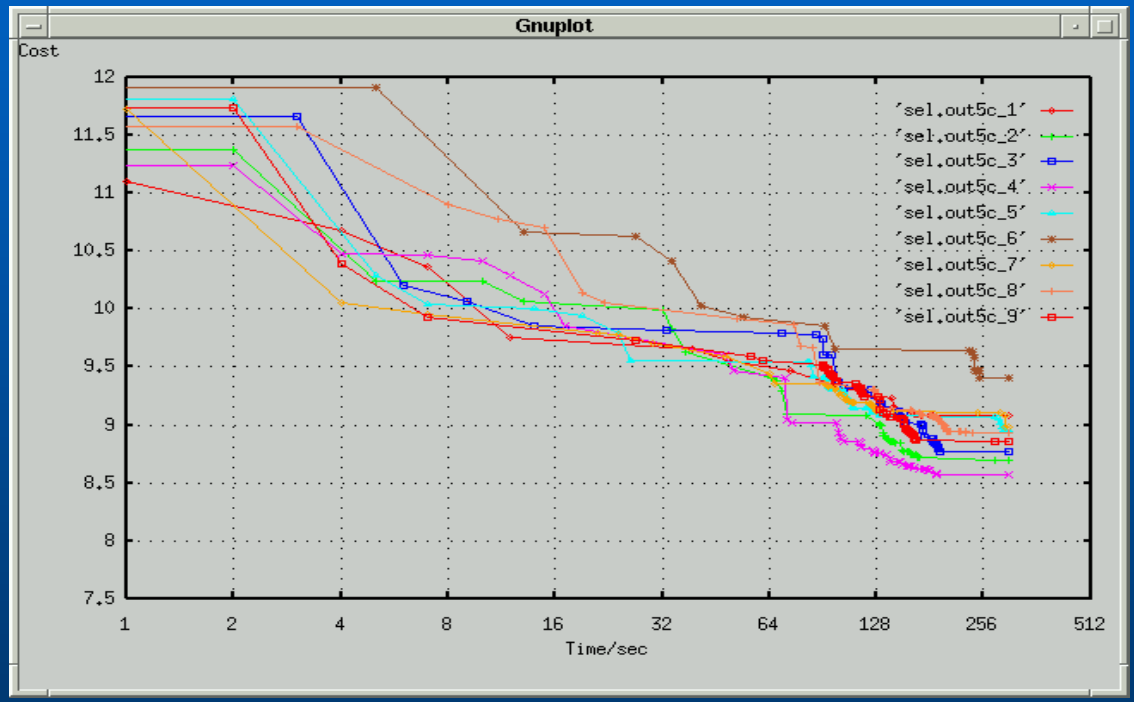
Example problem II

A 3D bin-packing problem with a lot of physical constraints and tight time contraints



