Supply Agents in MATSim: Some Results

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Why supply agents in MATSim?

In the urban system actors of different kinds are interacting:

- Individuals
- Policy Makers
- Public service providers
- Developers
- Retailers
- Firms / companies
- …

MATSim has the potential to incorporate an agent based representation of each actor of the urban system

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One of the few agent-based transport simulations which allows the dynamic interactions of demand side and supply side agents

Current MATSim

Policy Makers
Public services providers
Developers
Retailers
Firms / companies

} Scenario

Individuals → Individual Agent

MATSim with retailer agents

Policy Makers
Public services providers
Developers
Firms / companies

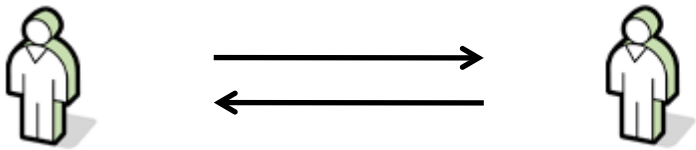
} Scenario

Individuals

Retailers

Individual Agent

Retailer Agent



MATSim with retailer agents

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Retailer Agent

Who are Retailers in MATSim?

from *www.wikipedia.org:*

> **Retailer**: "In commerce, a retailer buys goods or products in large quantities from manufacturers or importers, either directly or through a wholesaler, and then sells smaller quantities to the end-user."

In MATSim:

> **Retailer**: "Person or entity having the control on one or more shopping facilities"

Choice Dimensions for Retailer agents

- Location
- Price
- Opening time
- ...

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The retailer agent is controlling a group of shops and tries to improve their performance relocating them

Goals & Tasks

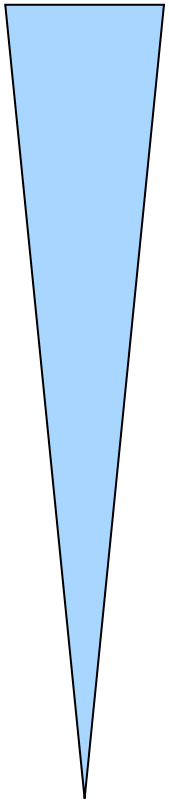
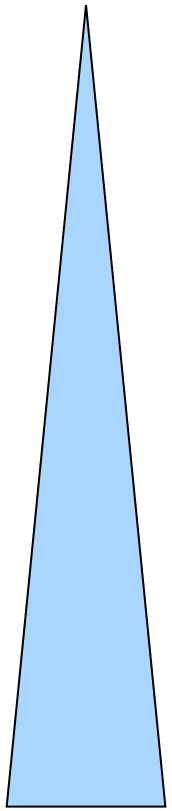
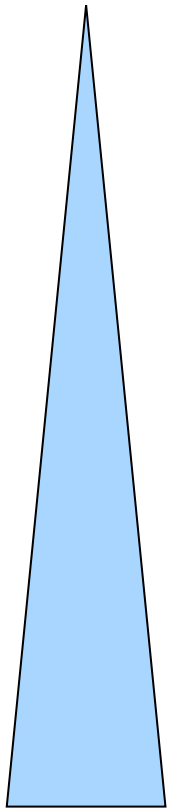
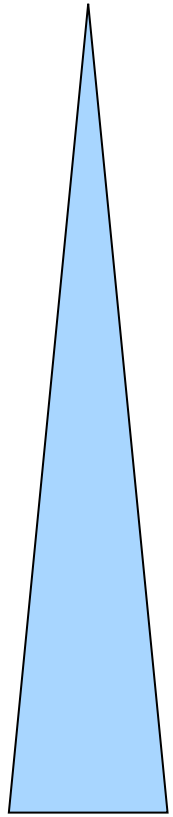
Goals:

- Correctly predict the location choices of retailers under a given policy scenario
- Estimate a benchmark value for retailers (# customers, turnaround, etc…) under a given policy scenario
- Investigate what happens to individuals' score if retailers are optimizing their location

Tasks:

- Define/implement retailer agents in the MATSim framework
- Enrich individual agents (customer aspect)

Common Methods and Tools in Retail Location Planning

Technique/s	Subjectivity	Cost	Technical experience required	Computing and data needs
rules of thumb, checklists, ratio and analogue methods				
multiple regression discriminant analysis, cluster analysis, gravity models				
Expert systems, neural networks				

Adapted from Hernandez and Benninson, 2000

Practice in Location Choices

Extensive literature research

11 explorative interviews accomplished in Germany and Switzerland in 2008

Results:

Location strategies vary both between and within different retail sectors

Location choices are still heavily based on experience and intuition, particularly those decisions at the micro scale

Simpler methodologies are still predominant, more sophisticated are sometimes used as a posterior confirmation

Retailer Agent Framework

Retailer Agent

Attributes
- Type
- Facility portfolio
- Price level
- …

Location choice methodology
- Checklists
- Market ratio
- Catchment area
- Gravity models
- …

