

**Control Software Vendor's
Perspective of Innovation Process**

Data-Centric Decision Support

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ACC, Anchorage, Alaska, May 9, 2002

Part 1

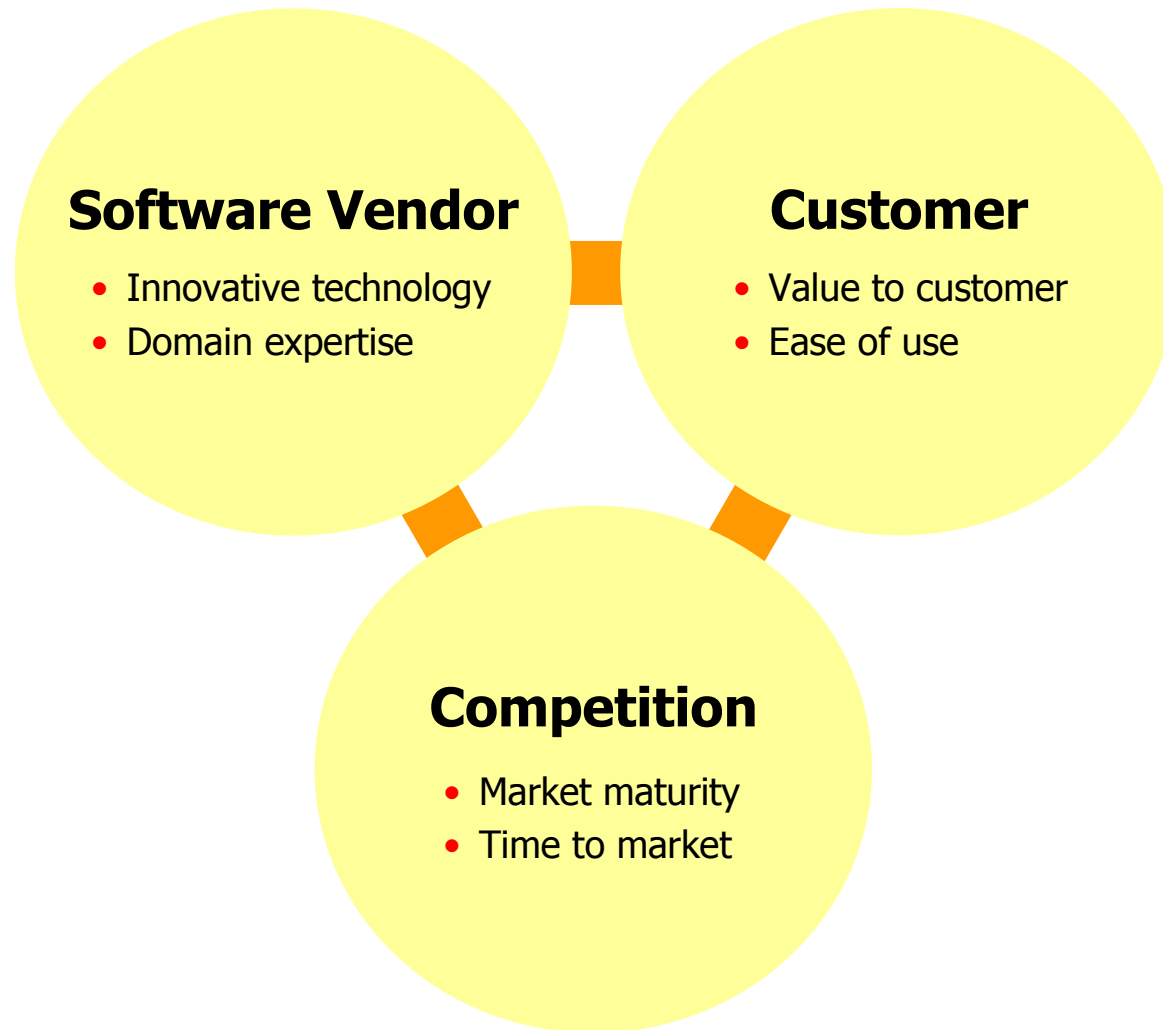
Some General Points



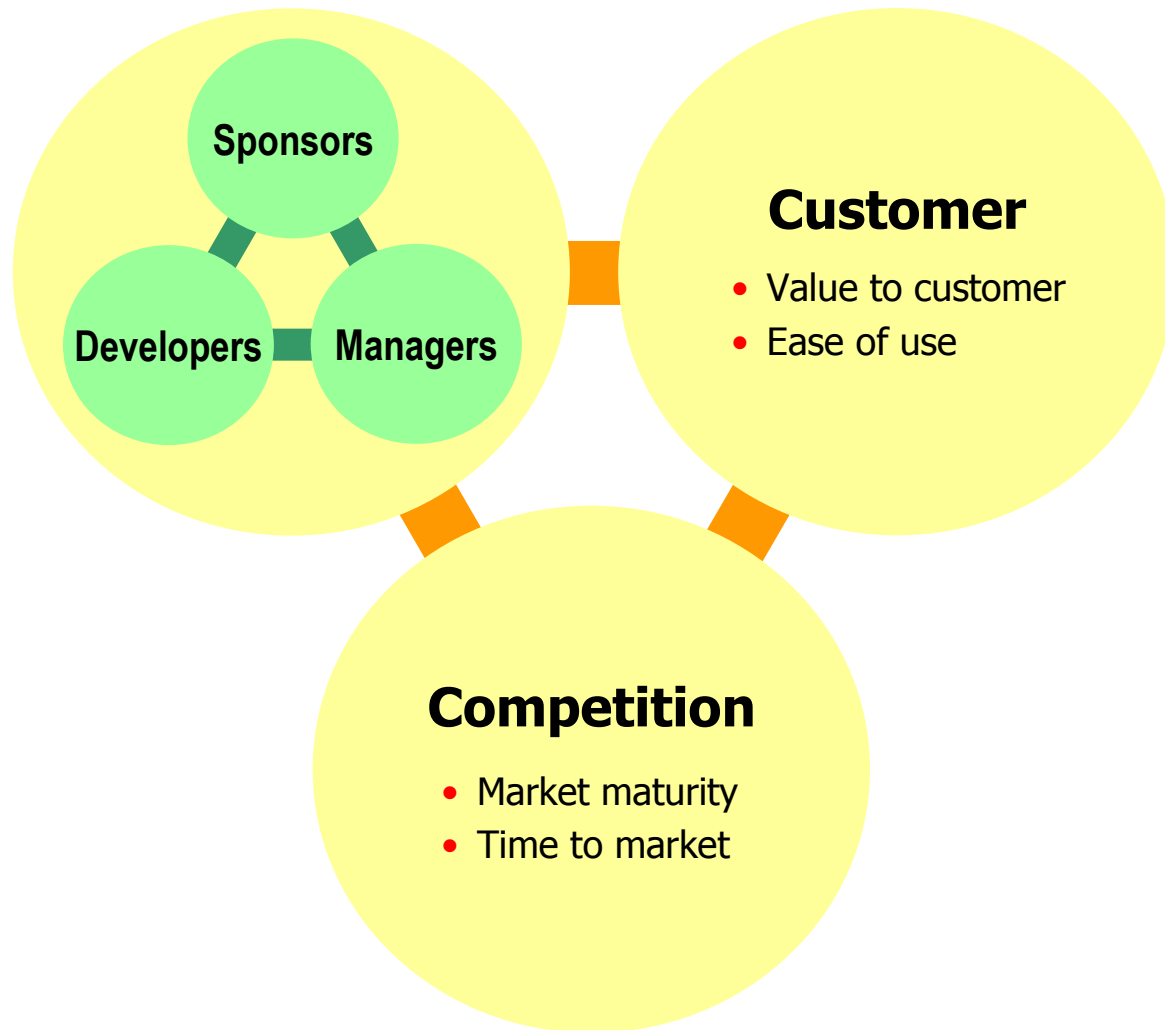
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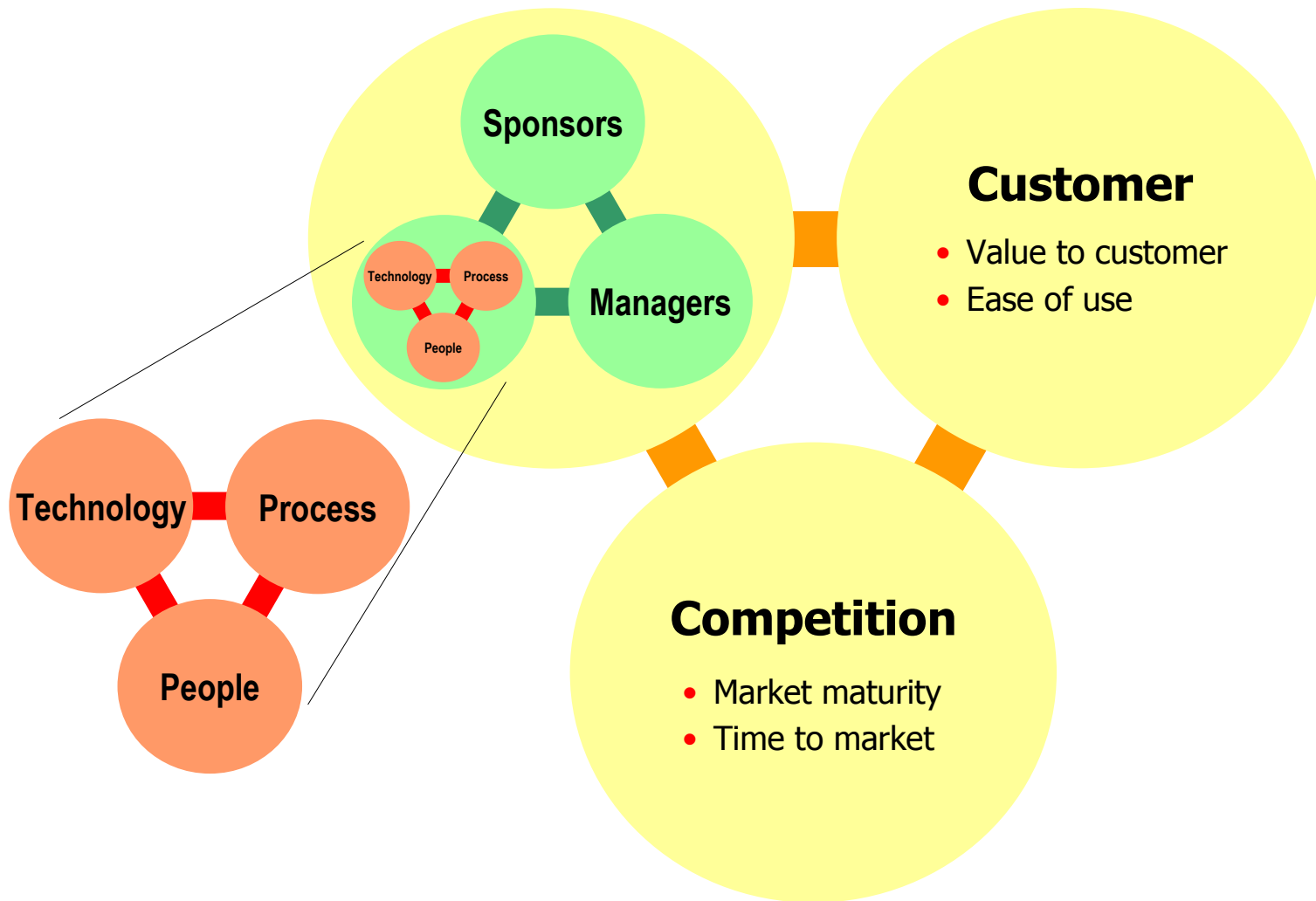
Key Dimensions of Innovation Process



Key Dimensions of Innovation Process



Key Dimensions of Innovation Process



Market Maturity

Source: <http://world.std.com/~uieweb/market.htm>

Stage	Users Want	Usability Means	Developers Focus on
Raw Iron	The basic capability	The product works	Technical issues and delivery
Checklist Battles	The best set of features	Having the right functions	Adding features and fixing bugs
Productivity Wars	To get their work done better and faster	Easy to learn, fast, powerful	Performance support, reducing technical support costs
Transparency	Lowest cost	The product is invisible	Reducing costs or seeking new markets