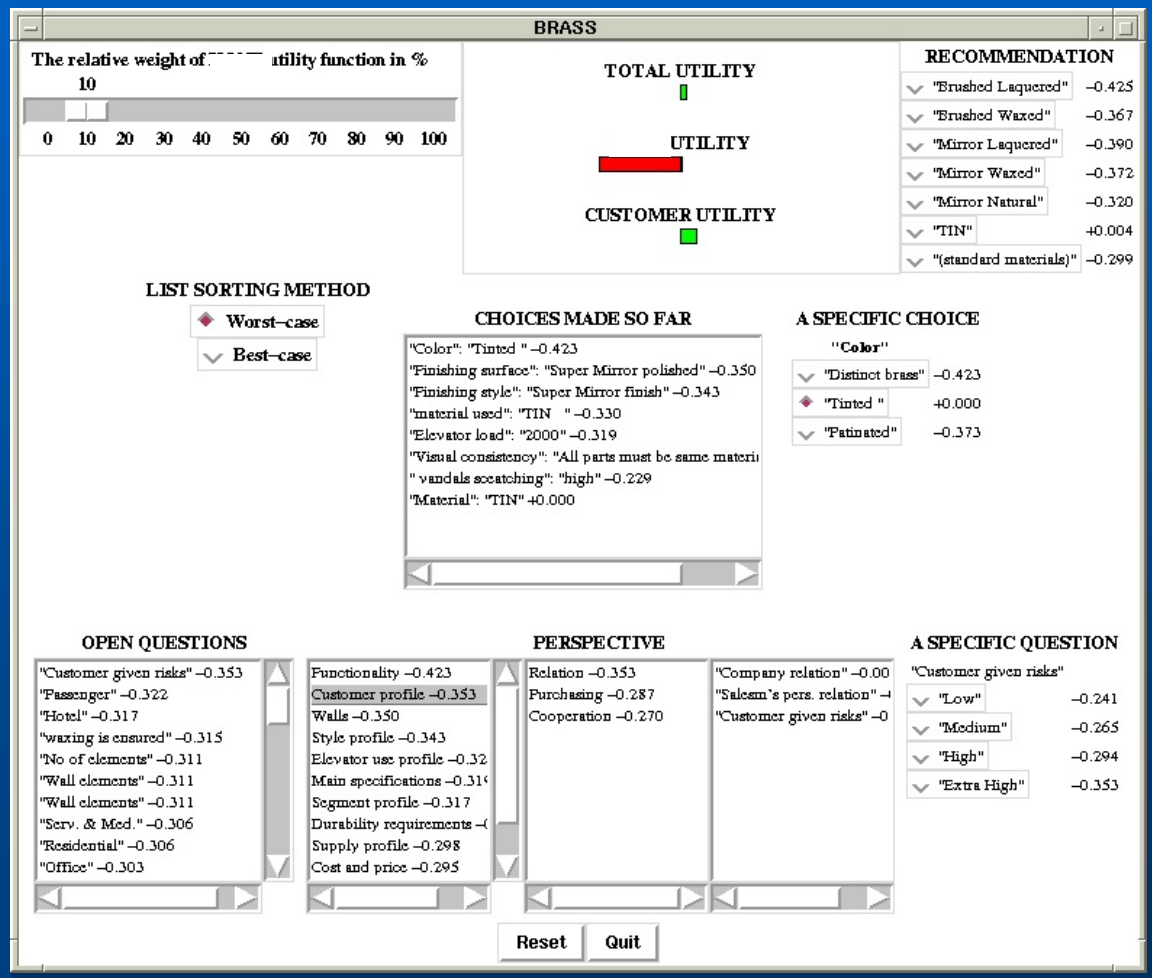
Example problem III

Frequency allocation for mobile networks



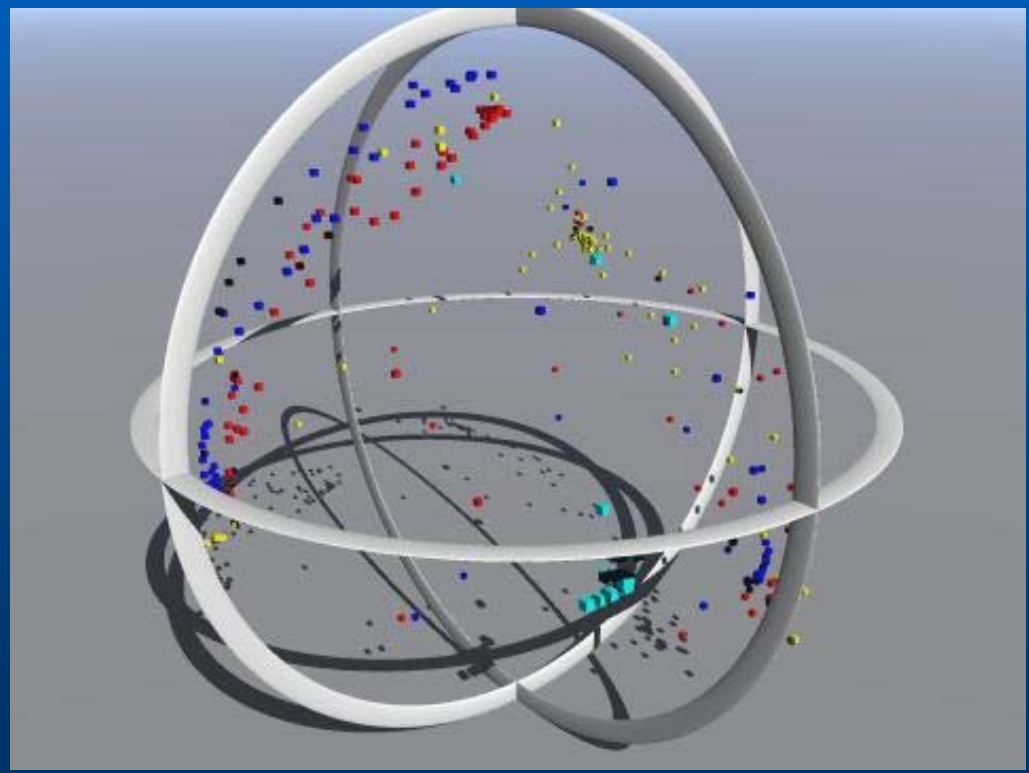
Example problem IV

A complex configuration problem, solved by combining expert knowledge with statistical data



Example problem V

Model-based visualization of high-dimensional data



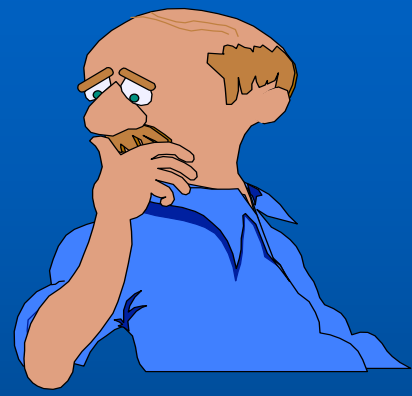
Example problem VI

Analysis and prediction of web browsing behavior

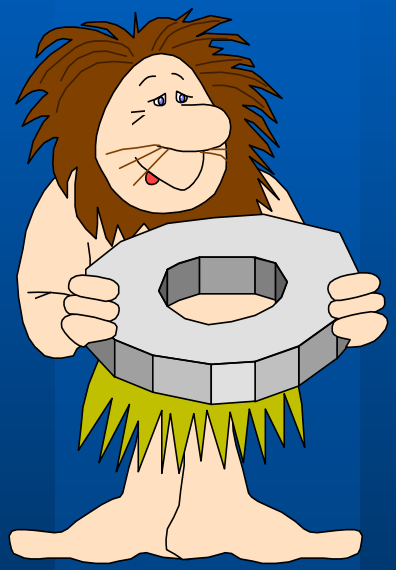
Previous Next

The big picture

- **Research areas**
  - **Modeling**
    - **Bayesian networks**
    - **Neural networks**
    - **Decision trees**
    - **Fuzzy logic**
  - **Optimization**
    - **genetic algorithms**
    - **simulated annealing**
  - **Visualization**



Name of the game?



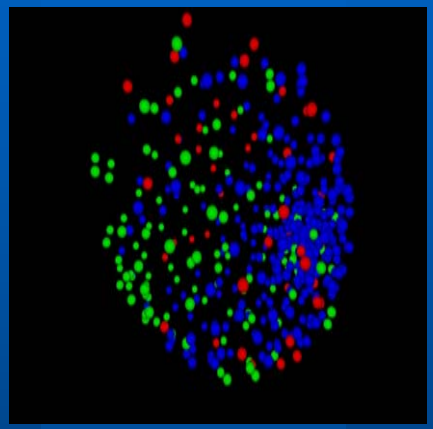
- Artificial intelligence (tekoäly)
- Science of uncertainty
- Intelligent systems (älykkäät järjestelmät)
- Computational intelligence (laskennallinen älykkyys)
- Soft Computing (“pehmolaskenta”)
- Real-world computing
- Complex systems computation
- Deep computing

What is Deep Computing?

