

Flexible Decision Support in Dynamic Interorganizational Networks

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WAI Seminar

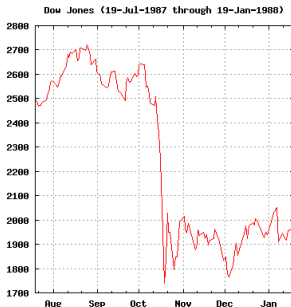
Vrije Universiteit Amsterdam, Monday, November 9 2009

Work done with: Andrew Nelson, and Dickens Nyabuti

Black Monday, October 1987

Motivation

The Dow Jones Industrial Average dropped by over 22% in one day. Before the dust settled, markets had dropped as much as 45%.

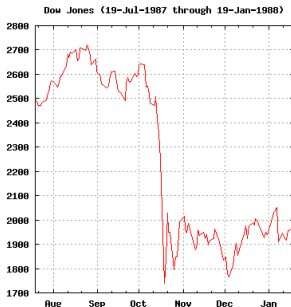


- This was widely blamed on naive computer programs that automatically sold when prices fell.
- Two possible outcomes:
 - Ban automated trading.
 - Learn how to build automated trading systems that exhibit rational behavior.

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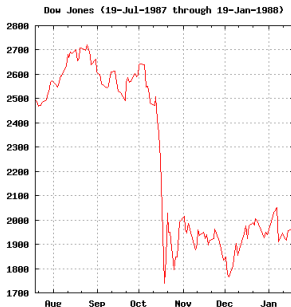


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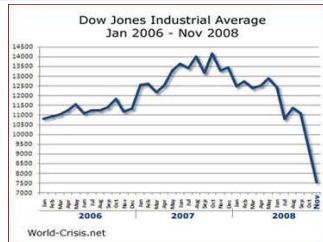
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Financial Crises, October 2008

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Credit crises became visible by the fall of Lehman brothers bank, and started a world-wide chain reaction in the economy.

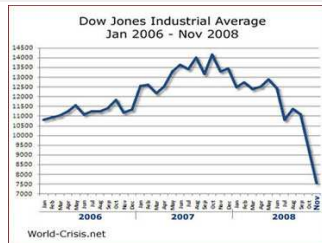
- Only partial network view.
- Risk management was based on individual perspective and not network perspective.
- Lessons learned:
 - Facilitate decision-making in complex business networks.
 - Need to understand network structure that provides high complex products and services.



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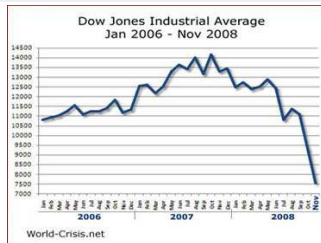


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The Tyranny of Choice

(Barry Schwartz, 2004)

Conventional wisdom

More choices make people happier, create greater opportunities for business.

Reality

People can be paralyzed by too many options. Online markets can lead to a combinatorial explosion of possibilities.

Therefore, people need good decision support!

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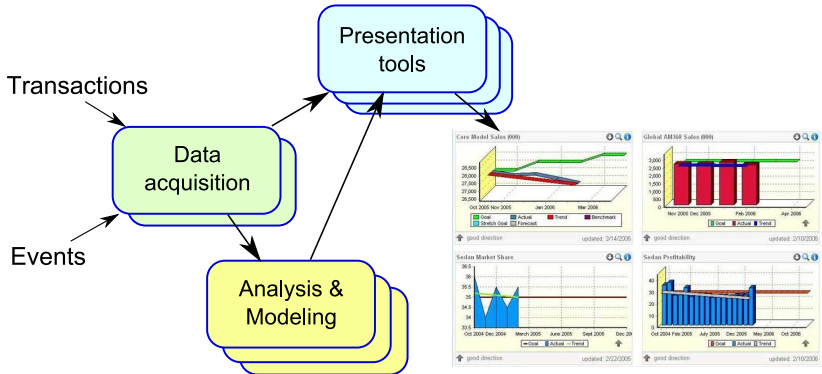
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Therefore, people need good decision support!

Elements of Decision Support

Decision support depends on information and analysis



Evolution of Decision Support Systems (1)

Intra-organizational networks

- There are many vendors and tools that promise to help build decision support systems, such as ERP systems.
- Most provide simple signals to make choices.

Static inter-organizational networks

- Traditional supply-chains.
- Static decision support systems.