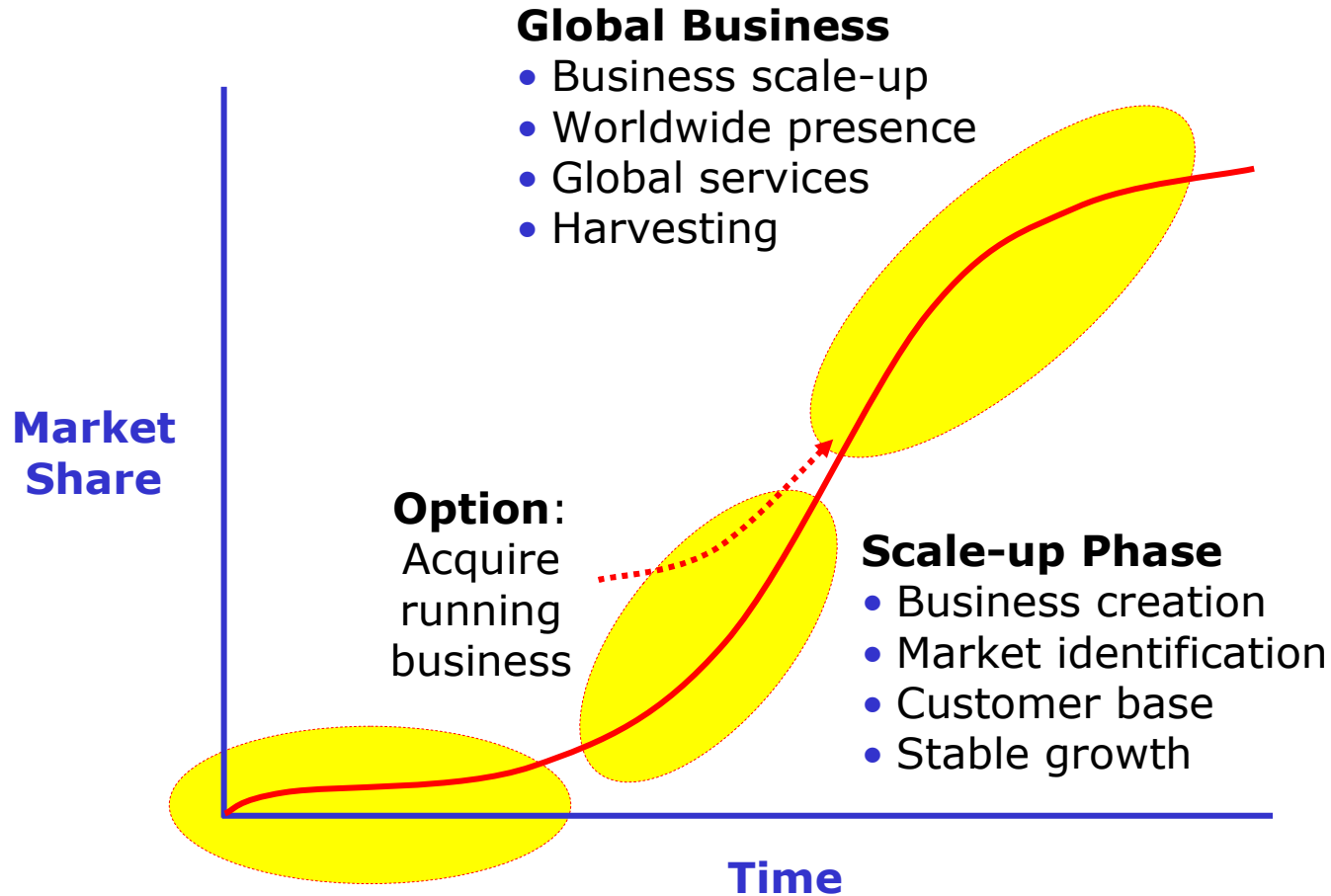
How mature is YOUR market ?



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Market Penetration



Prototyping

- New technology
- Software prototype
- Pilot applications



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People

- A prerequisite for bringing innovation close to the scale-up phase is a **cross-functional team** combining multiple roles, including
 - quick adoption of proper methods (technology brokering);
 - development and rapid prototyping of necessary algorithms;
 - software implementation of proprietary functional components;
 - integration with commercial-off-the-shelf components;
 - pilot applications in selected markets (assumes domain knowledge);
 - intensive communication with the company businesses;
 - technology marketing (communicate – and sell – your vision);
 - sales support for pilot applications.
- **Domain expertise** and **customer knowledge** make a huge difference.



Technology

- Innovation does not always mean a new technology ... Innovation can also come from
 - improved business practices,
 - easier to use interfaces,
 - additional software features,
 - more comprehensive services.
- Except for niche market products (such as software for researchers), technology must be selected and packaged so as to be **easy to install, learn, use, and maintain.**
- Technology acceptance is based on its perceived rather than a potential value:

What You See Is What You Get



Process

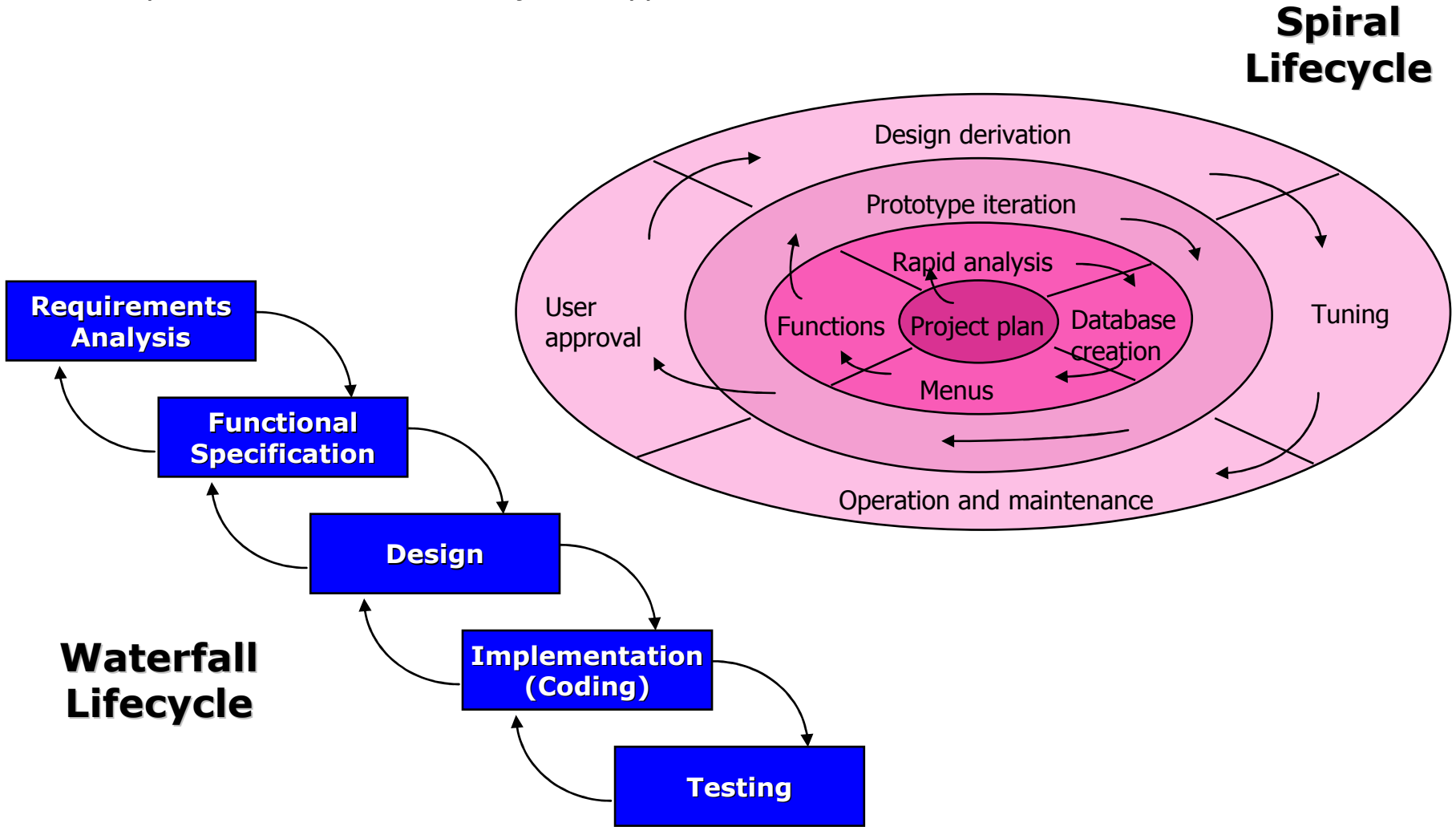
- In the increasingly dynamic and uncertain environment, most development teams currently prefer a **spiral/scrum model of software development** to the (traditional) linear/waterfall one.
- The scrum model assumes from the early phases involvement of a sample of target users and counts on evolutionary development with several iterations in software design and implementation.
- The objective is to capture the right product concept as quickly as possible, before the accumulated development cost prevents any further major changes to its design.
- Periodic testing against large-scale real-life problems is essential to guarantee a **continuous feedback** for further development of technology, software and solutions.
- Frequent releases (every 3–6 months) allow for **quick response to incipient deviations** between the requirements and the actual development.

Use Feedback Control



Development Lifecycles

Source: <http://www.brunel.ac.uk/~csstjds/sdlc.ppt>



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Part 2

DSS Development



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Decision Support System (DSS)

- DSS represents a specific form of control system that suggests multiple possible actions (decisions) to the ultimate controller (decision-maker).
- The crucial feature of DSS is its capability to **interact effectively with the user**.
- DSS is considered mostly at **higher levels of control hierarchy** where the complexity of task or the importance of decision requires human intervention.
- DSS often combines multiple functions, such as estimation, prediction, optimization, fault detection and diagnosis, and data visualization.
- DSS incorporates both data and models. Given that large repositories of historical data have become a common by-product of computerized control, the interest naturally increases in **data-centric DSS**.



Starting Point

Market Opportunity

- For the last 10 years, the processing capacity and data storage have doubled every 18 and 9 months, respectively.
- As a result, people have way more data than they know what to do with.

Enabling Technologies

The progress made in the last decade in

- nonparametric and Bayesian statistics,
- Markov chain Monte Carlo methods,
- real-time data warehousing,
- computer and database performance

has offered new ways of approaching the old problem.

Major Challenges

- How to package advanced technology for a non-expert user?
- How to balance performance and ease of use?



Technology Choices

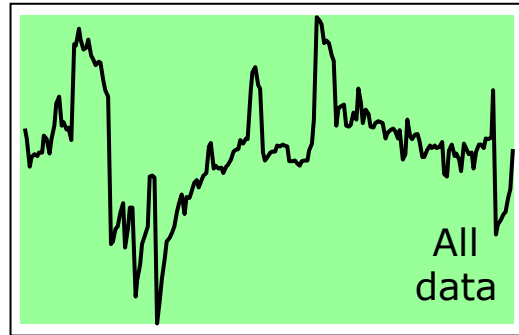
Allow for flexible modeling!

- First-Principle vs. Empirical Models
- Linear vs. Non-linear Dependence
- Adaptation vs. Learning
- Complete vs. Recent vs. Relevant History
- Closed-Form vs. Iterative Solution
- Recursive vs. Batch Processing
- Observed vs. Hidden Variables
- Continuous vs. Categorical Variables
- Uncertainty vs. Reliability
- Prior Knowledge vs. Actual Data
- Interpolation vs. Extrapolation

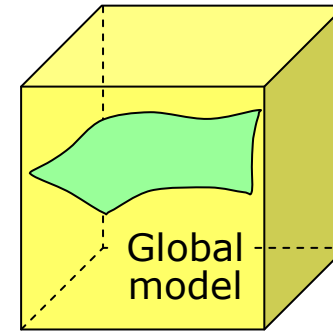


Memory-Based Learning

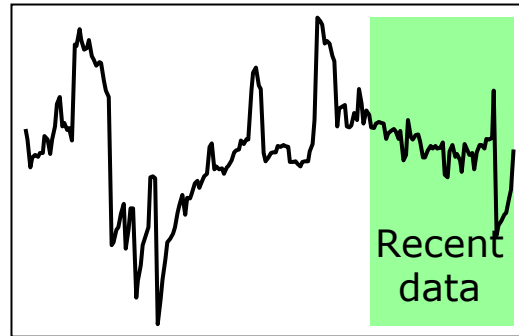
Shift of paradigm:
Use only data relevant to the case.