Deep computing is a term for methods solving complex and large-scale modeling and analysis problems with emerging computer systems that combine ultrafast processing with sophisticated analytical software

***Deep**: syvä, laaja, intensiivinen, syvällinen, syventynyt, keskittynyt, läpitunkeva, syvällekäyvä, vaikea, monimutkainen, vaikeatajuinen, selittämätön, arvoituksellinen, epämääräinen, kauas menevä, älykäs, järkevä*

Deep modeling

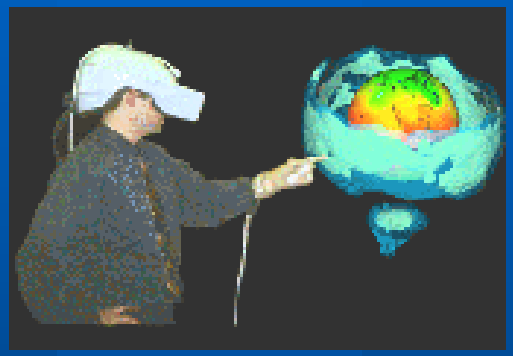


- Challenges
  - building models from very large data streams
  - automatic discovery of features
  - universal modeling
- Techniques (multi-disciplinary)
  - computer science
  - information theory
  - mathematical statistics
- Application areas
  - Business Intelligence
  - “super modeling” in sciences
  - telecommunications

Deep optimization

- Challenges
  - developing intelligent search methods
  - combining search with deep modeling
- Techniques
  - stochastic optimization methods
  - adaptive search methods
  - approximate pattern matching
- Applications
  - logistics
  - resource management
  - telecommunications

Deep view



- Challenges
  - model-based visualization
  - interactive interface technologies
- Techniques
  - deep modeling with haptic interfaces
  - high-performance graphics
  - high-dimensional transformations
- Applications
  - Business Intelligence
  - scientific data analysis

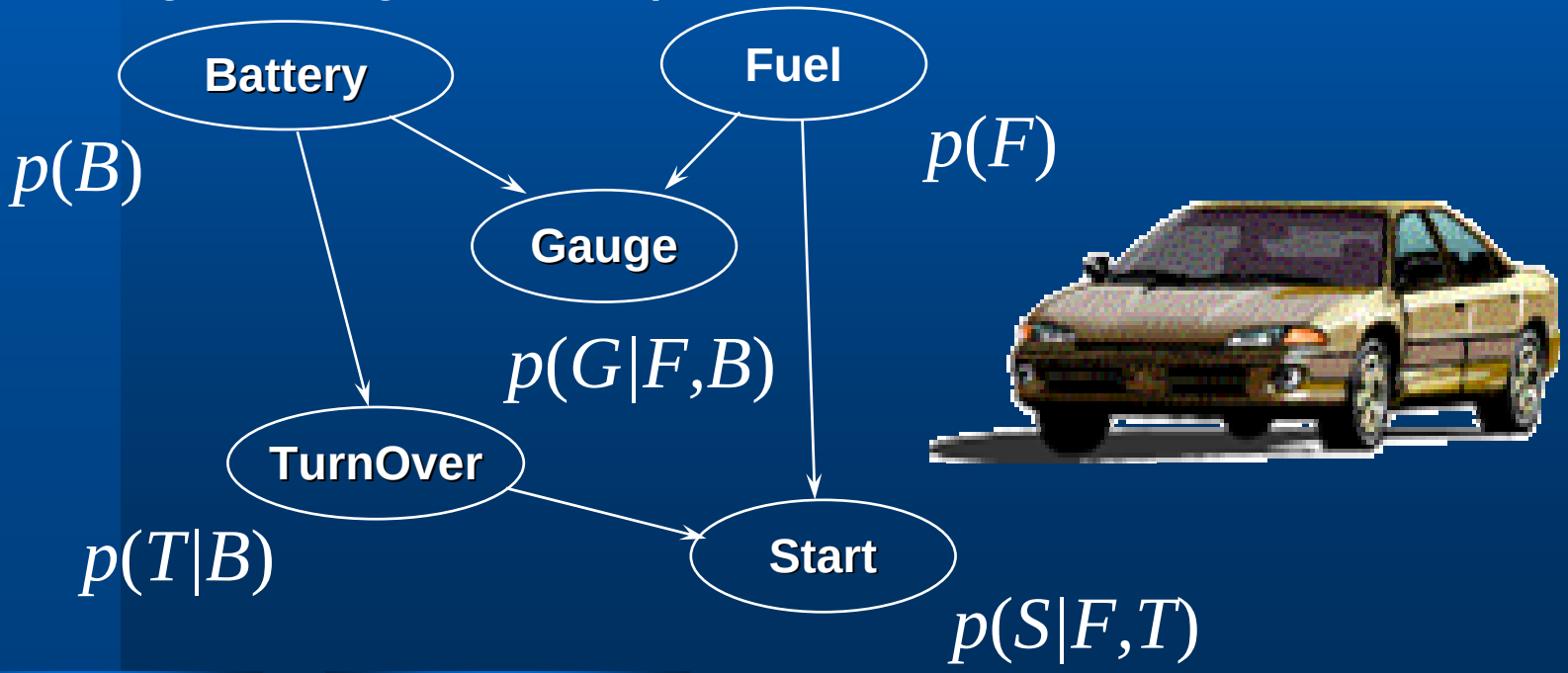
Bayesian networks: a billion dollar perspective