Objective
- Max. Customers
- Max. Revenue
- Max. Market share

Knowledge
- Customers
- Competitors
- Land Prices
- Land use regulation

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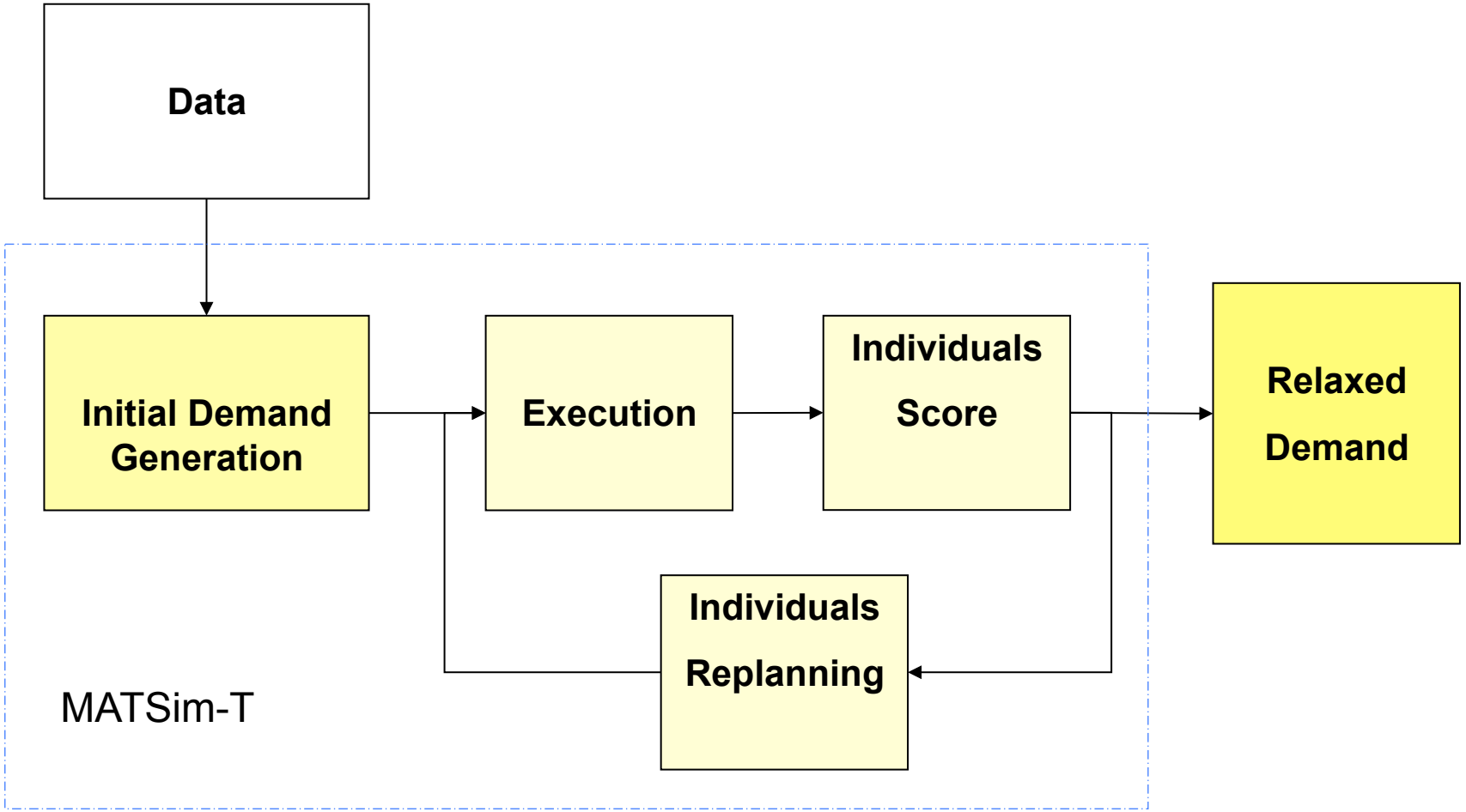
MATSim: Actual Framework

