Towards a spatio-temporal model of human movement surfaces for the simulation of best utility trajectories

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Outline

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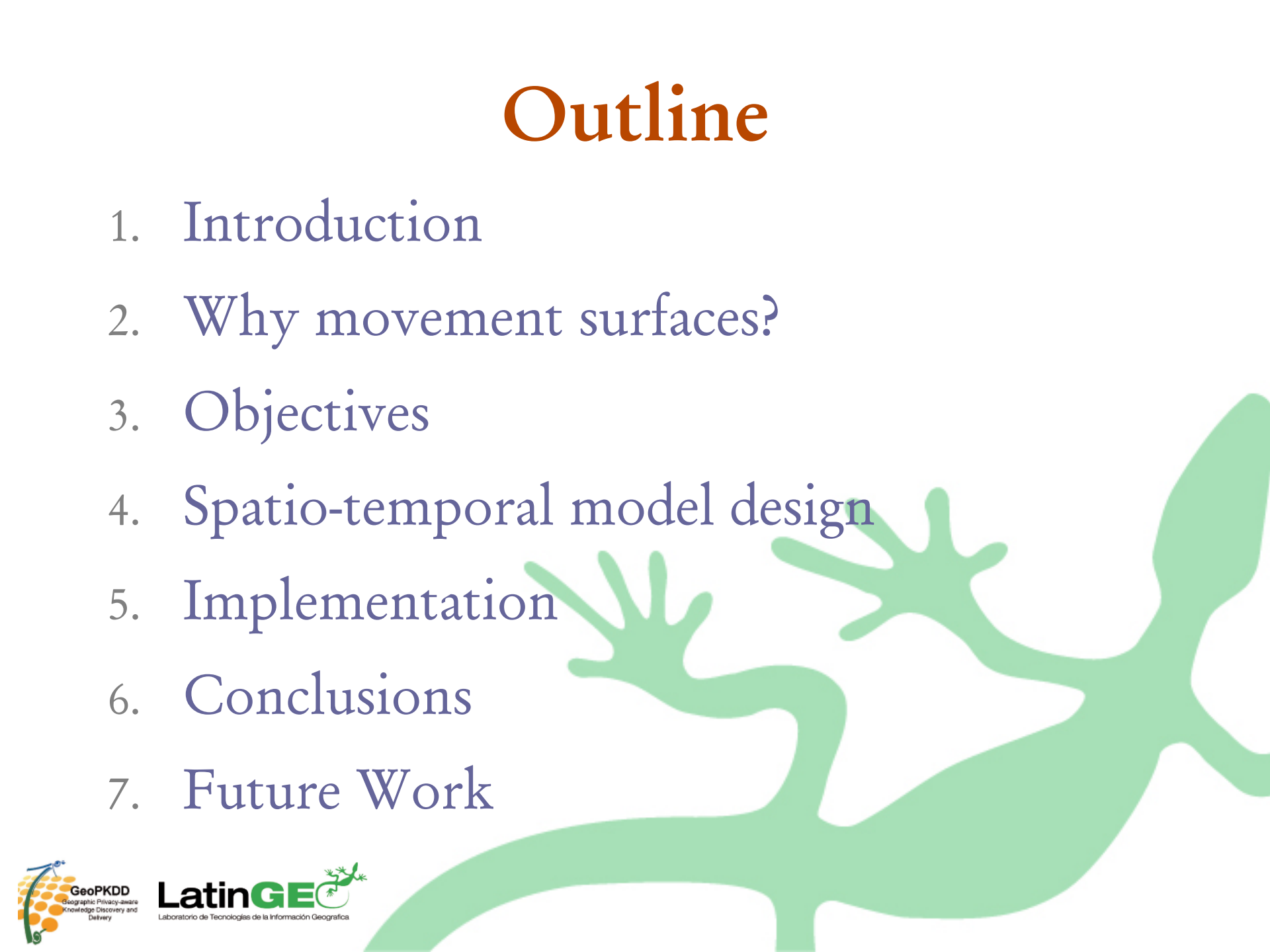
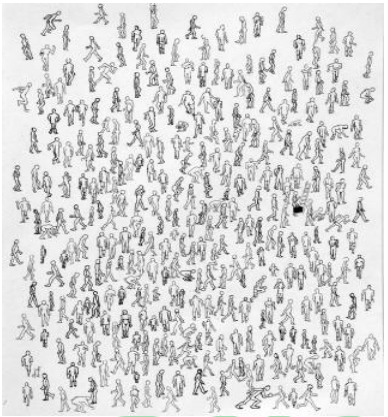
2. Why movement surfaces?
3. Objectives
4. Spatio-temporal model design
5. Implementation
6. Conclusions
7. Future Work