"Microsoft's competitive advantage, he [Gates] responded, was its expertise in "Bayesian networks". Ask any other software executive about anything "Bayesian" and you're liable to get a blank stare. Is Gates onto something? Is this alien-sounding technology Microsoft's new secret weapon?"

(Leslie Helms, Los Angeles Times, October 28, 1996.)

Bayesian (belief) networks

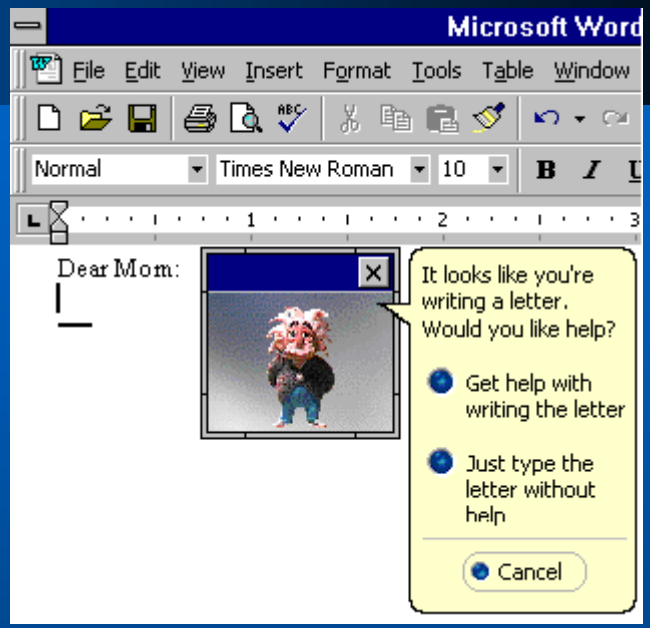
- A graphical representation of a joint probability distribution
- The nodes of the network represent the domain variables (attributes)
- The arcs represent dependencies
- The parameters of a Bayesian network model consist of conditional probabilities determining the strengths of the dependencies



Advantages of Bayesian networks

- Decision theory offers a theoretical framework for optimal decision making
- A “white box”: offers a clear semantic interpretation of the model parameters
- Possibility to combine expert knowledge with statistical data
- Flexible applicability
- Robustness, consistent calculus
- More information
  - Myllymäki, Tirri: Bayes-verkkojen mahdollisuudet. Teknologiakatsaus 58/98, Teknologian kehittämiskeskus (TEKES) 1998.

Example applications of Bayesian networks



- **Microsoft**
  - **AnswerWizard**
  - **software and system troubleshooters**
  - **MS Home Healthcare System**
  - **“adaptive OS” Lumiere**
  - **spam mail filtering**
- **NASA**
  - **Shuttle mission control (VISTA)**
  - **automated classification of satellite images (LandSat, IRAS)**
- **Hewlett-Packard: printer fault diagnosis**
- **Intel: Processor fault diagnosis**
- **Lockheed: Autonomous underwater vehicle control**
- **GE: Power generator monitoring**
- **Mitre: Weapons scheduling**
- **Several medical diagnostic systems (Intellipath, DXPLAIN, ILIAD, ACORN, ...)**