

Some research directions in Fuzzy Measures at Deakin

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CHALLENGES

- ▶ Capacities involve 2^n parameters, computational challenges, interpreting and assigning values
- ▶ Even under simplifications k -order capacities, interpreting Mobius values, ensuring constraints
- ▶ Learning capacities: are there enough data?
- ▶ Tools for operating with capacities (user-friendly)
- ▶ Broadening the area of their applications, large universes

RESEARCH PROBLEMS

- ▶ Capacity simplifications
 - ▶ k -order capacities (k -additivity does not reduce constraints complexity but for $k = 2$)
 - ▶ k -maxitive, k -interactive (reduces complexity)
 - ▶ Sparse capacities: tools, representations, forcing most parameters to 0
 - ▶ Hierarchical representations, forbidding interactions between members of the groups
- ▶ Interaction indices and representations
 - ▶ Non-modularity, non-additivity indices, ... , transformations
 - ▶ Axiomatisation and interpretation

RESEARCH PROBLEMS

- ▶ Capacity approximations and fitting
 - ▶ Approximations with sparse or k -order capacities
 - ▶ Approximations that enforce some properties (like supermodularity)
 - ▶ Building hierarchical representations from data
- ▶ Random sampling
 - ▶ Random sampling on polytopes in high dimensions - methods and tools
 - ▶ Measuring the quality of uniform distribution
 - ▶ Dealing with complicated constraints
 - ▶ Applications in MCDM - sampling through a set of solutions

RESEARCH PROBLEMS

- ▶ Using fuzzy integrals in optimisation
 - ▶ Replacing linear objectives with Choquet integral to account for dependencies
 - ▶ Linear \rightarrow nonlinear, but with some structure. For some types of capacities can be solved as LP
 - ▶ Mixed integer programming with Choquet integral (eg knapsack)
 - ▶ Replace linear constraints with Choquet
 - ▶ Non-convex capacities - Difference of convex, other NLP methods
- ▶ Multiobjective optimisation : scalarising functions
- ▶ Applications in MCDM: Modelling with capacities and their alternatives

SOME THINGS WE HAVE DONE

- ▶ k -interactive capacities
- ▶ Non-modularity and non-additivity indices, axiomatic, computational, attempts at interpretation
- ▶ Learning capacities from data - a variety of methods based on LP, special types of capacities, extra constraints, different learning criteria
- ▶ Computational tools: `fmttools` package (C++, R, python)
- ▶ Tools for sparse capacities: operations, computations, learning, simplifications, hierarchical
- ▶ Random generation of capacities of different types
- ▶ Special types of capacities (anti-bouoyant \subset supermodular)
- ▶ Choquet integral as the objective in knapsack

PLAN FOR OUR WORKSHOP

- ▶ Our team makes a number of 20 min presentations on various topics:
 - ▶ To bounce off some ideas
 - ▶ To inform Michael (and ourselves) on what we did/do/can do
- ▶ Michael will present some of his recent works
- ▶ We have dome discussions about
 - ▶ Feasibility and usefulness of some approaches
 - ▶ Potential for joint projects
 - ▶ What happens outside of our "small world", other perspectives
 - ▶ Strategic directions