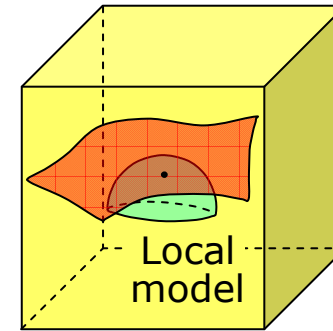
Estimation



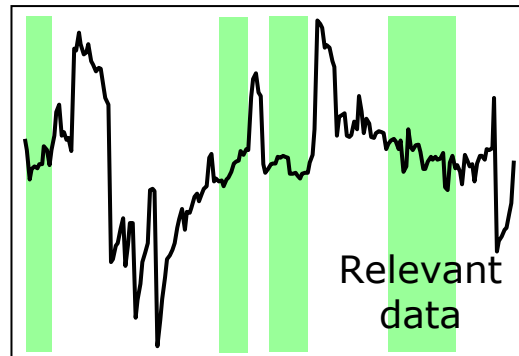
Data fitted globally



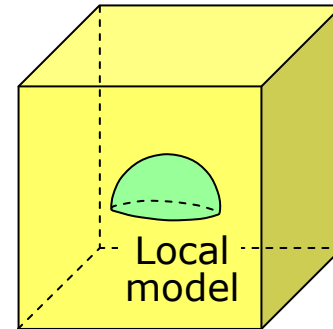
Adaptation



Data fitted locally in time



Querying



Data fitted locally in cube



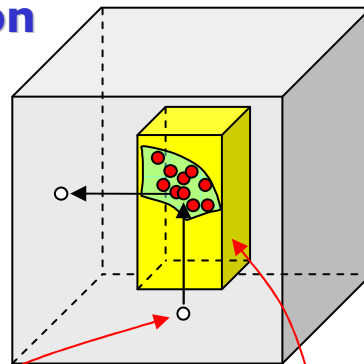
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Data-Centric Technology

Regression

Continuous target variable
(product demand, product property, perform. measure)



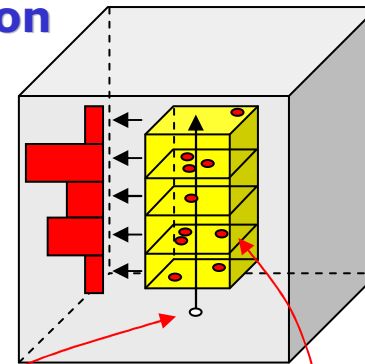
State and/or Action

Query point

Neighborhood

Classification

Categorical target variable
(discrete event, system fault, process trip)



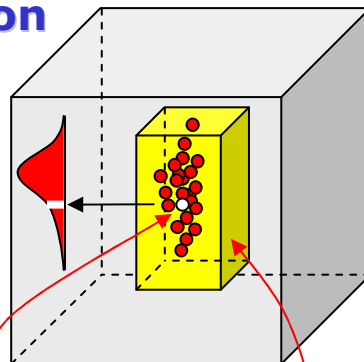
State and/or Action

Query point

Neighborhood

Fault Detection

Tested variable
(corrupt values, unusual responses, new behavior)



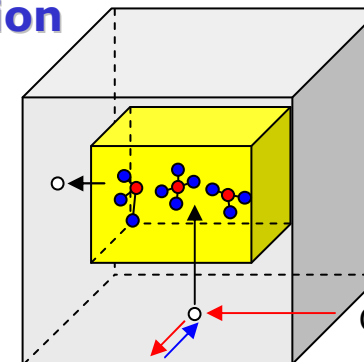
State and/or Action

Tested point

Neighborhood

Optimization

Reward
(operating profit, production cost, target matching)



Past & new

Action
(decision)

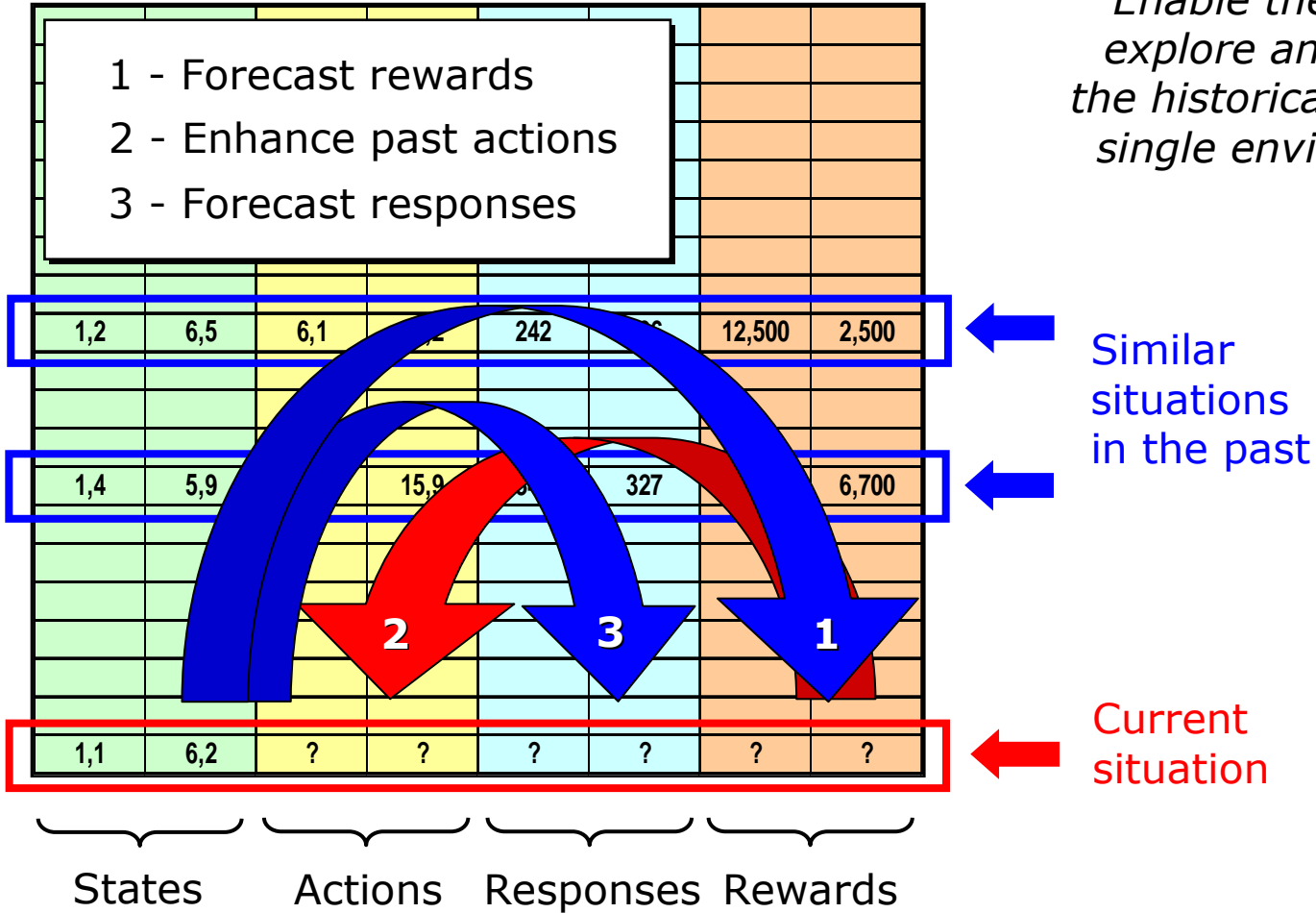
Current State
(operating conditions)



