

Level Of Models

Unit 1 : Lecture 2

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Learning & Course Outcomes

Use bloom's taxonomy to write the learning outcome of each lecture

LO1: To understand Conceptual Models.

LO2 : To differentiate Physical vs. Mathematical Models.

LO 3: To analyze Statistical and Computational Models.

LO4: To evaluate Hybrid and Agent-Based Models.

LO5 : To simulate Models.

Use bloom's taxonomy

CO1: Understand the basic concepts and techniques of Artificial Intelligence.

Summary/Key Points

- **Conceptual Models:** Simplified representations to understand systems, focusing on key concepts without specifics.
- **Physical Models:** Tangible representations, such as prototypes, used for visualizing and testing designs.
- **Mathematical Models:** Use equations and algorithms to analyze relationships and predict outcomes in various fields.
- **Simulation Models:** Virtual replicas of real-world scenarios for experimentation and testing without real-life consequences.
- **Statistical Models:** Use statistical techniques to analyze data, identify patterns, and make predictions.
- **Computational Models:** Employ computer algorithms and simulations to study complex systems and handle large data sets.

Introduction to Levels of Models

Models can be classified into different levels based on their complexity and scope.

Understanding the level of a model helps in determining its suitability for different purposes.

Levels of models range from simple conceptual models to detailed computational models.

Types of Models

- Models can be categorized into different types such as physical, conceptual, mathematical, and computational.
- Physical models are tangible representations of a system or object.
- Conceptual models are simplified representations used to understand complex systems.

Levels of Models

- Models can be classified into different levels based on the amount of detail and complexity they incorporate.
- Low-level models focus on specific details and interactions within a system.
- High-level models provide a broader view of the system with less detail.

Low-Level Models

- Low-level models are detailed and specific, capturing intricate interactions within a system.
- These models are often used for in-depth analysis and understanding of complex systems.
- Examples of low-level models include molecular dynamics simulations in chemistry and detailed financial models in economics.

High-Level Models

- High-level models offer a more generalized view of a system, focusing on overall behavior and trends.
- These models are useful for making strategic decisions and understanding the big picture.
- Examples of high-level models include economic forecasting models and population growth projections.

Balance of Detail

- The level of a model should strike a balance between detail and complexity to serve its intended purpose effectively.
- Too much detail in a model can lead to excessive complexity and computational burden.
- Insufficient detail may result in oversimplified representations that overlook important interactions.

Purpose of Models

- The purpose of a model influences the appropriate level of detail it should include.
- Decision-making models often require high-level abstractions for strategic planning.
- Simulation models may need low-level details for accurate predictions and analysis.

Model Validation

- Validating a model involves comparing its predictions or outputs with real-world data or observations.
- Different levels of models may require specific validation techniques based on their complexity.
- Validation is crucial to ensure that a model accurately represents the system it is intended to simulate.

Scalability of Models

- Models should be scalable to accommodate changes in the system or varying levels of detail.
- Scalable models can be adjusted to represent different levels of complexity as needed.
- Scalability enhances the versatility and applicability of models in different scenarios.

Model Flexibility

- Flexibility in models allows for easy modification and adaptation to changing requirements.
- Flexible models can be adjusted to incorporate additional detail or simplify complexity as needed.
- Model flexibility enhances the usability and longevity of models in diverse applications.

