Issues in the Application of Large Scale Complex Multi-Agent Models of Travel Demand

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Context

- Evolution of models of travel demand
  - Increased complexity
    - From individual via household to members of social network
    - From typical day via week to different time dimensions
    - From traffic zones to high resolution spatial representations
    - From utility-based only to combined preference-constraints based approach

Context

- Evolution of models of travel demand
  - Increased complexity
    - From aggregate models to micro-simulation and agent-based modelling frameworks
    - From models of travel demand generation to integrated models with land use, traffic flows, emissions, energy consumption etc
    - From mobility performance indicators to multi-domain performance indicators

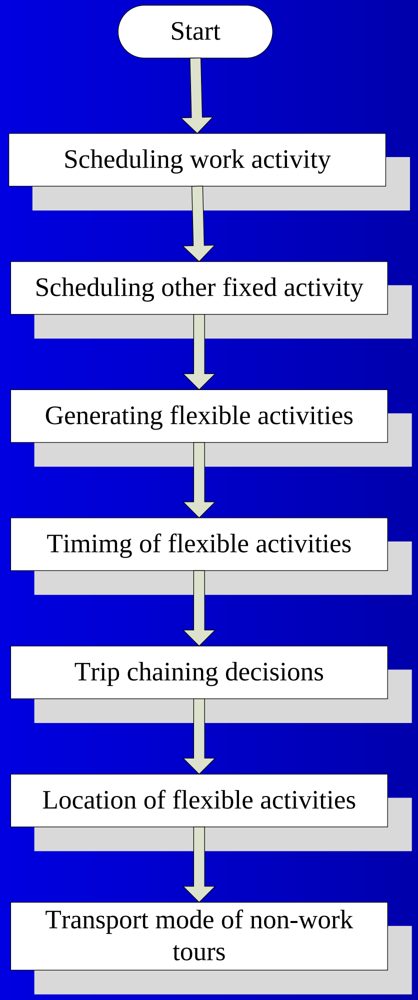
Consequences

- High computing times
- Not appealing for real-time plan or scenario development sessions
- Different runs will produce different outcomes
- Practically: use of fraction of synthetic population

Aim

- Because little is know empirically about these issues, this presentation presents some main findings on
- Effects of model uncertainty, using Albatross model as example
- Potential of using emulators in real-time plan development sessions

Model Uncertainty Albatross



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Model Uncertainty Albatross

$$p_{kq} = \begin{cases} 0 & \text{if } q \text{ is infeasible} \\ f_{qk} / \sum_{q'} f_{kq'} & \text{otherwise} \end{cases}$$

Model Uncertainty Albatross

1. City of Rotterdam
2. Create a 10% synthetic population, consisting of 41,668 persons and 27,961 households
3. Run Albatross to a maximum of 100 times
4. Calculate coefficient of variation = st. dev. / mean