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Evolution of Decision Support Systems (2)

Dynamic Inter-organizational networks

- Smart Business Networks view
 - Increasing modularity of business processes and products/services
 - Quick-connect and disconnect capability
- Many choices and opportunities are available.
- .. but choosing requires decision support that can adapt to the changing network structure, and learn from users.

A New Vision for Smart Business Networks

Requires infrastructure changes:

- Everything has an IP address!
- Standardization
- Demand side management (bottom-up instead top-down)
- Economic incentives
- Automated trading markets
- Self-organization
- Advanced user interfaces (Economic Dashboards)

Flexible and Personalized Decision Support

Desiderata (1)

Decision Sciences

- Ability to play out hypothetical scenarios.
- Transparency

Smart Business Networks

- Network structure visualization
- Quick connect and disconnect
- Goal directed service composition
- Flexible dashboard architecture

Flexible and Personalized Decision Support

Desiderata (2)

Software Engineering

- Appropriate separation of concerns.
- User configurability
- User-defined abstractions.
- Easy to experiment and test.
- Robustness, reliability, availability, etc.
- Scalability.

Decision Support Systems: A feature gap analysis (1)

Five technologies commonly used for building DSS capabilities

- Enterprise Resource Planning (ERP) Systems
- Data Warehouse (DW) Systems
- Spreadsheets (SS)
- Expert Systems (ES)
- Mash-ups (MU)

Decision Support Systems: A feature gap analysis (2)

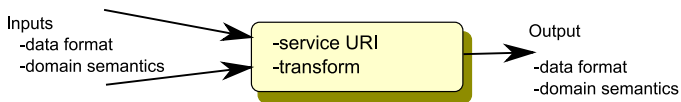
| <i>Desired property</i> | <i>DSS Technology</i> | | | | |
|---------------------------------------|-----------------------|----|----|----|----|
| | ERP | DW | SS | ES | MU |
| 1. Appropriate separation of concerns | + | + | + | - | - |
| 2. User configurability | 0 | 0 | ++ | + | ++ |
| 3. User-defined abstractions | -- | -- | - | - | + |
| 4. Easy to experiment and test | - | - | ++ | 0 | + |
| 5. Robustness | + | 0 | - | 0 | - |
| 6. Scalability | ++ | ++ | - | 0 | + |
| 7. Structure visualization | - | 0 | - | + | - |
| 8. Quick connect, disconnect | -- | -- | -- | - | + |
| 9. Service composition | -- | -- | -- | 0 | + |
| 10. Flexible dashboard | 0 | 0 | 0 | 0 | + |
| 11. Transparency | - | - | - | + | - |
| 12. Hypothetical scenarios | + | -- | ++ | + | -- |

Filling the gap (1)

Evaluator Service Networks

- Small single-purpose analysis modules:
 - compose into dataflow networks
 - connect inputs to compatible outputs
- Each evaluator has inputs, parameters, process, output, constraints.
- Evaluators refer to each other by name rather than direct reference.
- Evaluator names are configurable through:
 - XML configuration files
 - User interface

Filling the gap (2)

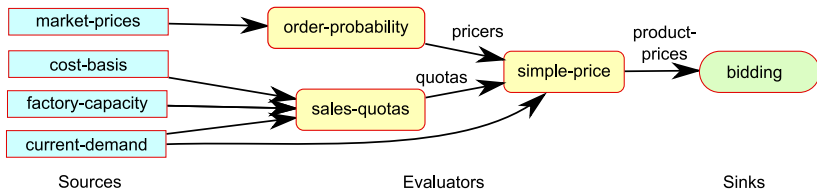


An evaluator service with its inputs, transform, and output.

Example: Sales Evaluators

Basic idea

- 1 Determine quantity Q_X of product X to sell
- 2 Set a price Φ_X such that when offered on all demand D_X for X , moves Q_X units in expectation.
- 3 etc.