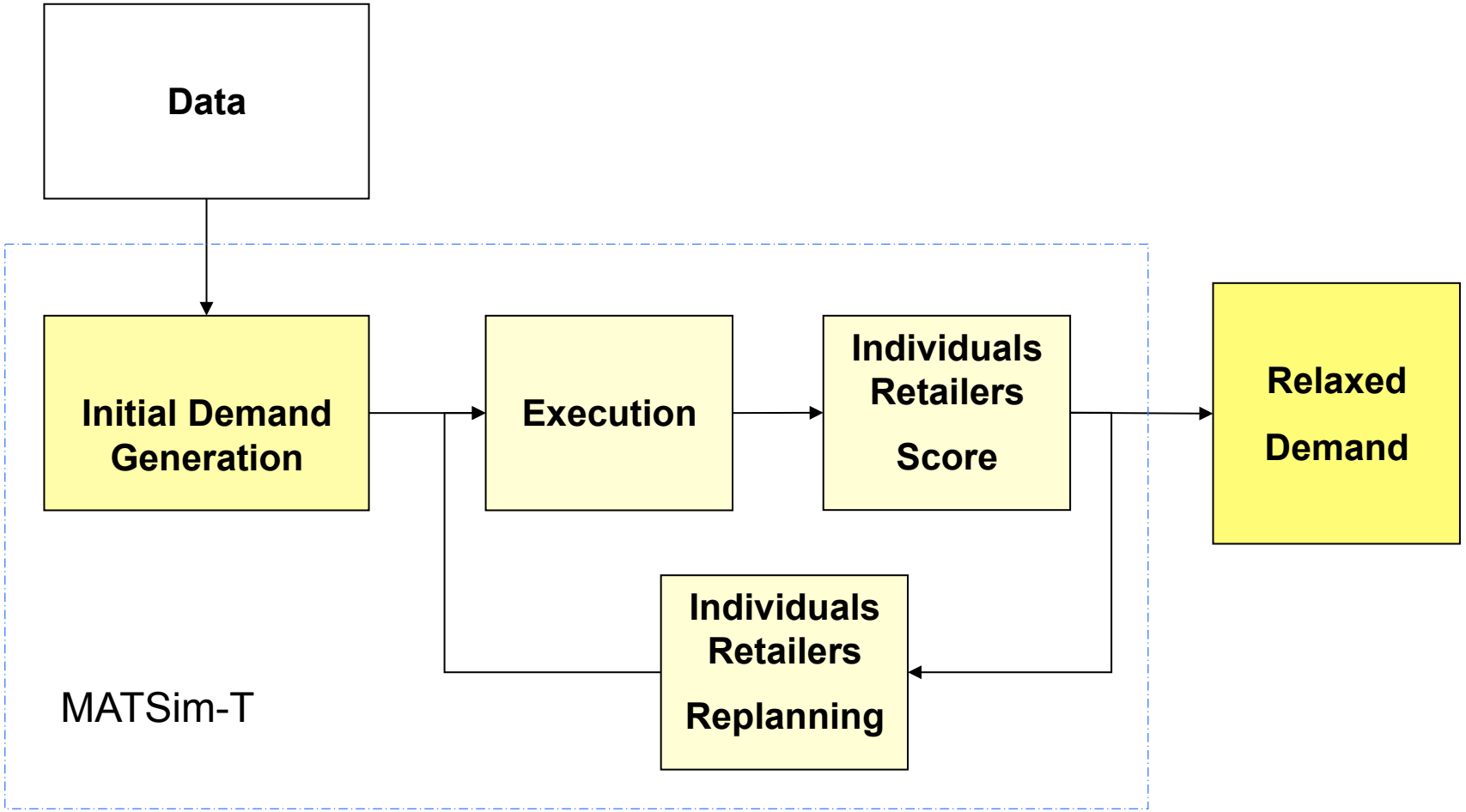


Adapted from Rieser, 2008

Possible approaches

- Parallel (Co-evolution)
- Sequential with feedback

MATSim: Parallel approach



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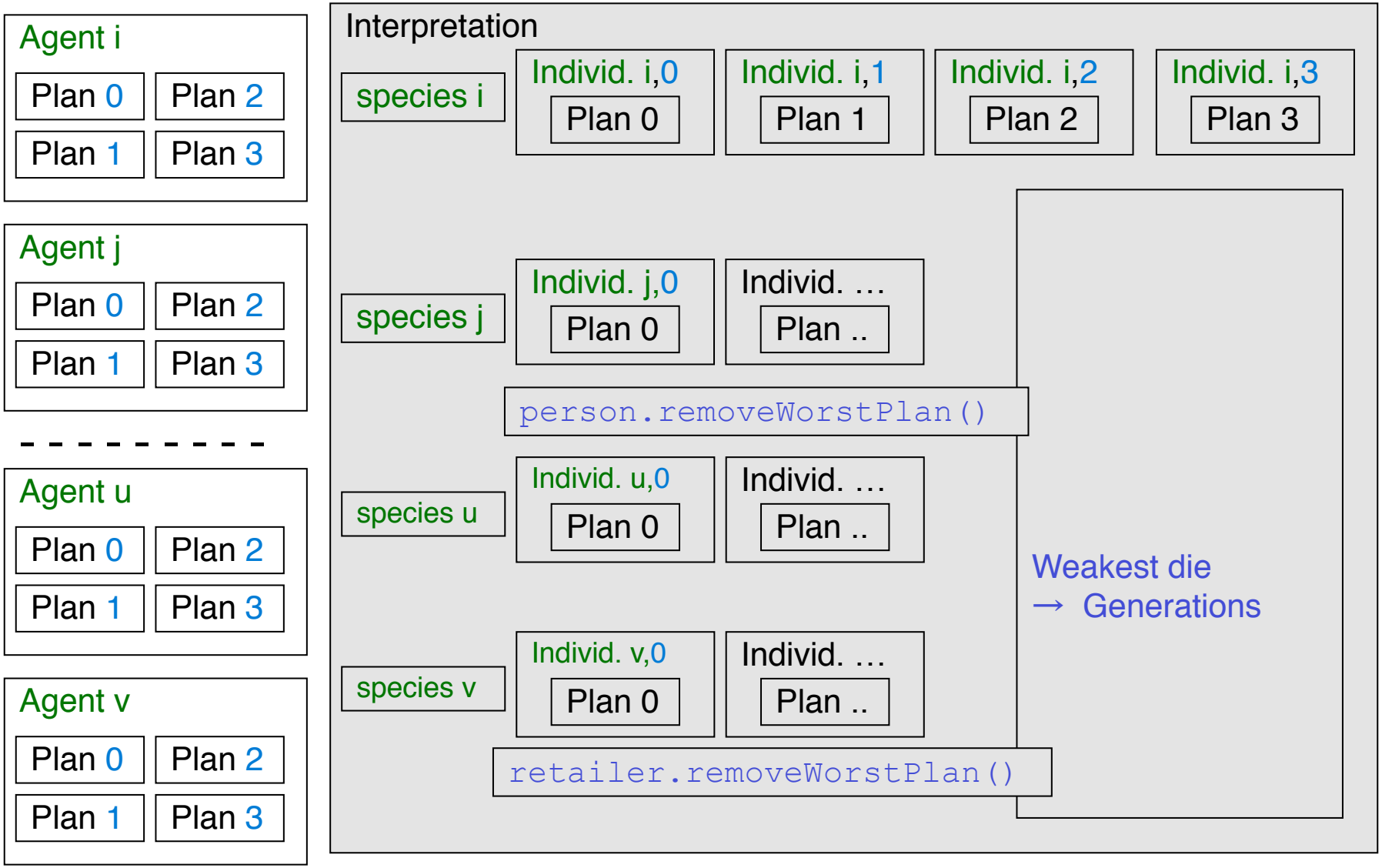
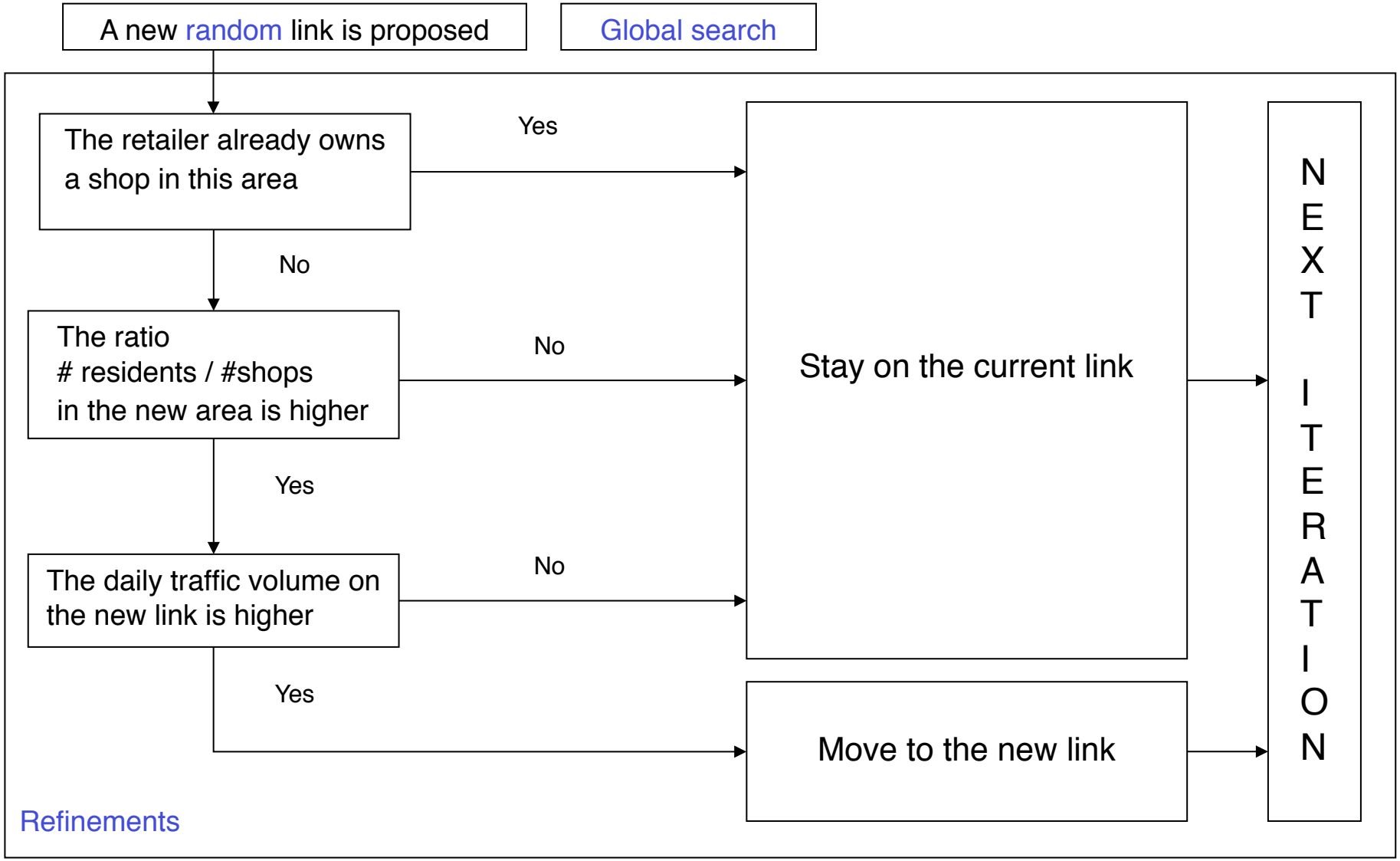
Parallel approach (Coevolution)