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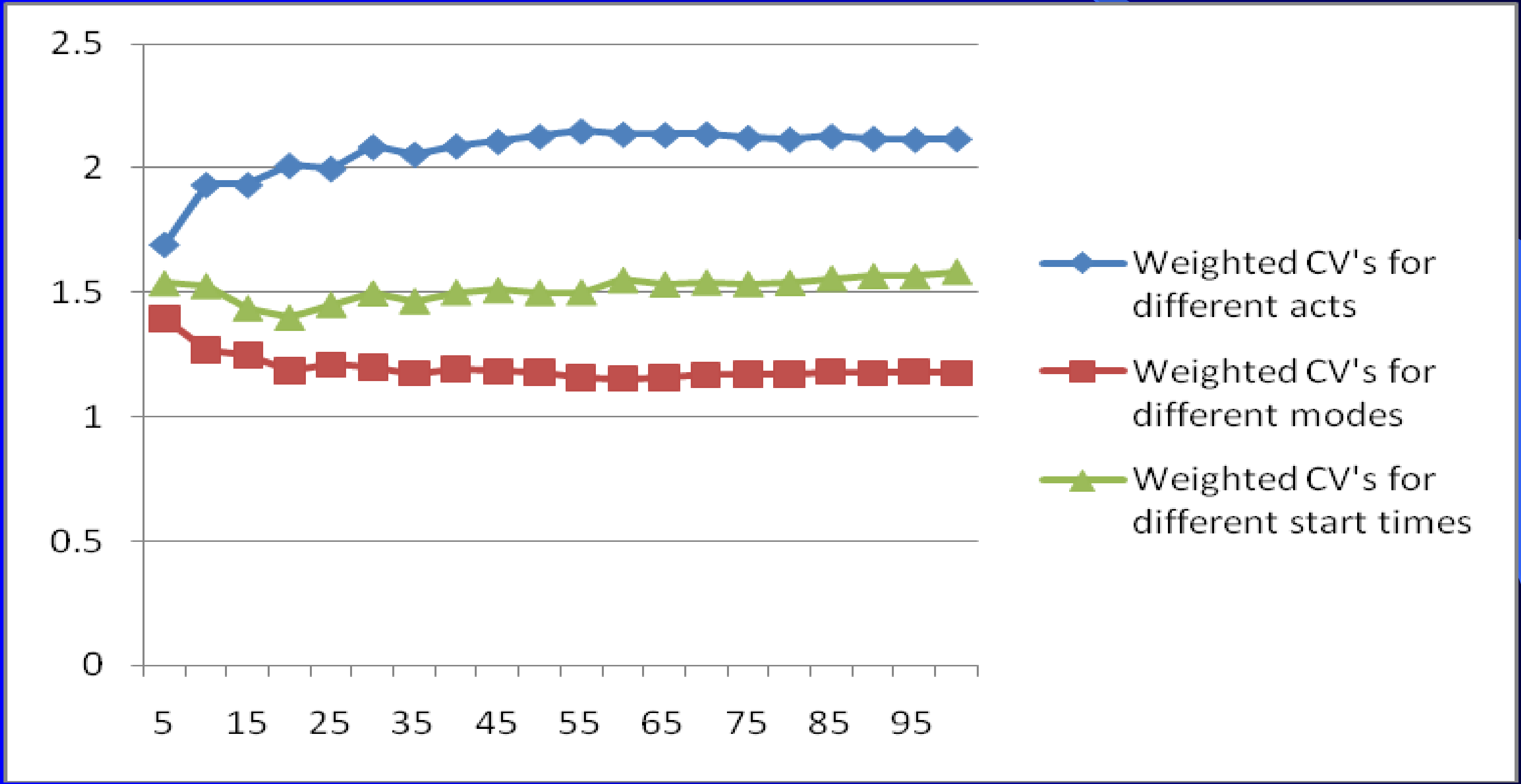

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Model Uncertainty Albatross

		McKay				Miller			
	No of runs	Lower boundary	Upper boundary	diff lower from mean(%)	diff upper from mean(%)	Lower boundary	Upper boundary	diff lower from mean(%)	diff upper from mean(%)
WORk	100	0.014	0.0183	12.2	16.1	0.01	0.02	14.1	13.7
	50	0.013	0.0197	16.4	24.6	0.01	0.02	19.935	19.6
	5	0.012	0.0558	40.1	187.5	0.01	0.03	69.3	69.2

Model Uncertainty Albatross

		McKay				Miller			
	No of runs	Lower boundary	Upper boundary	diff lower from mean(%)	diff upper from mean(%)	Lower boundary	Upper boundary	diff lower from mean(%)	diff upper from mean(%)
Car D	100	0.009	0.0122	12.27	16.2	0.01	0.01	14.1	14.1
	50	0.009	0.0128	16.5	24.6	0.01	0.02	17.9	21.7
	5	0.009	0.0452	40.1	187.7	0.01	0.03	69.3	69.3

Model Uncertainty Albatross

		McKay				Miller			
	No of runs	Lower boundary	Upper boundary	diff lower from mean(%)	diff upper from mean(%)	Lower boundary	Upper boundary	diff lower from mean(%)	diff upper from mean(%)
3am-10am	100	0.012	0.0161	12.2	16.1	0.01	0.016	13.9	13.9
	50	0.0115	0.0157	16.6	24.6	0.01	0.015	19.8	19.8
	5	0.007	0.0326	40.2	187.2	0.00	0.019	69.3	69.3