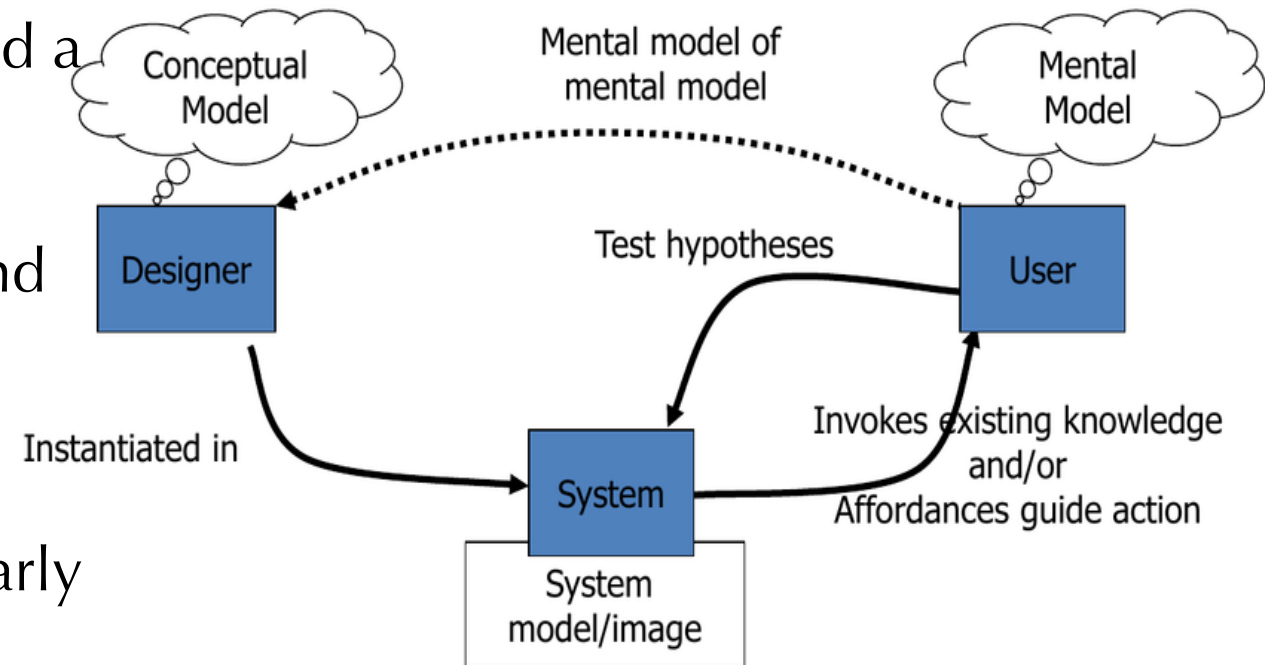
Conceptual Models

Conceptual models are simplified representations of reality used to understand a system or process.

These models focus on the key concepts and relationships without getting into detailed specifics.

Conceptual models are often used in the early stages of problem-solving and decision-making.

Conceptual & Mental Models



Physical Models

Physical models are tangible representations of real-world objects or systems.

These models can be scaled-down versions or prototypes that help in visualizing and testing designs.

Physical models are commonly used in engineering, architecture, and product development.

Mathematical Models

Mathematical models use mathematical equations and algorithms to represent systems or processes.

These models can be used to analyze complex relationships and predict outcomes.

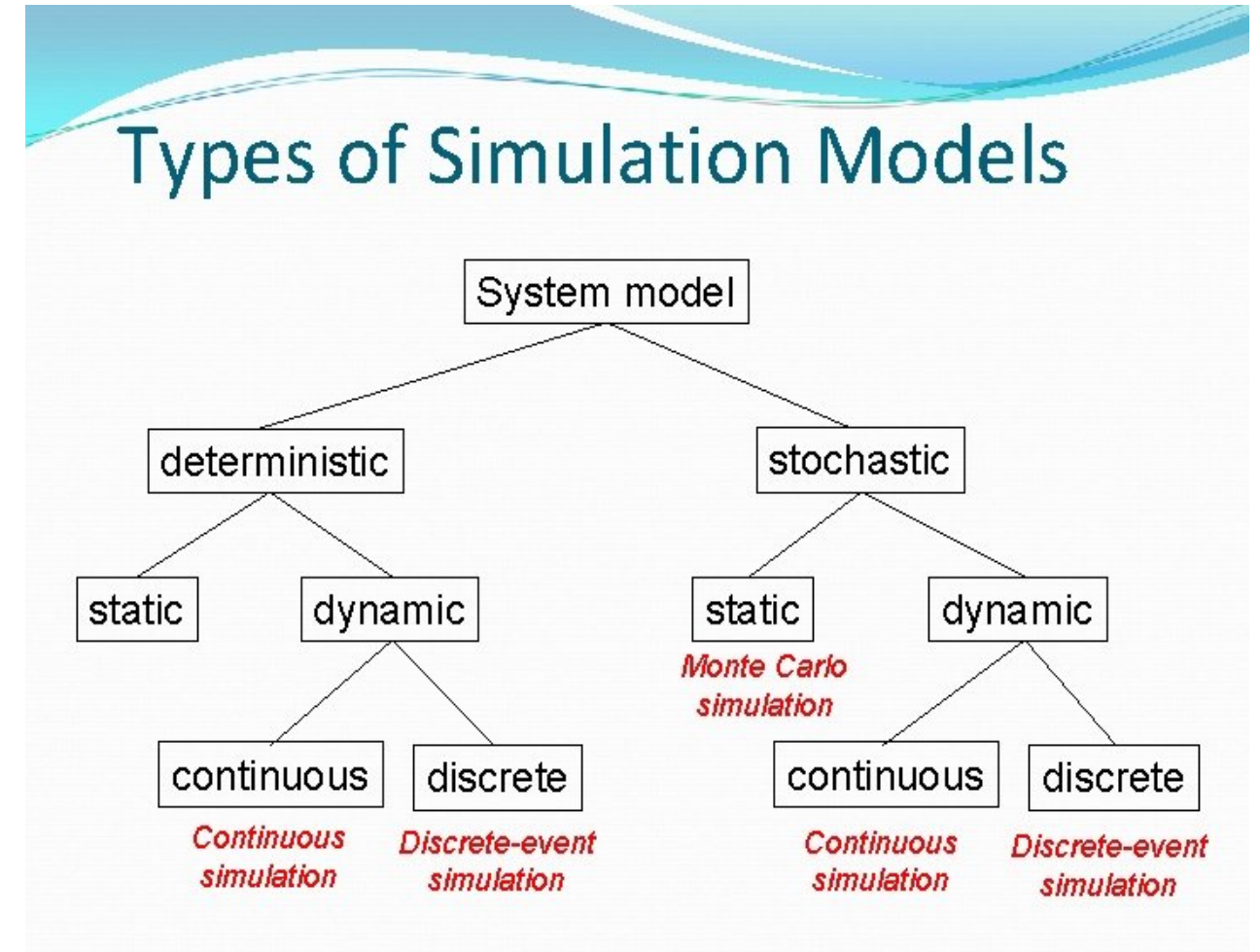
Mathematical models are widely used in fields such as physics, economics, and engineering.