Parallel approach – Relocation steps



Simulation Inputs and Parameters

Inputs:

- Retailers file:

  List of retailer agents and shop facilities controled by them

- Links file
  - Links allowed for the relocation of shop facilities

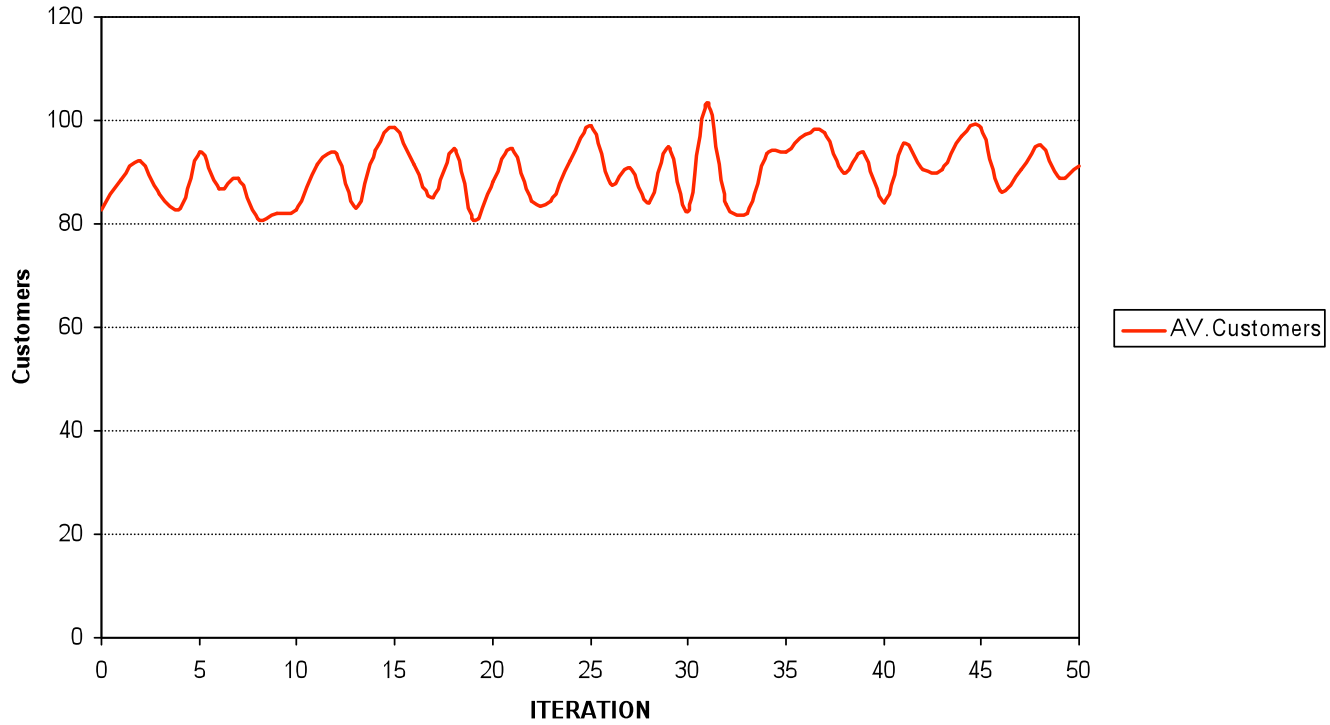
Parameters:

- Frequency of retailers relocation
- Catchment area dimension

Parallel approach – Results

Simulation scenario: Zürich 10% (~60.000 agents, ~1000 shops, ~60.000 links)

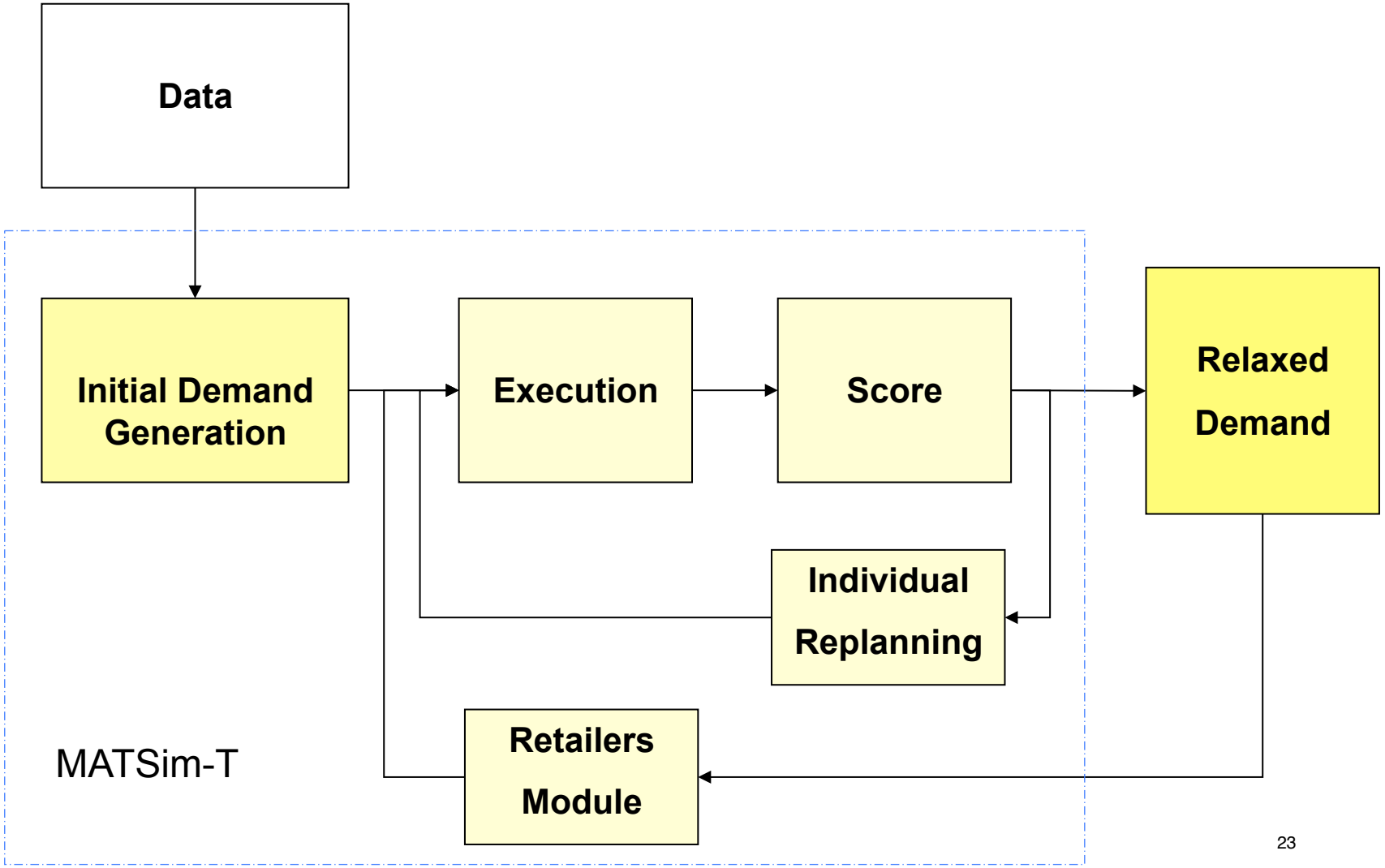
Number of shops relocating: 80 (2 supermarket chains)