Albatross Emulator

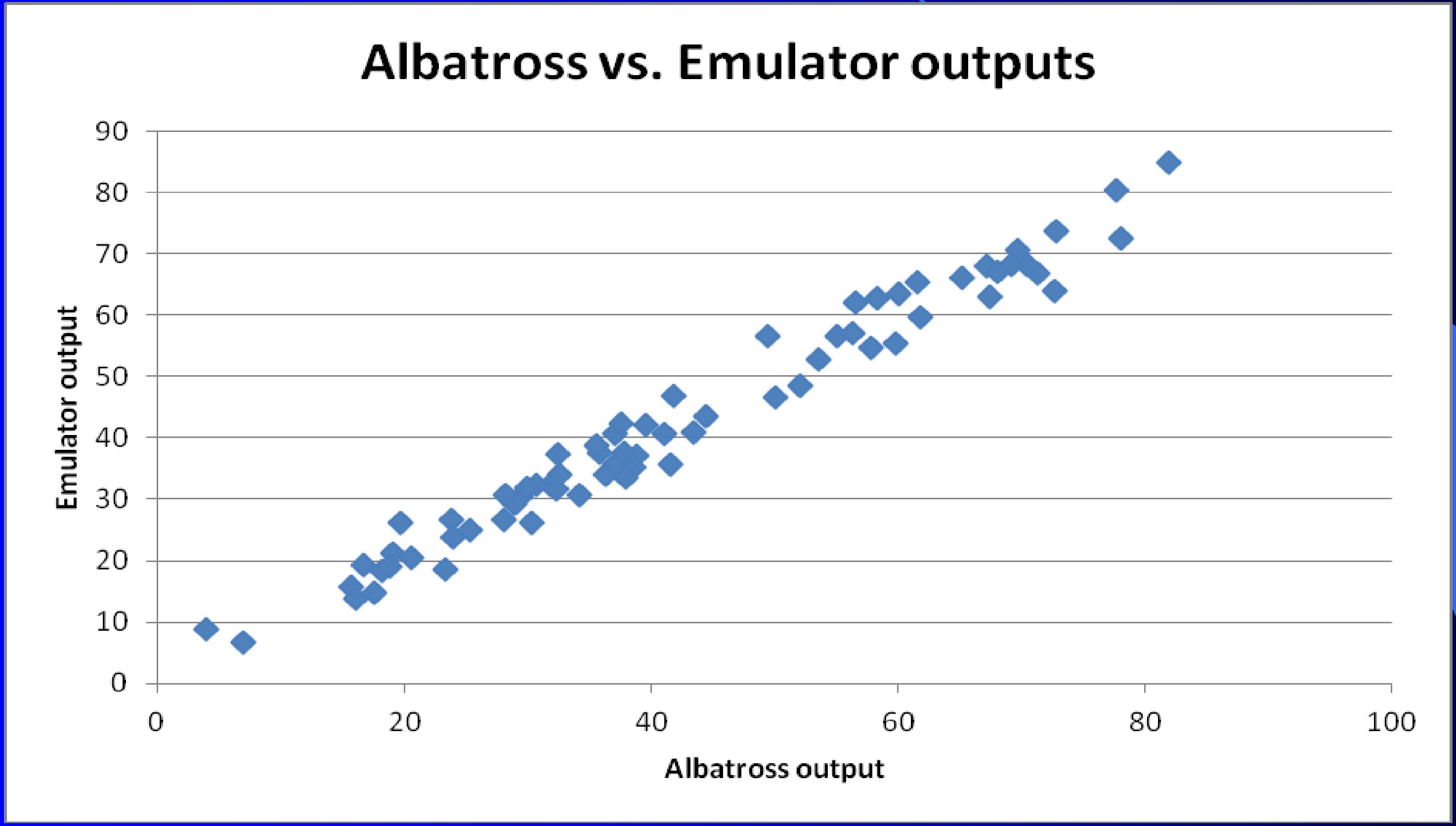
An emulator is a statistical model depicting the relationship between the input variables and the output variable of interest. It replaces and approximates the underlying process model of individual and household decision making and choice behavior and characterizes a particular feature of the complex process model.

Albatross Emulator

The following procedure was followed:

1. Draw a random sample *s* from the synthetic population;
2. Obtain for each sample *s*, the configuration of *K* input variables;
3. Run the agent-based model x times to obtain a stable estimate of *E*(*Y*)s.
5. Estimate an appropriate statistical response curve model

Albatross Emulator



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Discussion

- Systematic comparison of model uncertainty required
  - Level of performance indicators
  - Activity sequences
  - OD matrices of traffic flows
  - Individual space time trajectories
- Expand to input uncertainty and
- Combination of input and model uncertainty, combined with sampling fraction

Discussion

- Èmulators may be interesting option for real-time plan development sessions
- But, it is a statistical model of a behavioral process model and hence may not be appealing to all models of travel demand

THANK YOU