Cognitive Aspects of Multicriteria Decision Making and the Theory of Freedom of Choice

Andrzej M.J. Skulimowski

Decision Sciences Laboratory, AGH University of Science and Technology

Real-Life Motivations (I):
- How much decision freedom can be given to Artificial Autonomous (Decision) Systems (AADS)? And how should it be determined in each such system?
- Solutions to the decision problems with quickly changing set of admissible alternatives and/or changing attributes or criteria
  Example: choice of a flight when seats in a selected price class may get overbooked reluctantly and/or prices change in real time
- Solution: explore psychological and social decision patterns rather than use optimal stopping theory
- Modelling consequences of a decision made taking into account various future scenarios, contacts, aspects, and exposure to risk
  [world models, games with environment]

Real-Life Motivations (II):
- Different approaches to ‘learning from mistakes’ and from the knowledge of previous decisions of a Decision-Maker
- Deriving a preference structure out of previous choices
  [widespread naive approaches in the web, no satisfactory theory can exist without studying the cognitive decision mechanisms]
- Principal application: cognitive recommenders
- Integrating forecasts, forecasts, predictive control models, temporal databases, dynamic feature extraction and decision-making
- Dynamic rankings, time-dependent preferences, applications to derive robust decision rules in a dynamical environment

Specific areas of research underlying the decision freedom

Interdisciplinary research on:
- Neural, psychological, and social decision-making mechanisms in the decision support systems architectures and interfaces, which adapt to the neural mechanisms or follow them in an optimal way
- Philosophical, mathematical, and teleological interpretations of decision-making processes
- Innovative algorithms of multicriteria optimisation and cooperative games dedicated to solve selected classes of complex temporal decision problems, such as problems of strategic planning, dynamic prioritisation and rankings, multicriteria choice in a dynamic environment

The notion of Freedom of Choice (FOC) - preliminaries

The playground – decision subjects:
- Human decision-making
- Autonomous Decision Systems
- Intelligent Intention-Understanding systems – a new subclass of Cognitive DSS

The playground – decisions:
- Conditionally Rational Decisions vs. Pareto-optimality w.r. to a given set of criteria
- Where to choose from: soft and hard constraints and real options, ability to change constraints in time and its price
- Freedom to make an irrational decision
- Freedom to set goals and define criteria

Principal Applications

New ideas and approaches allow to carry out detailed studies of applications in different fields, such as:
- Real-life AADS (vehicles, rescue systems, decision-making in emergency situations, robot vision)
- Financial decision support and decision-making (forecast-based DSS for foreign equity portfolio, energy commodities)
- Recommender systems (specific areas: recommenders based on visual information preferred, previous purchase, product-related choices, multimedia etc.; new challenge: recommendations in medical expert systems

Hints and conclusions

- Cognitive mechanisms embedded in decision support systems must take into account human ability or right to make a rational decision
- Autonomous agents (automatic decision pilots) can be built in recommenders and other DSS to allow to make cautious decisions (by a ‘cautious decision’ one should mean the selection of an alternative which conforms maximally to the individual cognitive decision model)
- Formal models of the decision freedom are indispensable in the design and implementation of AADS.

Reference values of criteria derived from the analysis of decision-makers’ behaviour and from experts’ judgments

A model of networked multicriteria decision problems (\(U_j,F_j\)) with anticipatory feedback mechanisms, and causal multivalued dependence \(Y_j\) between the outcomes of decision problems at \(n\)-th level and the scope of admissible decisions at the next \((n+1)\)-th level

Further inquiries and contact are welcome:
Decision Sciences Laboratory
Chair of Automatic Control
AGH University of Science & Technology
Al. Mickiewicza 30, 30-050 Kraków, Poland
www.decyzje.agh.edu.pl
ams@agh.edu.pl