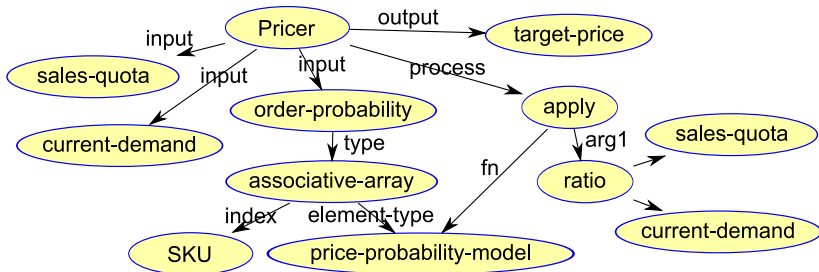
Service Composition

A pipe-and-filter model

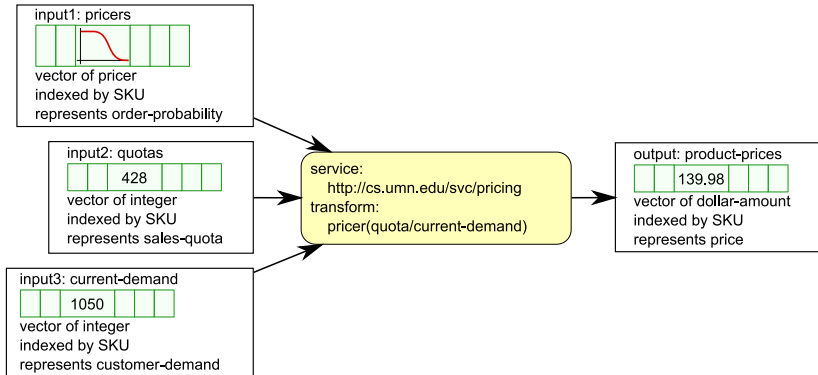
- Restrict services to dataflow components that can be composed into directed graphs.
- Abstractions can be composed from subgraphs.
- Add rich semantic descriptions to components.
- Process annotations to ensure that composed graphs have consistent semantic descriptions.
- Assist user in finding and understanding data.
- Assist user in composing graph modifications.

Service Semantics (1)

- Dataflow restriction simplifies annotation.
- Connection from component A to component B is possible if output of A can be mapped to an input of B.
- Semantic mappings propagate from input to output of B.



Service Semantics (2)



MinneTAC

A highly flexible research tool

- The MinneTAC agent is a general architecture for autonomous decision-making agents.
- **Evaluator Service Networks** are at the core and strung together at runtime.
- A typical configuration contains between 60 and 80 of these services.
- 3rd place in the 2009 TAC SCM competition.

What is a Trading Agent?

as opposed to an “Agent”

*Definition of an autonomous agent
(Wooldridge & Jennings 1995)*

1. Autonomy

Agent has persistent identity, operates without direct control.

2. Social ability

Agent interacts with other agents and/or human users.

- Most communication is negotiation or otherwise related to trading - requests, offers, orders, shipments, payment, etc.
- Agents often do not communicate directly with their competitors.

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What is a Trading Agent? (2)

3. Reactivity

Agent perceives its environment, responds appropriately.

- Tracks prices, supply and demand,
- Updates internal models (learning),
- Makes offers, accepts orders.

4. Proactivity

Agent exhibits goal-directed behavior, takes initiative.

- Uses models and market signals to “buy low, sell high.”
- Engages in strategic behavior.
- Evaluates its own market power, drives market in desirable directions.

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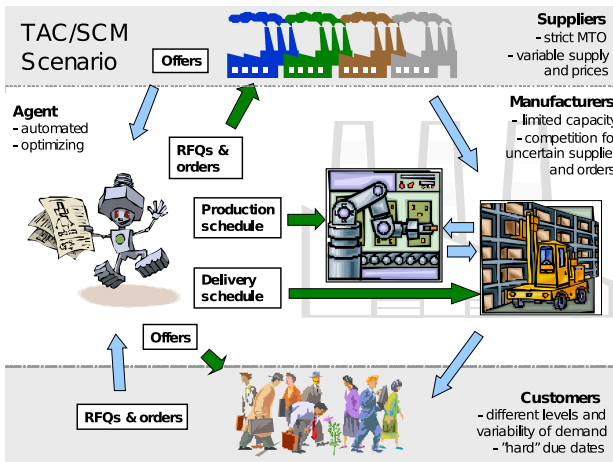
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TAC SCM

Overview – Dynamic Business Network Testbed



TAC SCM

Why a simulated testbed?

Enabling research

- The problem is too complex for a game-theory solution.
- It's hard to do experiments with real organizations.
- Evaluation is needed to validate solutions.

The "Game"

- An abstraction of a simple three-tier supply chain (Dell).
- Balance between real-world complexity & ease of analysis.
- Data can be collected and analyzed, experiments can be repeated.

