



Modelling Simulation and Machine Learning

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Modelling, Simulation and Learning

- ◆ Modelling
 - To identify key components and their relations
 - Why? Can it go wrong? (Wind Tunnel Testing)
- ◆ Simulation
 - To explore multiple futures
 - To ask what-if questions
- ◆ Machine Learning
 - To identify opportunities or threats
 - To learn strategies, e.g. in bargaining or trading
- ◆ Projects

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Research Agenda in Modelling

- ◆ Modelling involves
 - Identifying stake holders, and
 - Describing their relations
- ◆ Relations are described
 - Mathematically, or
 - Procedurally
- ◆ Modelling give us a chance to find equilibrium of the system

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Research Agenda in Simulation

- ◆ Given a model, equilibrium can be found mathematically in simple models
- ◆ In complex models, simulation is the only practical way to find equilibrium
- ◆ Simulation may reveal conditions which lead to undesirable outcomes
 - Such are a crash in the stock market
- ◆ One may introduce policies to remove such conditions

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Machine Learning in modelling

- ◆ Suppose you want to find a trading strategy
- ◆ You may build a model and simulate the performance of your strategy
- ◆ Then you may change your strategy and try again
- ◆ How many models can you test by hand?
- ◆ Machine learning does the search for you (day and night)

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Sample Projects in Modelling

- ◆ Software Wind-tunnels project
 - Vernon Smith (Economics Nobel Prize laureate, 2002) wind-tunnel tested new auction designs
 - Modelling is used in war tactics; they can be used for market design
- ◆ Credit card payments project
 - Model card issuers, merchants & customers for market understanding
- ◆ Automated bargaining project
 - Approximated equilibrium through reinforcement learning
- ◆ Flexible workforce management project (BT sponsored)
 - Study different ways to allocate jobs to technicians.
- ◆ Related project: constraint satisfaction and optimization
 - Computational techniques used in some of the above projects

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Modelling is commonly used

The map illustrates the Battle of Waterloo on June 18, 1815. It shows the positions and movements of three main military forces: the French (led by Napoleon Bonaparte), the Anglo-Dutch (led by the Duke of Wellington), and the Prussian (led by Blücher). Key locations like Mont St. Jean, Zetheren, and the Bois de Chêne are marked. Arrows indicate the direction of attacks and reinforcements. A legend at the bottom identifies the symbols for each force and Prussian camps. A scale bar at the bottom right indicates distances in miles.

Wind-tunnel tests for new markets

The top image shows a modern fighter jet on a runway. The bottom image shows a large, circular wind tunnel facility with a large propeller-like structure inside, used for testing aircraft models.

- ◆ New markets are invented all the time, e.g.
 - e-Bay
 - Electricity
 - Roads
 - Pollution

Why Modelling?

- ◆ Modelling has been used extensively, e.g.
 - War plans, wind-tunnels for aeroplane & car design
- ◆ A cost-effective way to assess a situation.
- ◆ Stress testing: answering "what-if" questions
- ◆ Machine learning enables us to *learn* policies and business strategies.
- ◆ Modelling enables us to scientifically evaluate such policies and strategies.

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Remarks on Modelling

- ◆ Could we be wrong?
 - Of course we will make mistakes!
- ◆ “All models are wrong, but some are useful” (George Box 1987).
- ◆ But a model allows us to improve scientifically
 - Whereas “intuition” goes when people depart
- ◆ “More calculation is better than less, Some calculation is better than none” (translation, The Art of War by Sun Zi 6BC).

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For more information:
<http://www.bracil.net/info/modelling>