Parallel approach – Results (2)

- Results vary according to input and parameters
- At the moment iterations are quite slow (~1h)

MATSim: Sequential approach



Adapted from Rieser, 2008

Sequential approach

1. Run the simulation until a relaxed state is reached
2. Use the data available to compute parameters of a gravity model for shops
3. Compute the potential for each of the candidate links
4. Use an optimization algorithm to find the best „constellation“ of shops
5. Exit if specific condition is fullfilled, otherwise go to 1

Gravity models

Idea: The attractiveness of a facility for individuals is proportional to the distance they need to travel to reach this facility

Advantages: Make use of data which are available in MATSim, is a method which is used in the practice

Shortcoming: Their goodness is always more discussed in the academic field

Savings algorithm

Idea: From a starting configuration different new combinations are tested, take the first which improves the score, used in VRPs

Advantages: Easy to implement, guarantees that at each step the score is improved

Shortcoming: Not fast

Parallel vs. Sequential

Parallel

+ : Fully exploiting the potential of MATSim, the new agents are simulated within the main loop

? : Hard to understand the behaviour of such a complex co-evolutionary system (probably many iterations to reach a relaxed state)

Sequential

+ : A proper optimization method can be used

- : Agents are simulated only in an external loop not within the main loop of MATSim

Main limitations

- The land market is not represented
- Introduction of monetary costs for activities and taking into account prices for them
- Retail shops are undifferentiated
- Persons behavior on Saturday is different than during the week -> Simulating only Mo-Fr retailers' location decision are biased
- …

Conclusions and future work

Conclusions:

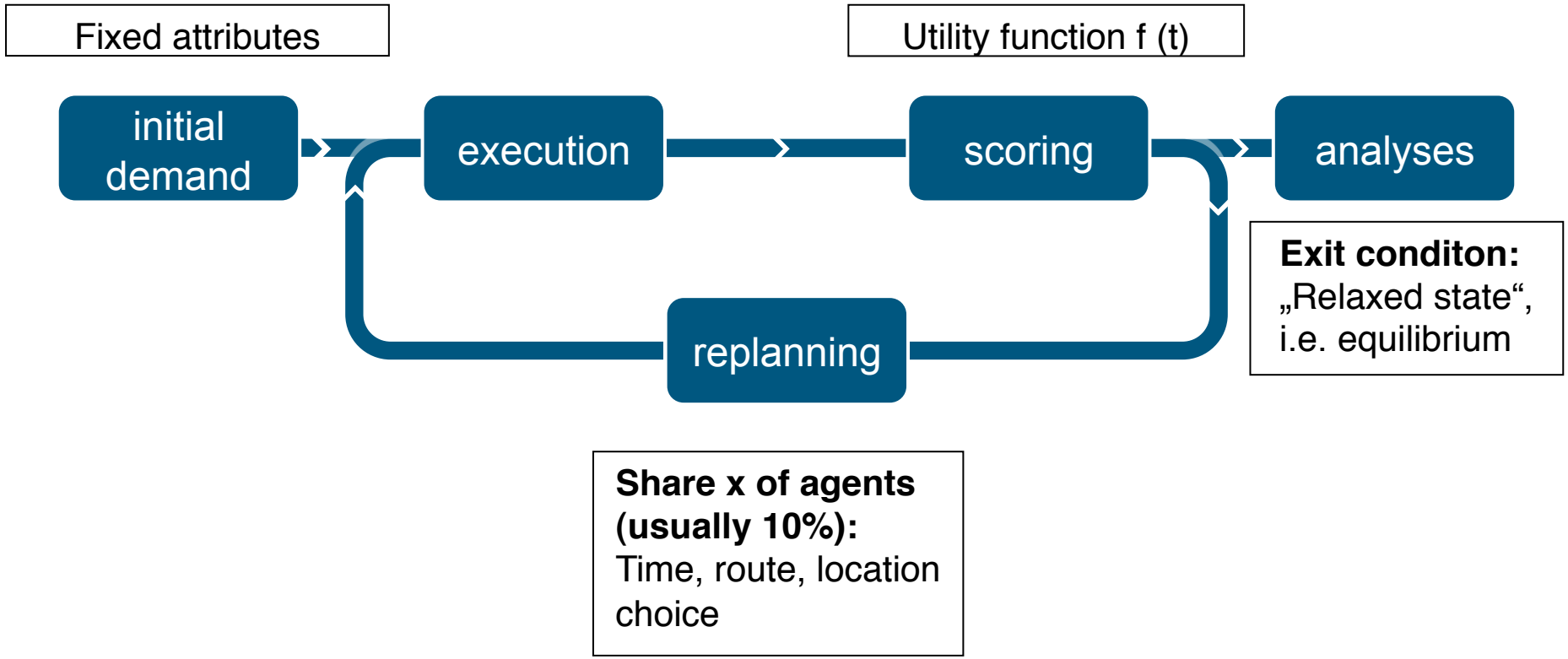
- The new supply agents have been introduced in MATSim, their functionality has been proofed
- Results are not yet as expected...

Future work:

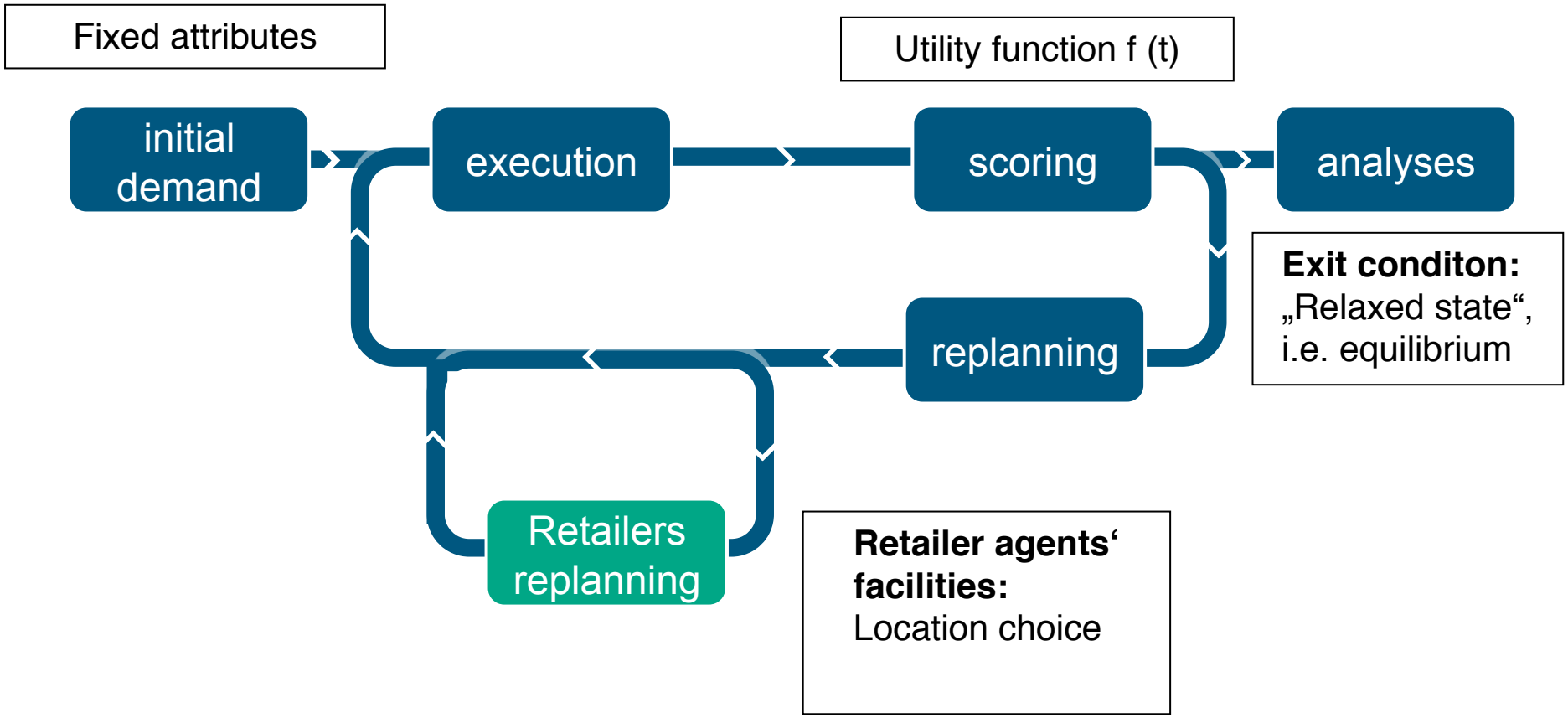
- Try to use new strategies (Sequential)
- Improve the current strategy (Parallel)
- Overcome some of the limitations (e.g. take into account different types of retail shops, account for monetary costs, etc…)

THANK YOU FOR YOUR ATTENTION !