Simulation Models

Simulation models replicate real-world scenarios or systems in a virtual environment.

These models allow for experimentation and testing without real-life consequences.

Simulation models are valuable for training, optimization, and decision-making.

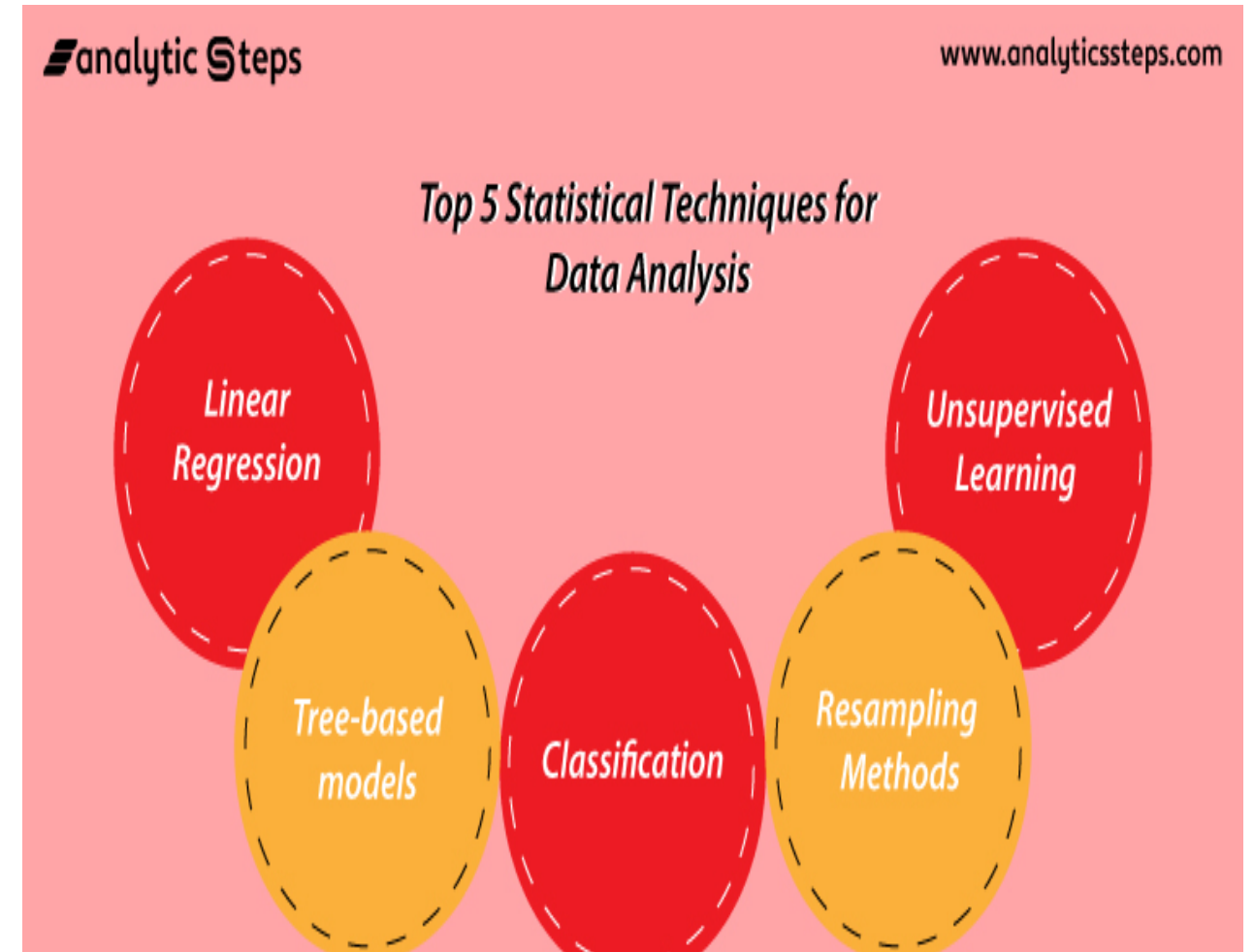


Statistical Models

Statistical models use statistical techniques to analyze data and make predictions.

These models help in identifying patterns, trends, and relationships in data.

Statistical models are commonly used in fields such as finance, healthcare, and social sciences.