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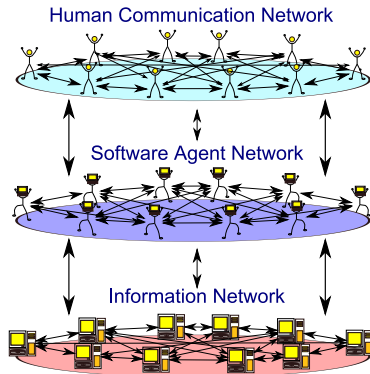
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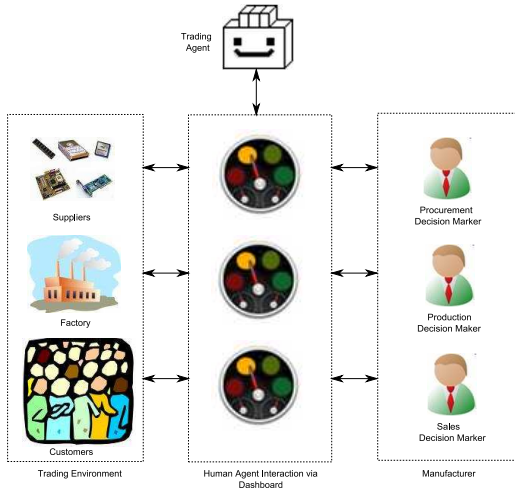
TAC SCM

Lessons learned

- Businesses don't trust fully autonomous agents.
- Human preferences matter.
- Decision support vs. decision automation.
- Actor vs. network decisions.
- Flexible agent architecture.



Proposed Human-Agent Interaction in TAC SCM



Human Agent Interaction

Radically rethink user-agent interaction by

- Offering just-in-time information.
- Highly relevant to a unique user and his/her current focus of attention.
- In a non-disruptive, easily accessible, privacy protecting way.

Essential steps

- 1 User preference modeling.
- 2 Decision recommendation.
- 3 Feedback.

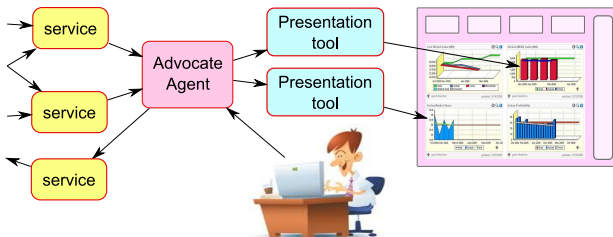
Using an Advocate Agent

Enhanced functionality

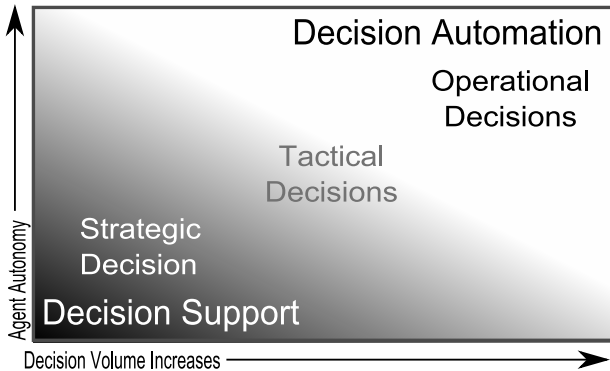
- Multiple user roles
- Alerts
- Control appliances
- Control batteries

Adapting to the user

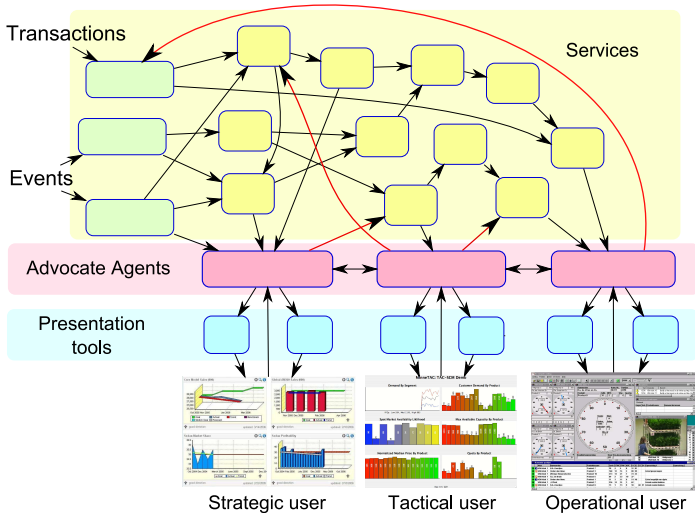
- Learn preferences
- Reduce cognitive load
- Focus on human judgement