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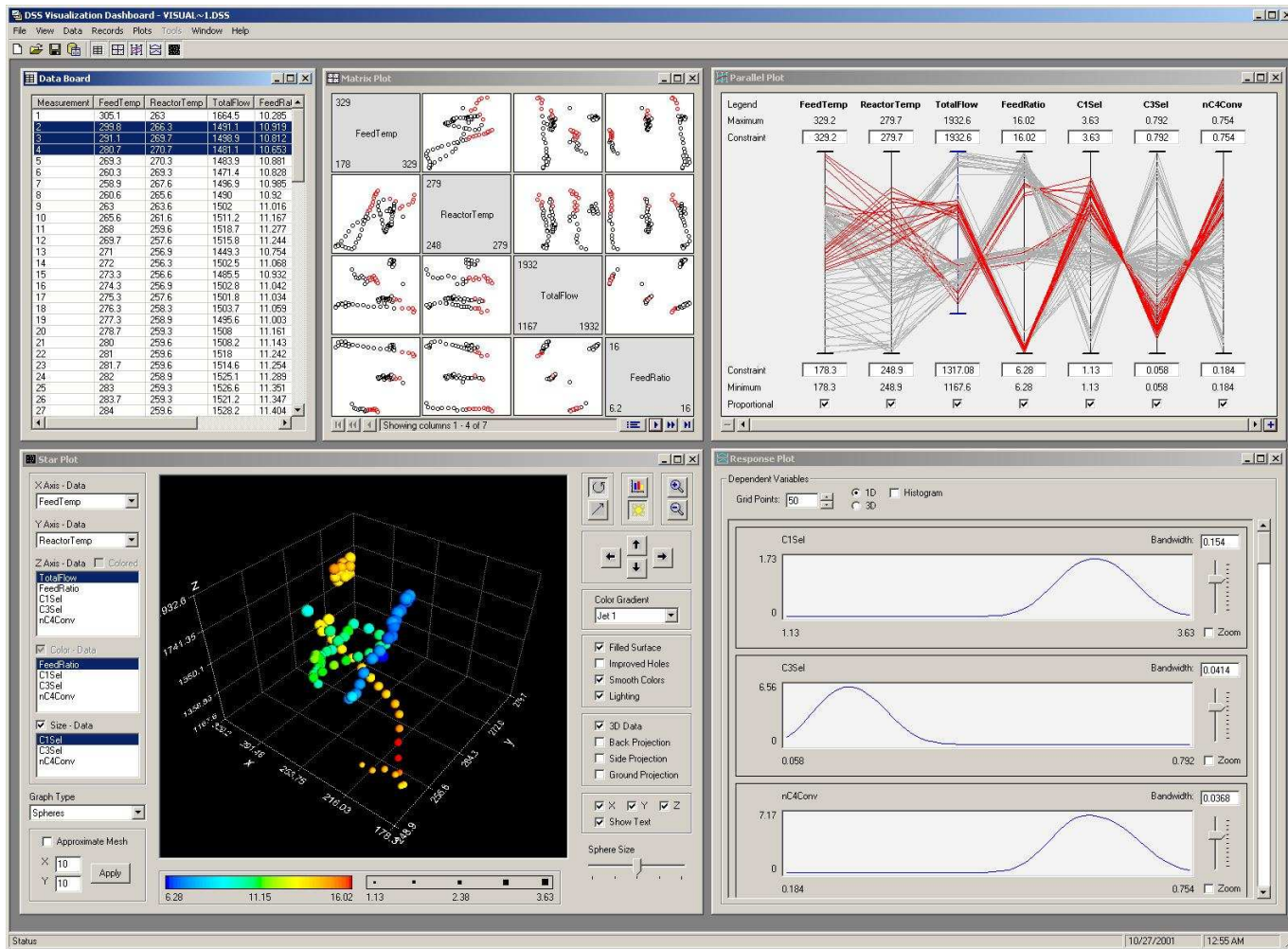
Comprehensive Functionality



Enable the user to explore and exploit the historical data in a single environment.