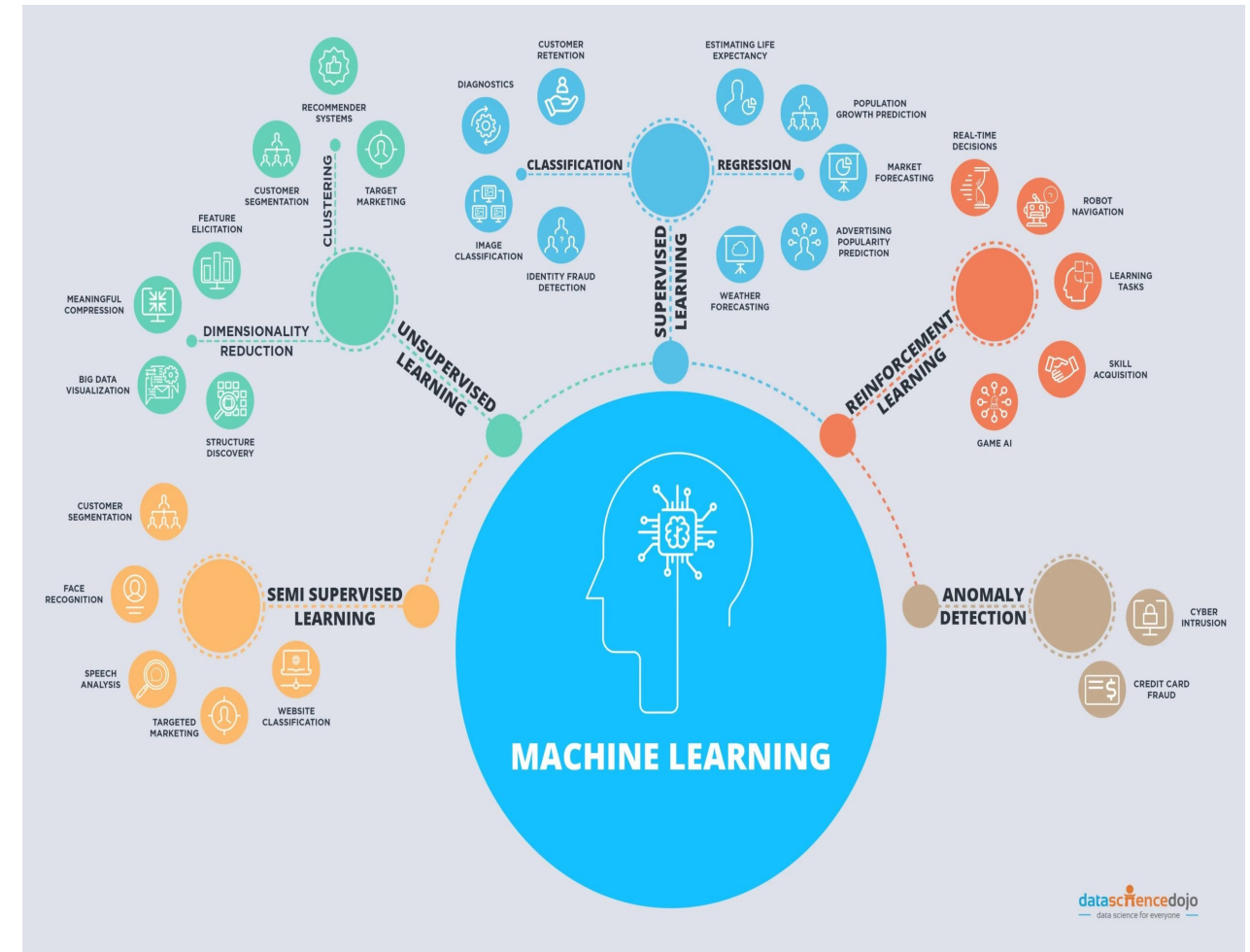


Computational Models

Computational models use computer algorithms and simulations to study complex systems.

These models can handle large amounts of data and perform intricate calculations.

Computational models are essential in fields like climate modeling, bioinformatics, and artificial intelligence.



Empirical Models

Empirical models are based on observed data and statistical analysis.

These models describe relationships between variables without explicit theoretical foundations.

Empirical models are often used in forecasting, trend analysis, and data-driven decision-making.

EMPIRICAL EVIDENCE EXAMPLES

Empirical evidence is knowledge obtained through systematic observation, measurement, or experimentation.

SURVEY DATA

Data systematically collected from sample populations that provide insights into opinions, attitudes, and perspectives of the population.

CROSS-SECTIONAL DATA

Data collected from a population at a specified time to get a snapshot of time, such as when a nation all completes a census on the same day.

CULTURAL ARTIFACTS

Artifacts that are generally collected from historical sites and analyzed as evidence of the social, cultural, and technological practices of times past.

OBSERVATIONAL DATA

Data collected by scientists through observational notes that are compared and contrasted with other scientists' observations to develop themes.

