Modelling Simulation and Machine Learning

Edward Tsang
Centre for Computational Finance and Economic Agents (CCFEA)

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

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

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

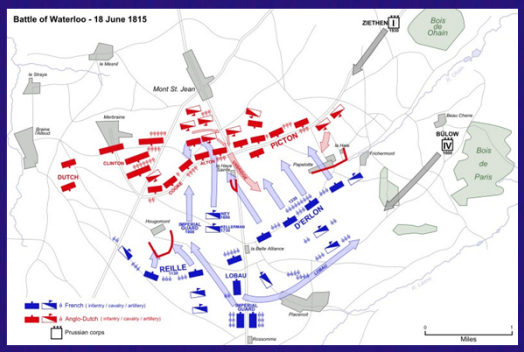
Machine Learning in modelling

- 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)

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

Modelling is commonly used



Wind-tunnel tests for new markets

- 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.

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