Decision Support vs. Decision Automation



Evaluator Service Networks with Advocate Agents



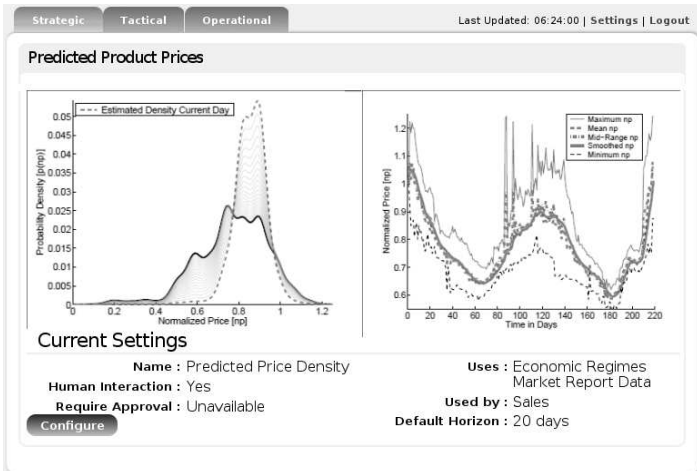
User roles

We find it useful to distinguish among three classes of users and decision makers:

- *Strategic* users
- *Tactical* users
- *Operational* users

Each class needs tools to support their reasoning.

Strategic Dashboard



Tactical Dashboard

Strategic

Tactical

Operational

Last Updated: 06:24:00 | [Settings](#) | [Logout](#)

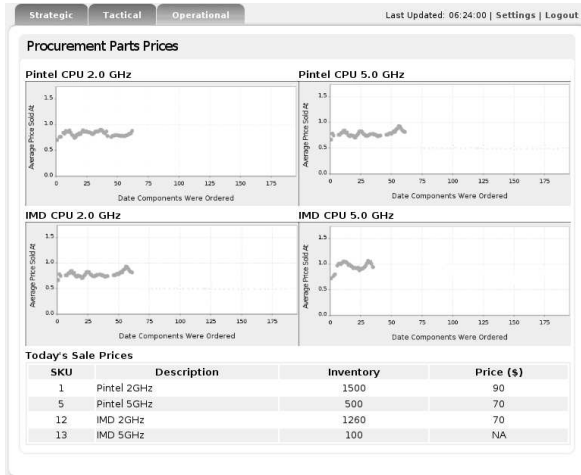
Current Recommended Product Sales Prices

Please approve the recommended prices below.

| SKU | Description | Price (\$) |
|-----|---|-----------------------------------|
| 1 | Pintel 2GHz, 1Gb Memory, 300 Gb Hard disk | <input type="text" value="1650"/> |
| 2 | Pintel 2GHz, 1Gb Memory, 500 Gb Hard disk | <input type="text" value="1750"/> |
| 3 | Pintel 2GHz, 2Gb Memory, 300 Gb Hard disk | <input type="text" value="1750"/> |
| 4 | Pintel 2GHz, 2Gb Memory, 500 Gb Hard disk | <input type="text" value="1850"/> |
| 5 | Pintel 5GHz, 1Gb Memory, 300 Gb Hard disk | <input type="text" value="2150"/> |
| 6 | Pintel 5GHz, 1Gb Memory, 500 Gb Hard disk | <input type="text" value="2250"/> |
| 7 | Pintel 5GHz, 2Gb Memory, 300 Gb Hard disk | <input type="text" value="2250"/> |
| 8 | Pintel 5GHz, 2Gb Memory, 500 Gb Hard disk | <input type="text" value="2350"/> |

Approve

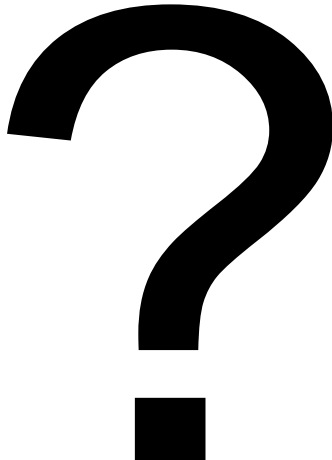
Operational Dashboard



Summary

- Highly configurable, transparent decision processes that are described in terms that end users can understand.
- MinneTAC design shows how decision processes can be composed from networks of analysis and modeling tools.
- Teaching tool and research framework.

Questions?



Contact

Email: `wketter@rsm.nl`

URL: `www.ketter.ws`

URL: `large.rsm.nl`

Join us!