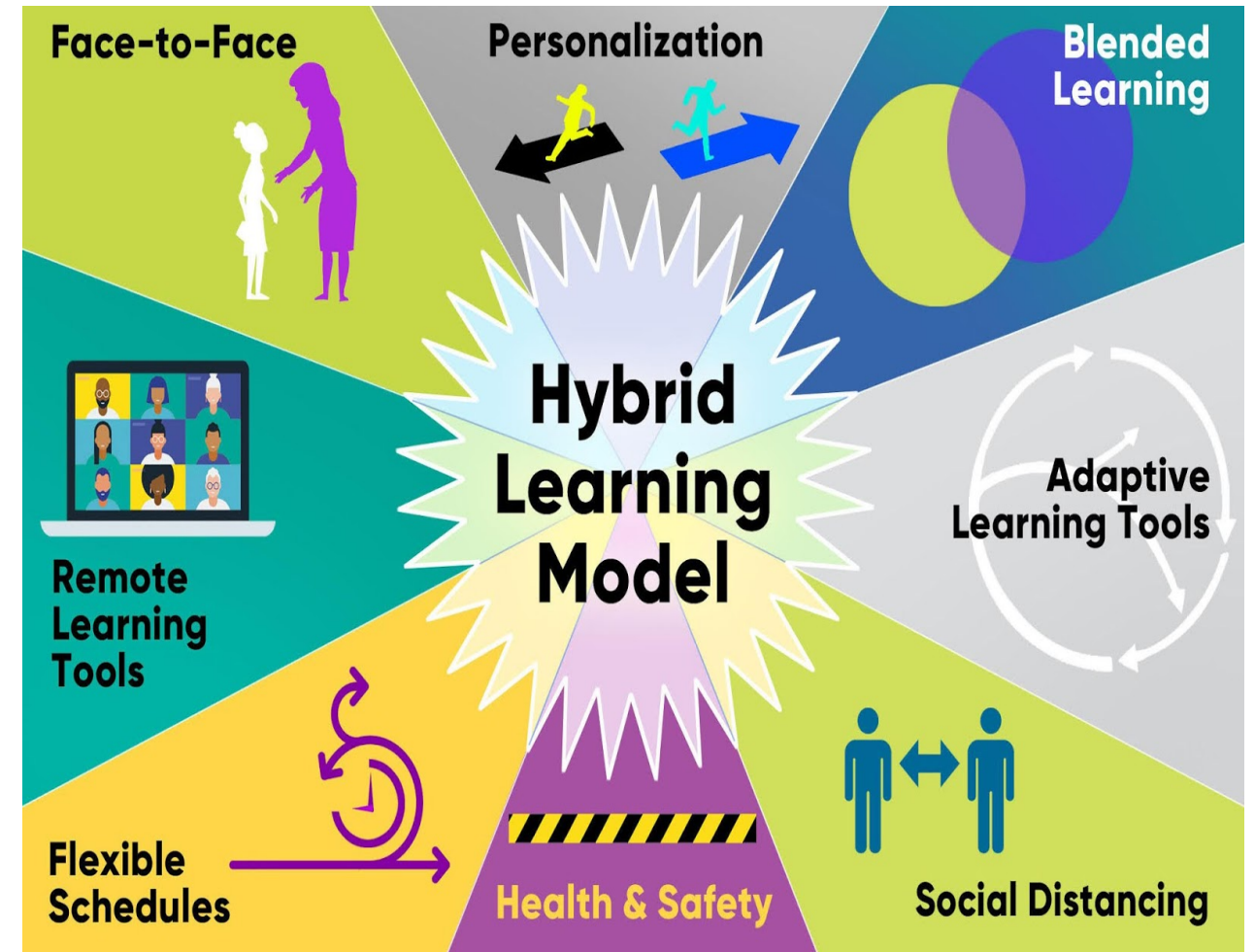
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Hybrid Models

Hybrid models combine elements of different modeling approaches to achieve a more comprehensive understanding.

These models leverage the strengths of multiple modeling techniques to address complex problems.

Hybrid models are increasingly used in interdisciplinary research and systems analysis.

