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A Novel Agent Software Architecture Inspired by Psychology

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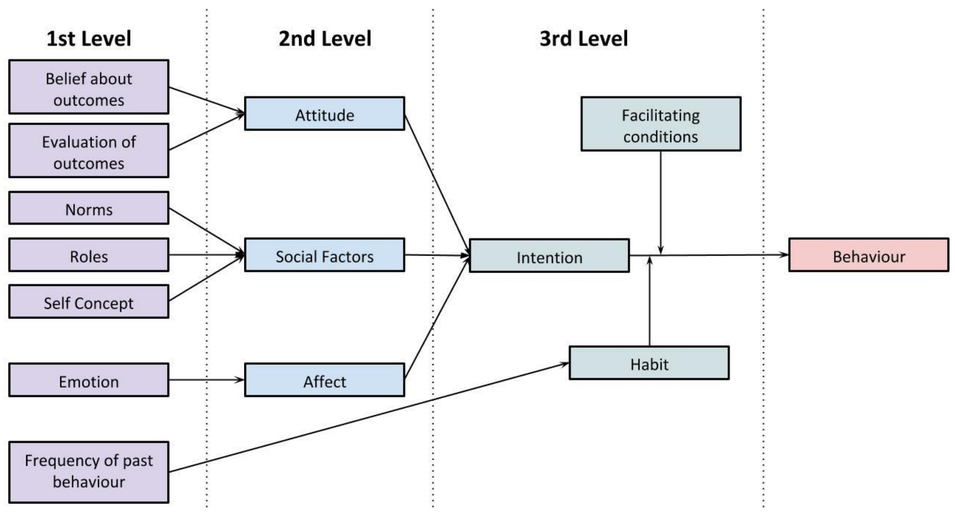
Introduction

- Agent based technologies have been used to **simulate human society** and aim to **provide explanation** for emerging behaviours and social phenomena.
- Current state-of-the-art agent architectures (i.e. BDI, EMIL-A, SOAR, CLARION) were inspired by technical developments of Computer Science, which can **cause gap in communication** with non-technical scholars since they often do **not consider metaphors** of the application domain.
- We propose a new agent architecture based on the **Triandis' Theory of Interpersonal Behaviour** (TIB). It originates from **psychology** and therefore we consider it to be more suitable for the usage in interdisciplinary research, as it enables domain experts **to encode better human-like decision-making processes**.

Objectives

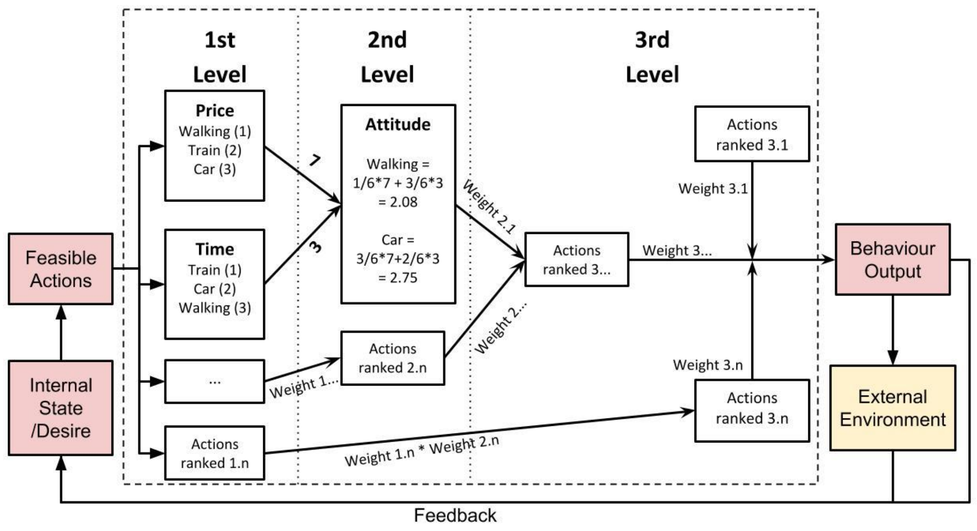
- **Develop a new agent architecture** incrementally from individual cognitive components of TIB.
- **Create a framework** to implement an agent-based computational economics model (**BedDeM**) that focuses on heterogeneous **mobility demand of individuals**.

Triandis' Theory of Interpersonal Behaviour



- **Provides a large set of aspects** that contributes to decision-making in psychology and can be incorporated inside an agent design.
- Can **reflect other behaviour theories** by exchanging the psychological elements and assigning weights to them.
- **Cover perspectives** (such as cognitive, social, affective, learning) that are partly **missing from previous researches**.