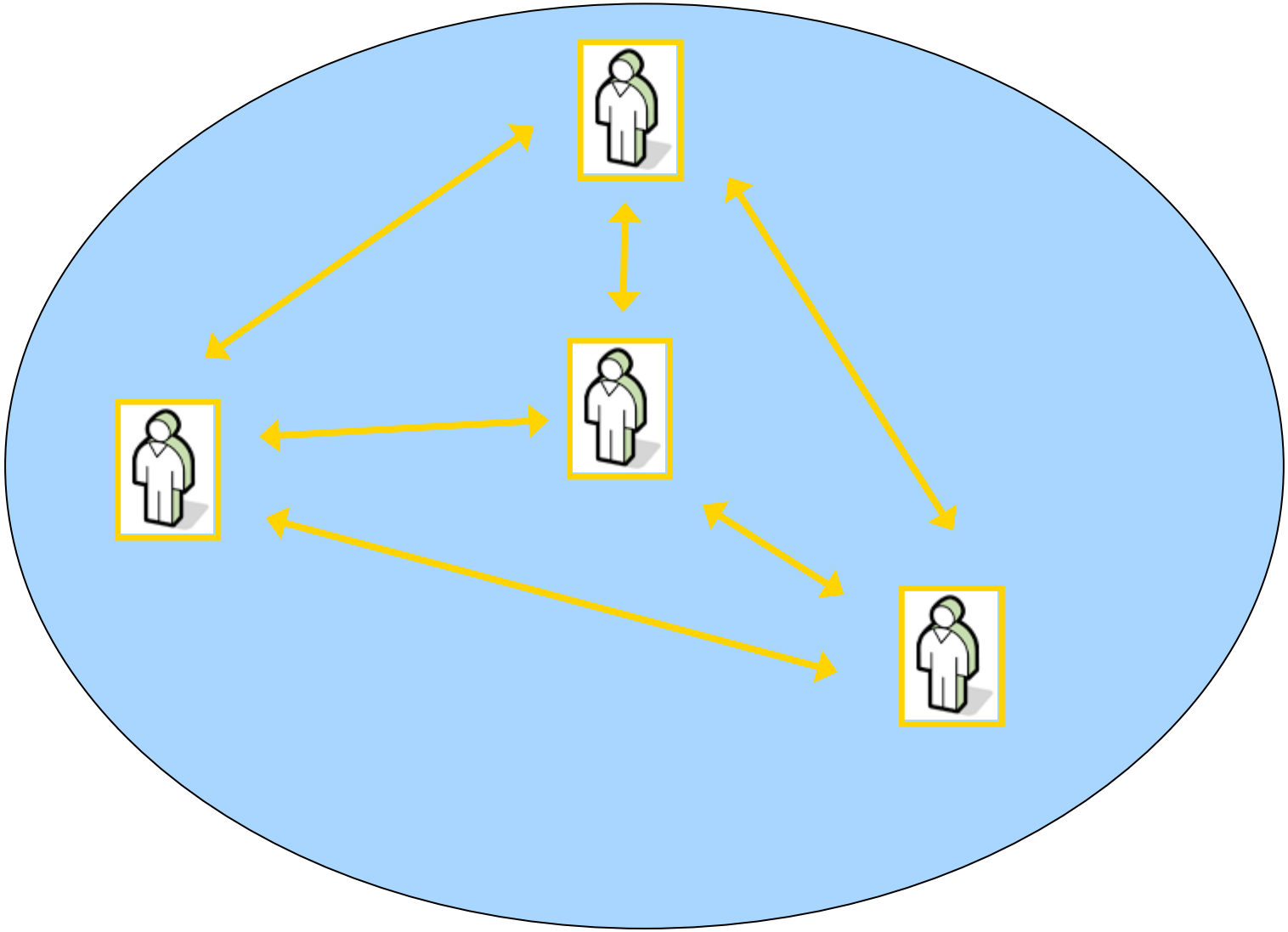
MATSim: Actual framework



Framework with Retailer Agents – Static approach



Agent-based modeling



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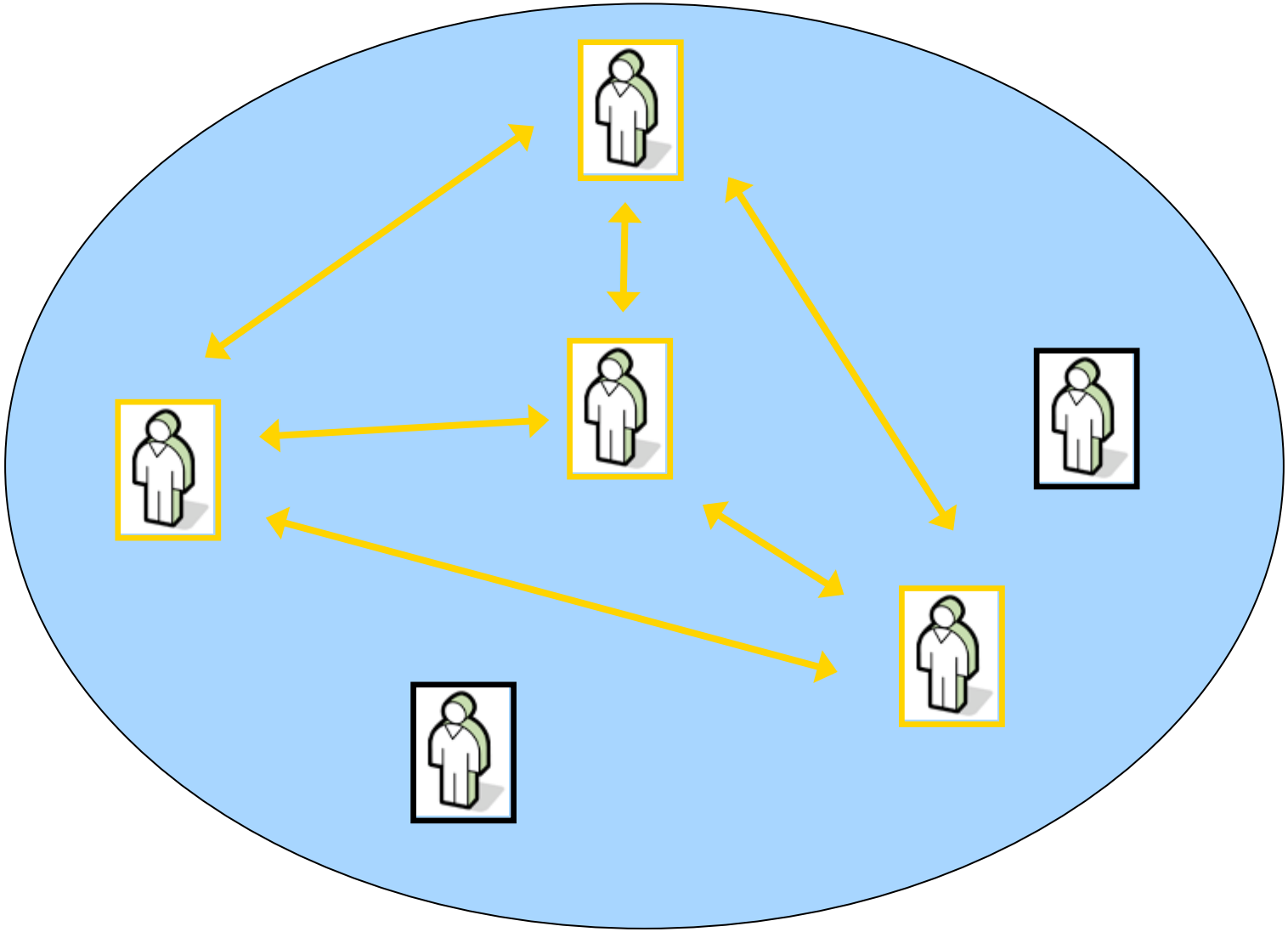

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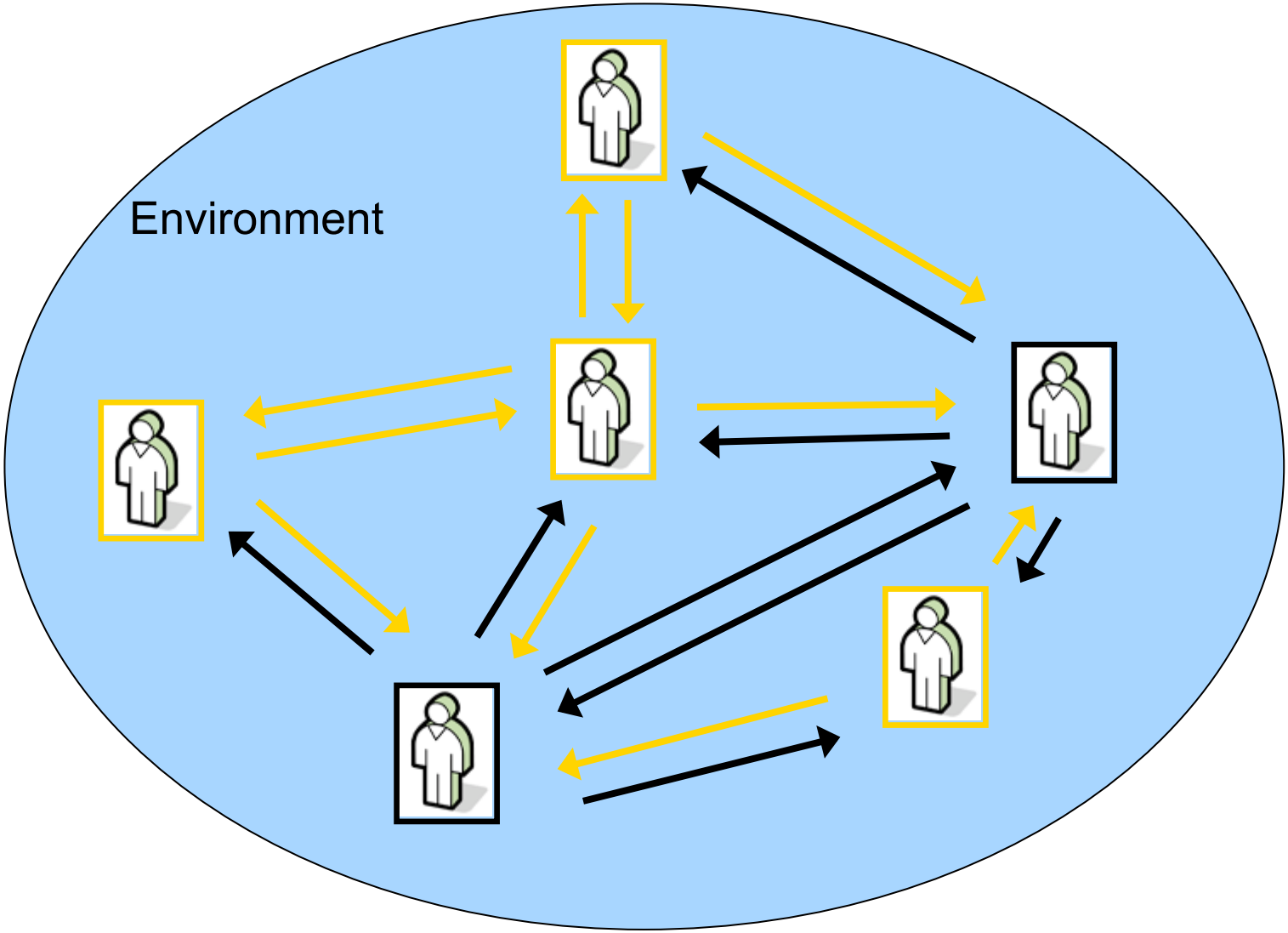