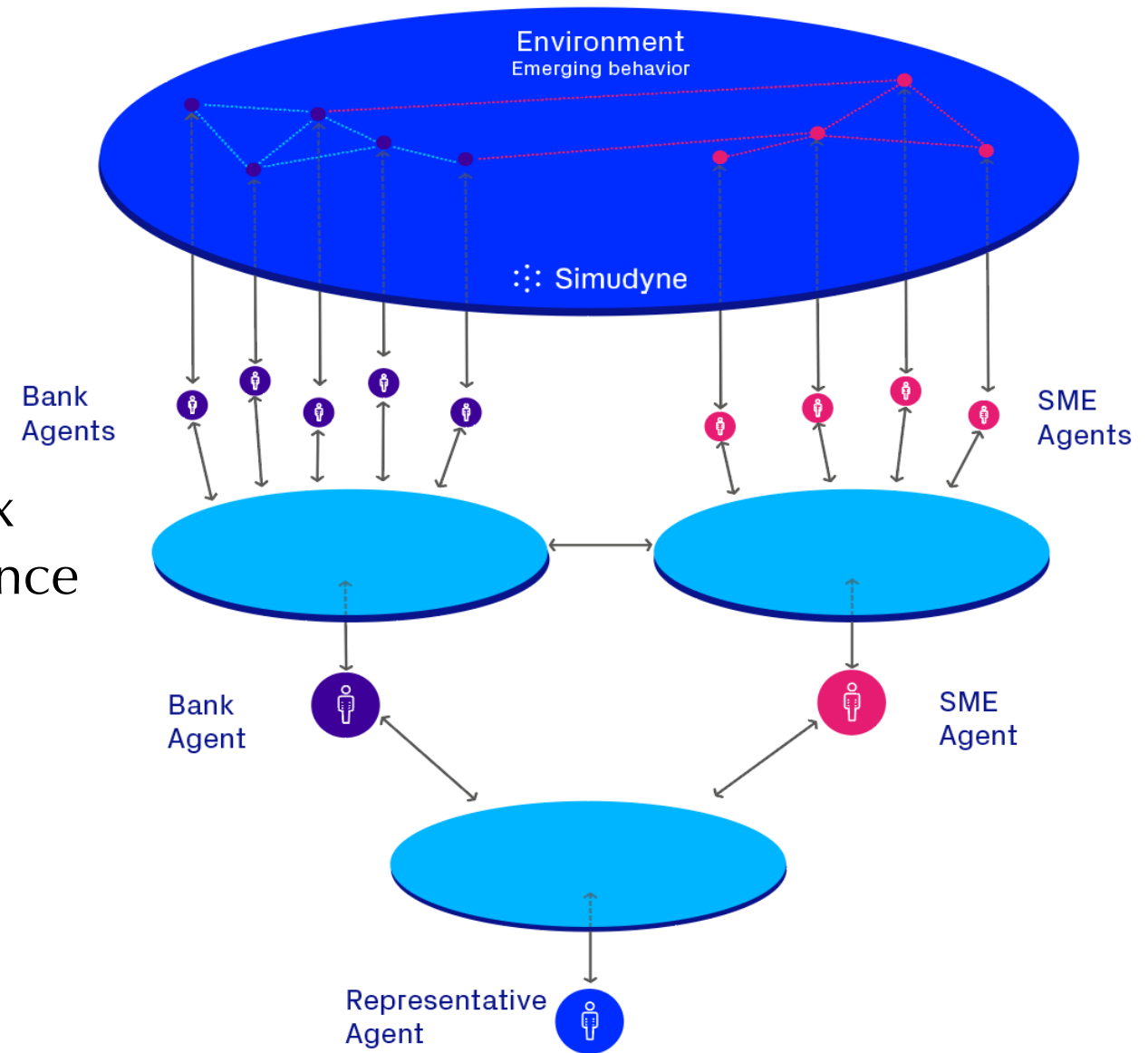


Agent-Based Models

Agent-based models simulate individual agents and their interactions to study emergent phenomena.

These models are used to explore complex systems where individual behaviors influence overall outcomes.

Agent-based models are applied in economics, ecology, social sciences, and public policy.

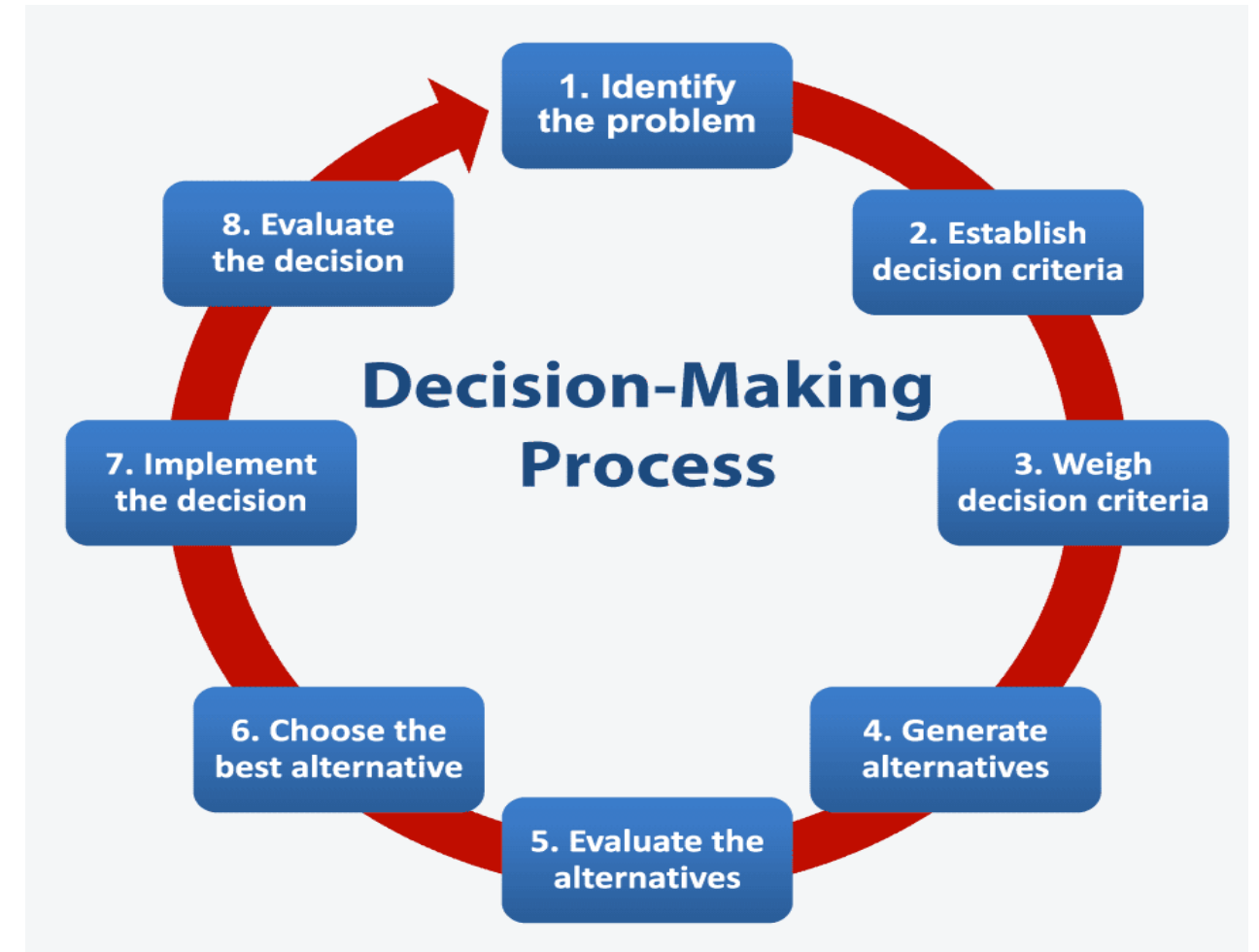


Decision Support Models

Decision support models help in making informed decisions by analyzing data and scenarios.