New Agent Architecture



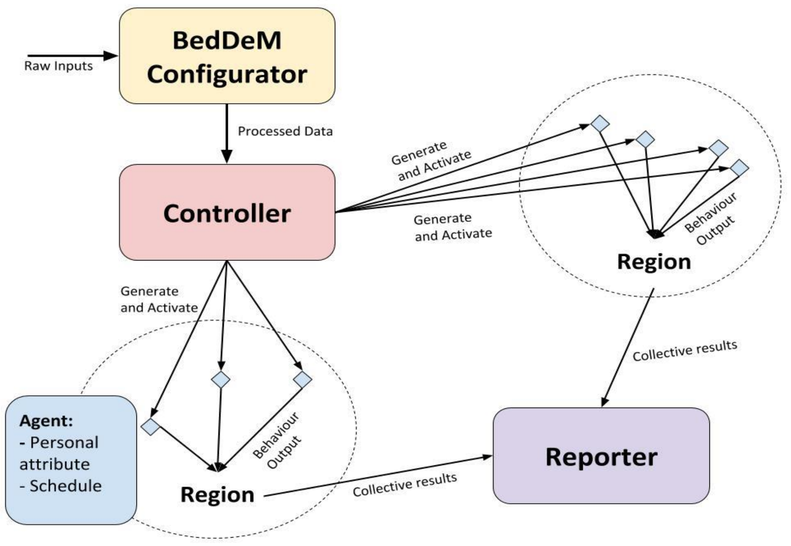
- An agent first **selects** a single isolated decision-making **task** from its schedule.
- Its personal desire/goal is then combined with external means (provided by the external environment) to **generate** the list of **possible actions**.
- Actions are **ranked** (or given a normalised value) according to specific psychological aspects, which are organized into layers (or levels).
- The action's value in one level can be **combined together with an associated weight** to **produce a new value** in the next level.

For example: According to the price, an agent can rank walking (1), train (2), car (3) - total 6. According to time, it can rank train (1), car (2), walking (3) - total 6. If weights of price and time are 7 and 3 respectively, the new value of walking in next level list (Attitude) would be 1/6*7 + 3/6*3 = 2.08 and value of car would be 3/6*7+2/6*3 = 2.75.

- This process continues until the actions arrive at Behaviour Output. Each **value** can then be **interpreted as the probability** that the action will be performed.

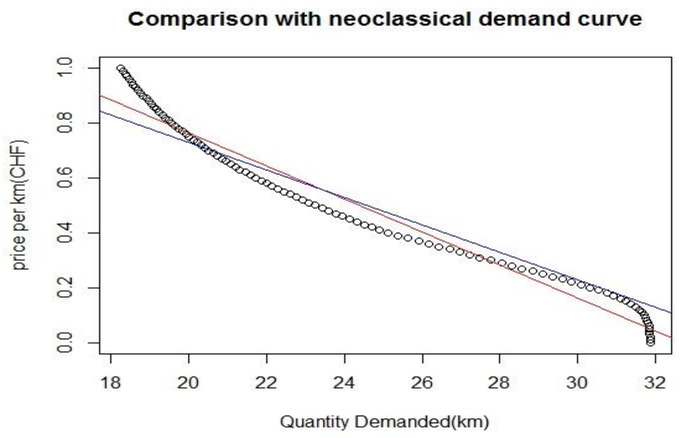
Current State of BedDeM

- **BedDeM Configurator** pre-processes raw input data (e.g. attributes, time series).
- **Controller** generates agents and schedules them according to their list of activities (ordered by time) and starts the simulation.
- **Reporter** collects the result at region level after the simulation finishes.



Previous Experiment*

- **Objective:** Determine whether BedDeM is capable of mimicking neoclassical linear demand curve if agent is hyper-rational (e.g. only considers two parameters: cost and time).
- **Method:** The observed values that BedDeM creates are benchmarked with the values that are gained through linear demand curve of private car usage using real data from Swiss Statistical Office's publication.
- **Result:** Correlation coefficient (ρ) ~ -0,98; Coefficient of determination (R-squared) ~ 96%; Slopes of the linear regression line of the dots and neoclassical demand curve are close to each other (which are -0.06 and -0.05 respectively).



Dots: Observed values created by BedDeM
Red: Linear regression line of the dots
Blue: Gradient of neoclassical demand curve

* Bektas, A., Nguyen, K., Schumann, R.: Can agent-based computational economics mimic neoclassical linear demand curve? (2018)

Future directions

- **Extend the framework** to fully reflect all aspects of the TIB model.
- **Apply it to other areas** (i.e. mobility policies, tourism) and obtain collaborators' feedbacks.
- **Perform action research** with state-of-the-art architectures.

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