When Humans and Computers Make Decisions

Decision Making: an activity where people and computers systems cooperate

Decision Making: a complex task

- uncertainty, multiple criteria, multiple agents
- combinatorial set of possibilities
- distributed problems, complex systems
- importance in organizations, Social impact

$\rightarrow$ scientific support $\rightarrow$ rational preparation of decisions

Aim of decision sciences

- help people make better decisions (complex environments, important issues)
- construct autonomous decision agents, with possibly different behaviors (value systems, attitudes towards risk),improve human experts

Decision Support Tools

Evaluation and decision models, axiomatic properties

- *Descriptive models:* describe how actual decision makers act
- *Normative models:* how individuals ought to make their decision
- *Prescriptive models:* recommendations that fits agent's preferences

Algorithms

- determination of preferred elements (best choice, top-k, ranking, ...)
- problem complexity and algorithm complexity

Decision Systems

- *Recommender Systems* (preference elicitation, elaboration of a recommendation) and *Interactive DSS* (interaction loop: preference model $\rightarrow$ generate a solution $\rightarrow$ get feedback $\rightarrow$ revise the model)
- Autonomous DS (e.g. path planning, resource allocation, credit scoring)

Achievements

- Numerous successful applications of DS in various domains such as electronic commerce, transport, energy, security, medicine, biology, agriculture etc.

Dealing with Preferences: some critical issues

Preferences are pervasive but not always accessible

- preference are not always stable nor well defined
- preferences cannot always be made explicit (confidentiality, privacy), e.g. priority assigned to some individuals in multiagent problems
- reported preferences might not be true. Manipulation of decision procedures (examples in Social Choice)
- experts may be reluctant to share their expertise (specificity, power)

Available preference information might not be sufficiently rich to apply a given decision theory (e.g. EU theory requires to quantify utilities of consequences and likelihood of events), we need several models

Preferences do not necessarily match standard models, standard decision theories do not always fit to observed human decision behaviors

Elicitation can be practically infeasible (compromise between expressivity of the model / complexity of the elicitation procedure)

Humans do not trust the system and need justifications, explanations

Hot Research Topics and Main Challenges

Preference modeling (mathematical models)

- new models with enhanced descriptive capabilities (closer to humans)
- models fitted to the information level (preference, beliefs)
- axiomatic study of these models

Preference representation (machine) and acquisition

- languages for preference representations (logic, graphs, utilities)
- preference elicitation procedures and learning of preferences
- succinctness vs expressivity

Algorithms for preference-based optimization

- preferences based-search on implicitly defined domains
- distributed decision making and communication complexity
- collaborative filtering algorithms, case-based decision
- design of truthful mecanisms, complexity of manipulation,

Interactive Decision Systems

- Human-machine or Human-Human collaboration for decision making
- Automatic explanation of decisions, argumentation theory