These models provide insights, recommendations, and predictions to support decision-making processes.

Decision support models are used in business analytics, operations research, and strategic planning.

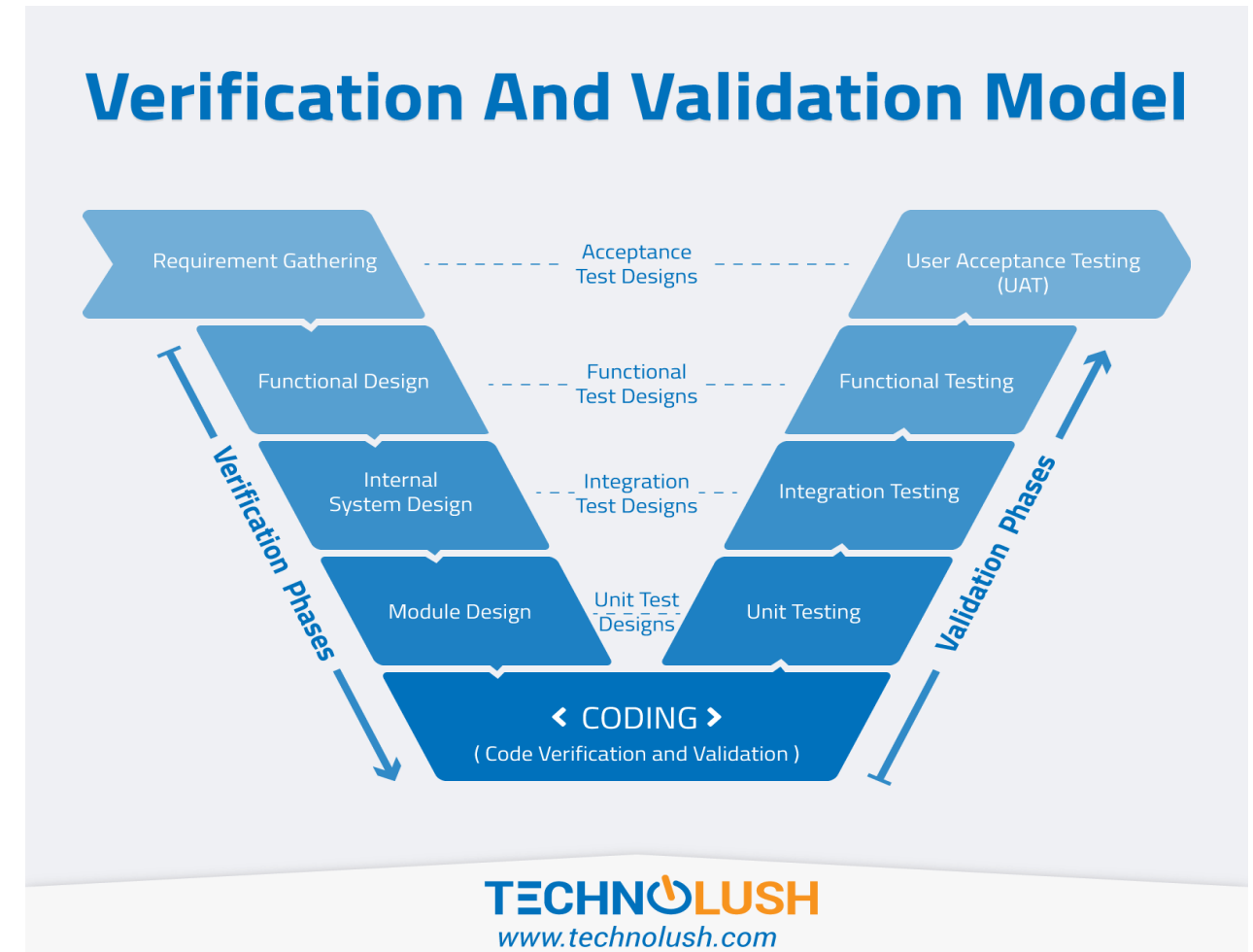


Validation and Verification of Models

Validating models involves assessing whether they accurately represent the real-world system.

Verification ensures that the model's implementation is correct and free of errors.

Validation and verification are crucial for ensuring the reliability and credibility of models.