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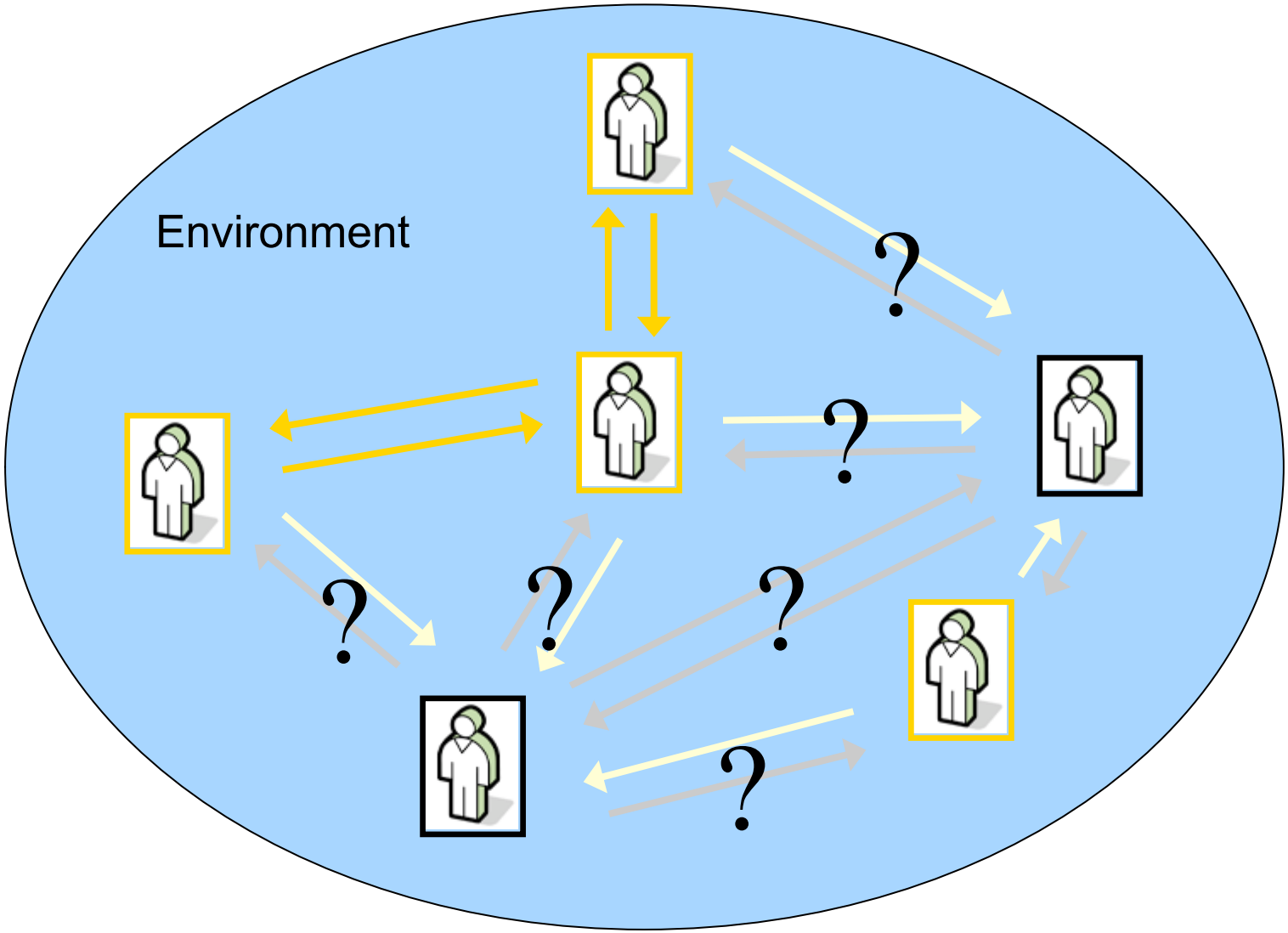

Issues and possible solutions

Simulations with different combination of input parameters: No relaxation is observed

Real Optimization Technique (e.g. SA)?

Same story as before: Search space prohibitively large ...

Alternative: Adapt local search techniques …

- In each iteration
- Outer loop

  → Replanning of person agents → relaxed state → local search

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Gravity models

Description:

Advantages: Make use of data which are available in MATSim, is a method which is really used in the practice

Disadvantage: Their goodness is always more discussed in the academic field

The problem of trying to optimize toghether different reteilers types:

Ratio #allowed / #number of shops to be relocated

Different retailers types

Big retail-chains with few but large stores in one region (ex. IKEA)

- Few available spots
- Key:

Big retail-chains with many stores in one region (ex.

Issues related with the dynamic approach

Number of iterations (or process internal relaxation- external relaxation…)

Individual Agent Framework

Current MATSim

Next Stage

Individual Agent

Personal attributes

- Age
- Gender
- Home location
- Work location
- Driving License
- Car availability
- Transit tickets ownership

- Income
- Household

Location choice methodology

- Not optimized

- Optimized in time and space

Objective function

- Time based

- Utility based with budget constraints

Knowledge

- Memory of previous plans (score)

- Shop Attributes (Price, Quality, Parking, etc.)

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How different agents do interact?

Retailer Agent

Individual Agent

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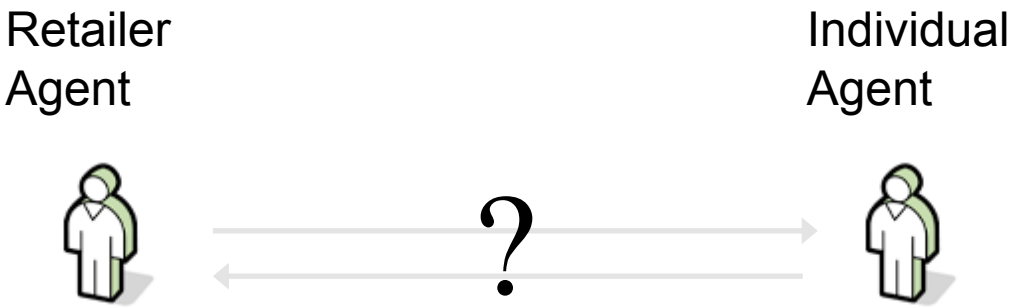

Importance of Location for Retailers