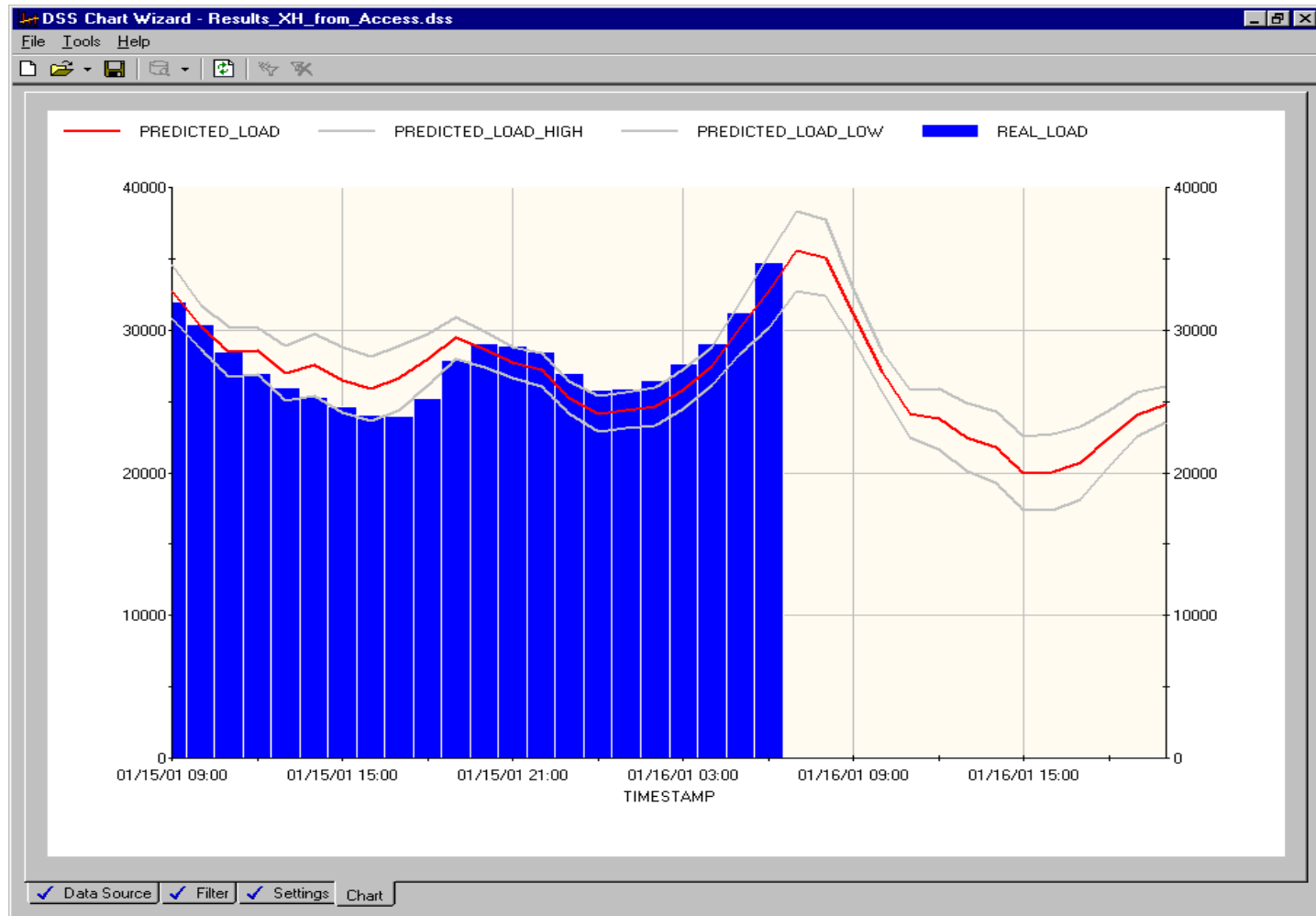
Exploratory Data Analysis



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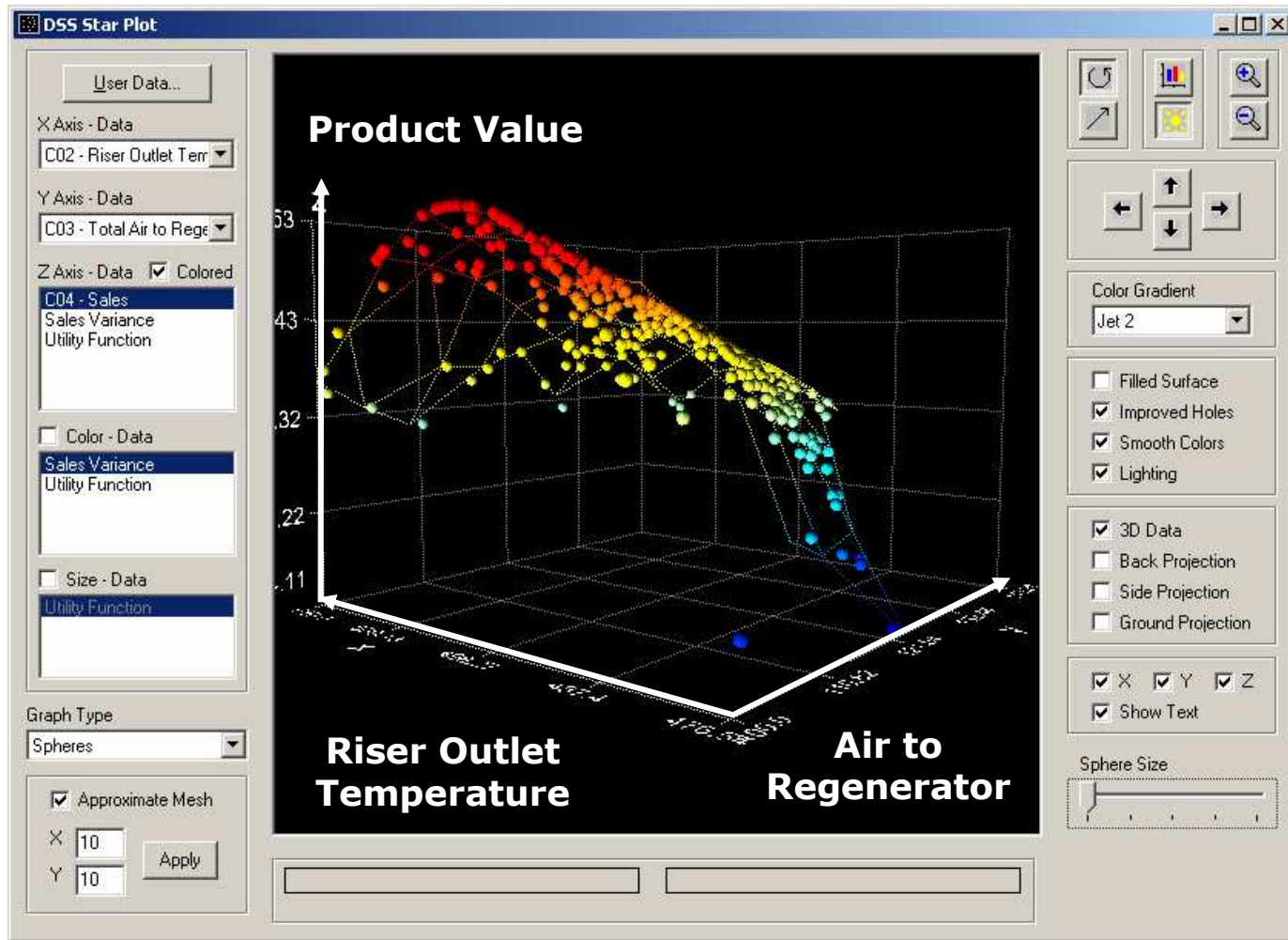
Predictive Modeling



