Next Steps in Evolutionary Computing in the Chemical Industry (panel discussion)

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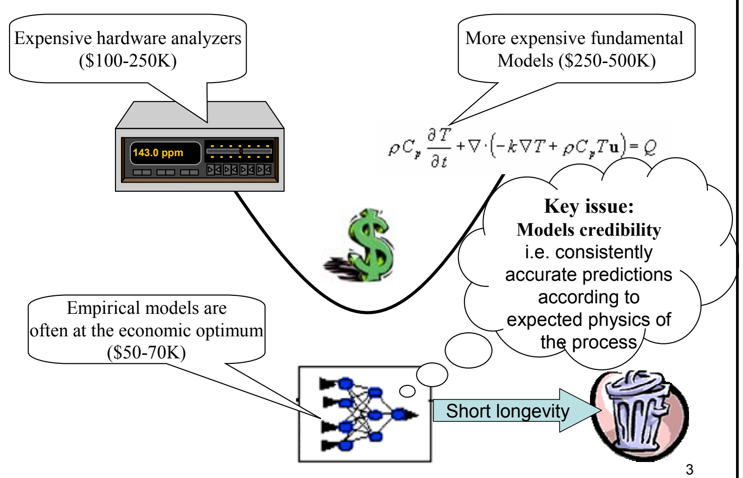
GECCO 2004

Overview

- Why industry needs Evolutionary Computing?
- Attractive features of Evolutionary Computing
- Current state of the art of industrial applications
- Expected future needs in the chemical industry
- Expected features from Evolutionary Computing

Economic advantage of data-driven models

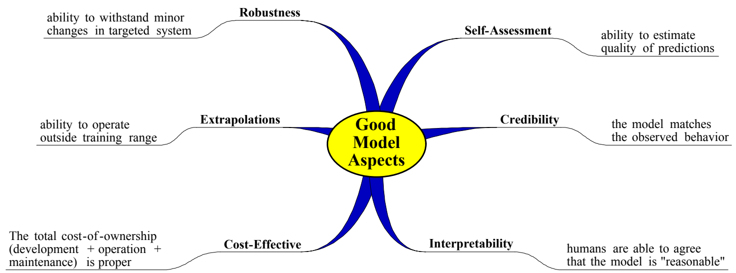


Application Issues in the Chemical Industry

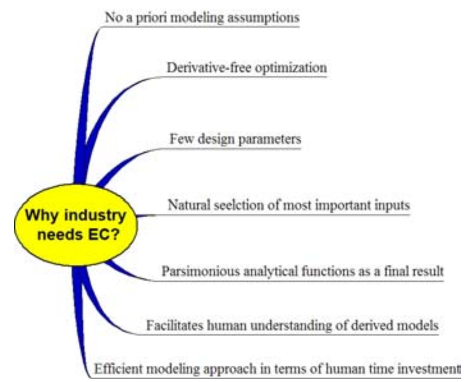
- High dimensionality of the data
- Highly correlated data with time delays
- Outlier detection
- Multiple optima
- Intensive number crunching needed
- Too much or too little data
  - Often sparse, or “statistically insignificant” instances, but at the same time, physically meaningful or commercially viable
  - Often lots of redundant data

Requirements for successful data-driven modeling

Objective function:
Minimizing modeling cost and maximizing data analysis efficiency under broad range of operating conditions



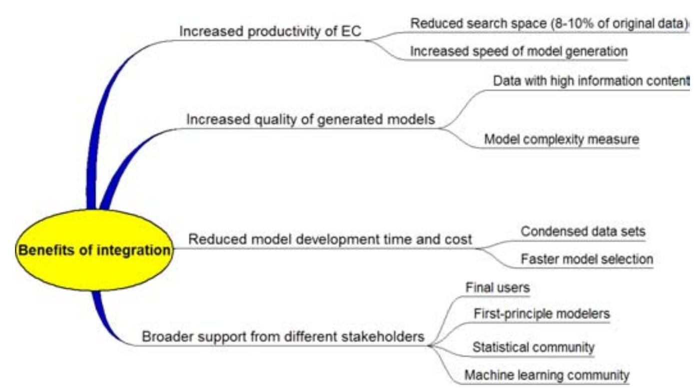
Why industry needs Evolutionary Computing?



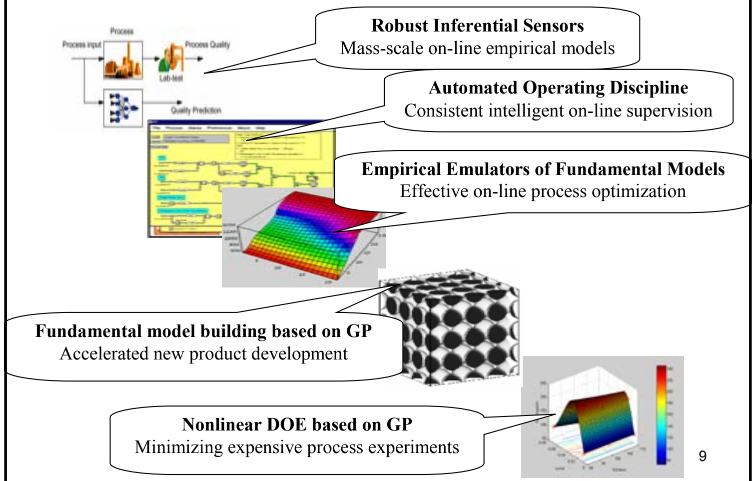
Economic benefits from Evolutionary Computing

- Resolve complex optimization problems (PSO/GA)
- Physical Interpretation & Insight (Symbolic Regression)
  - Suggestions for profitable directions for research/sensors/etc.
  - Accelerate research & development
  - Higher credibility in comparison to black-boxes
- Reduce model development cost
  - Significantly reduced development time relative to alternatives
- Reduce model exploitation cost
  - Minimal model implementation cost (no need for specialized software)
  - Reduced maintenance cost (less frequent re-training)
- Reduce cost of industrial experiments
  - Minimizes the number of additional experiments

Benefits of integrating Evolutionary Computing with other approaches



Key application areas



Key implementation issues to overcome

- **Key implementation issues**
  - **Data pre-processing and condensation**
  - **Model selection**
  - **User-friendly implementation tools**
  - **Marketing of EC to different modeling communities**
  - **Resistance to implement empirical models (inherited from black-box models)**
  - **Seamless integration into existing maintenance and support infrastructure**
  - **Critical mass of model developers familiar with EC**

Expected future needs in the chemical industry

- **Future needs**
  - Adaptive sensors
  - Fault-tolerant process supervision
  - Economic optimum process control
  - High-troughput model development
  - Model predictive supply chain
  - Optimal market penetration

Expected features from Evolutionary Computing

- **Features needed from EC**
  - Model ensembles generation
  - Automatic model selection based on complexity and diversity
  - Swarm-based process control
  - Effective knowledge integration
  - Agent-based swarm optimization
  - Artificial markets