Sensitivity Analysis of Models

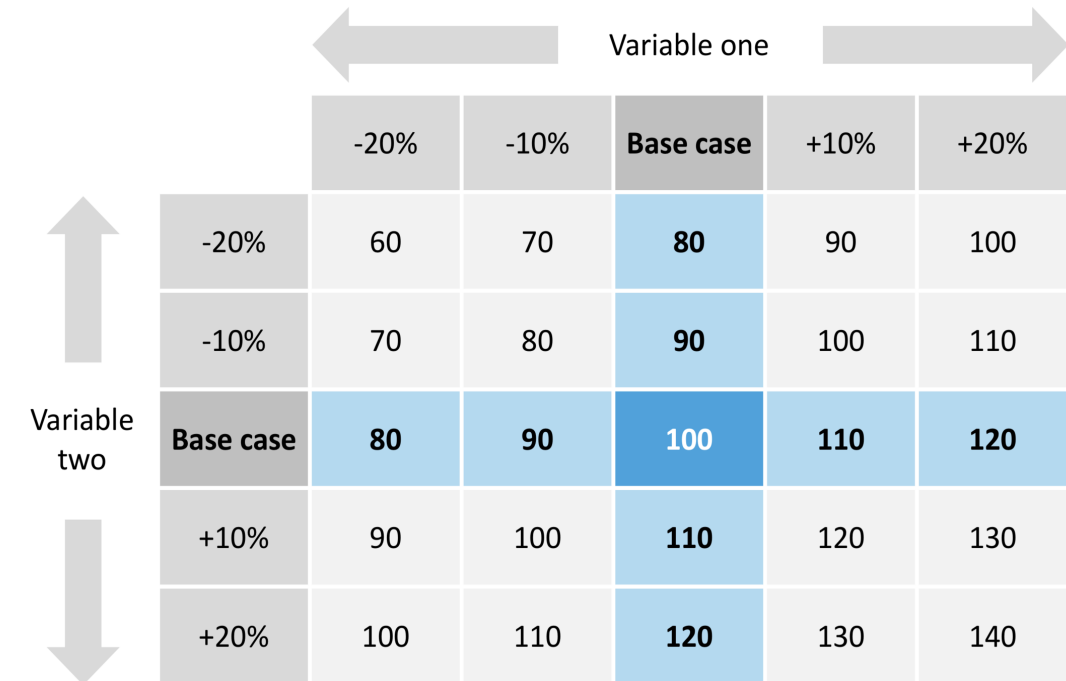
Sensitivity analysis evaluates how changes in model inputs affect the outputs.

This analysis helps in understanding the impact of uncertainties and assumptions on model outcomes.

Sensitivity analysis is important for assessing the robustness and reliability of models.

Sensitivity analysis

NPV, \$ million



A 5x5 matrix showing the sensitivity of NPV to changes in two variables. The columns represent 'Variable one' and the rows represent 'Variable two'. The base case is highlighted in blue.

		Variable one				
		-20%	-10%	Base case	+10%	+20%
Variable two	-20%	60	70	80	90	100
	-10%	70	80	90	100	110
	Base case	80	90	100	110	120
	+10%	90	100	110	120	130
	+20%	100	110	120	130	140

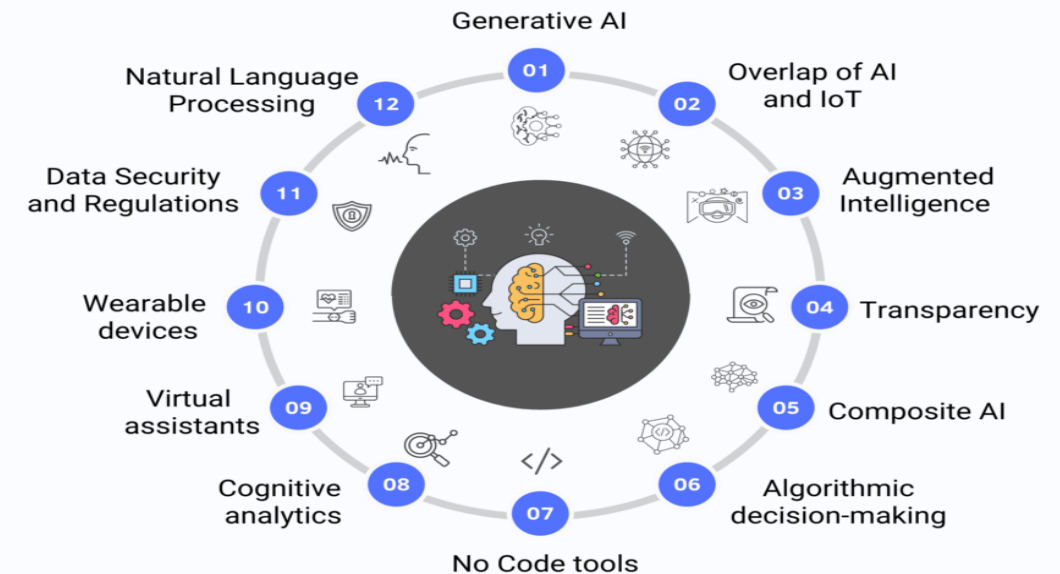
Future Trends in Modeling

Future trends in modeling include the integration of artificial intelligence and machine learning techniques.

Model interpretability, explainability, and robustness will be key focus areas for model development.

Collaborative and interdisciplinary modeling approaches will become more prevalent in addressing complex challenges.

2023 Emerging AI and Machine Learning Trends



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Reference Material

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