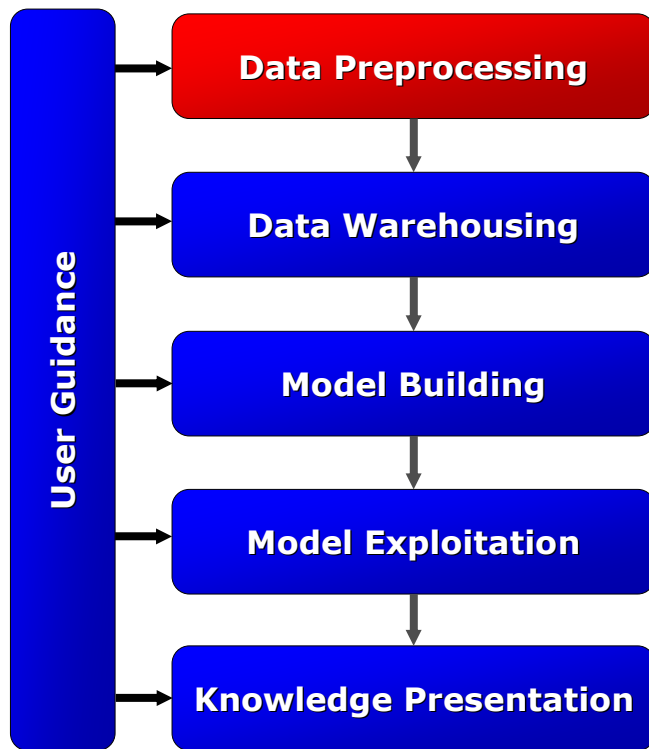
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Decision Analysis



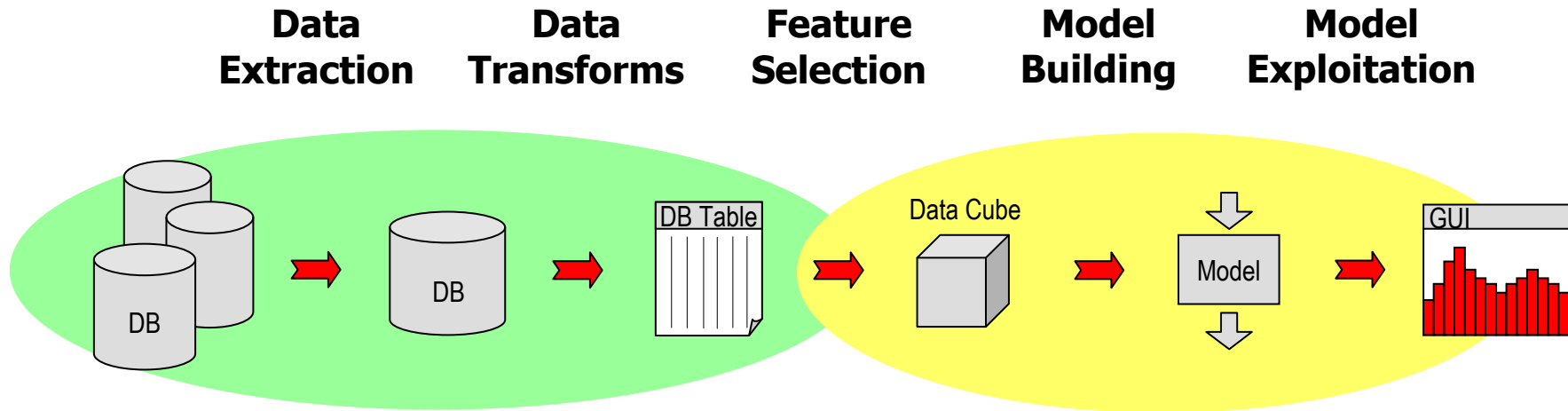
Typical Workflow



- Key to success is to **support the entire data mining lifecycle.**
- Components are required for
 - data access,
 - data exploration,
 - data cleaning,
 - data manipulation,
 - regression models,
 - classification models,
 - model assessment,
 - decision analysis,
 - etc.
- **Data access and preprocessing occupy 60%-80% of a data miner's effort!**



Make It Easier to Use ...



Labor-intensive phases supported by

- Workflow Automation
- Visual Programming

Technology-advanced phases supported by

- Solution Libraries
- Modeling Services
- User Training



Key Features

Flexible Modeling

- Data-centric ... just-in-time ... on-demand modeling.

Extreme Scalability

- Built-in similarity search through the process history.

Vertical Focus

- Domain-specific applications in selected markets.

Task Automation

- 24x7 mode of operation fully supported.

No Special Skills Required

- Packaged for non-statisticians.

Affordable Tool

- Bringing decision support to desktop level.



Conclusion

- The technology is a crucial but – measured by the overall productization and commercialization effort – a relatively small part of the whole endeavor.
- A successful control of the innovation process requires to view the technical part of development from the overall system perspective, which takes into account the conflicting interests of all major stakeholders and ultimately benefits the end user.