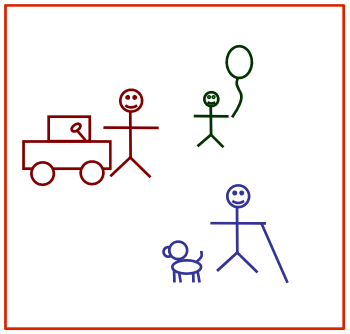
Introduction

If you stop and observe a moving crowd..



... it could seem to be a chaotic phenomena at first sight

But if you look at this phenomena a little more...



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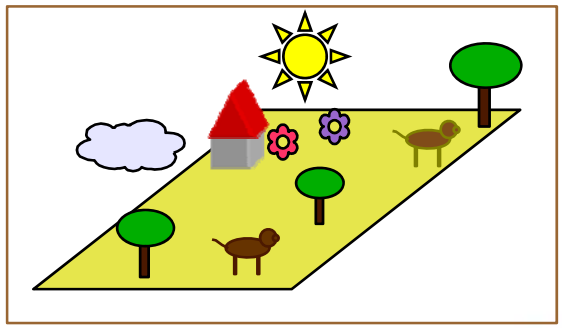

&

THE SUBJECTS

THE ENVIRONMENT (and restrictions)

THE MOMENT

... you will realize that human movements is not a chaotic phenomena but is the result of human **intentional behaviour**

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Then if we infer about this intentional behaviour..

INTENTIONAL BEHAVIOR = PERSON PREFERENCES ∩ ENVIRONMENT

... we can make predictions about human movement!!

Movement Surface

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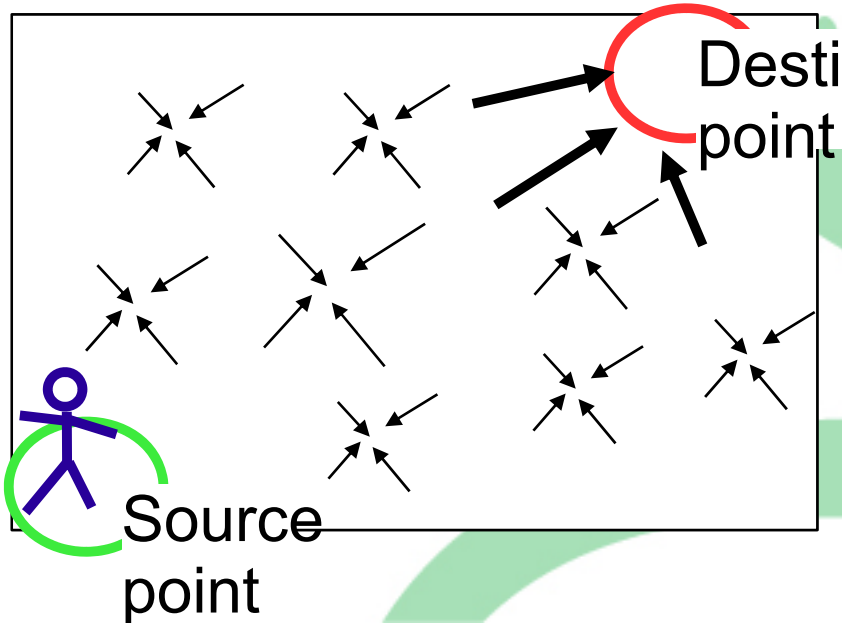
Why movement surfaces?

- Any movement is the consequence to the forces acting over the person that moves.
- Movement surfaces represent the forces field which generates such a movement.



Attraction forces due to utility

Movement surface

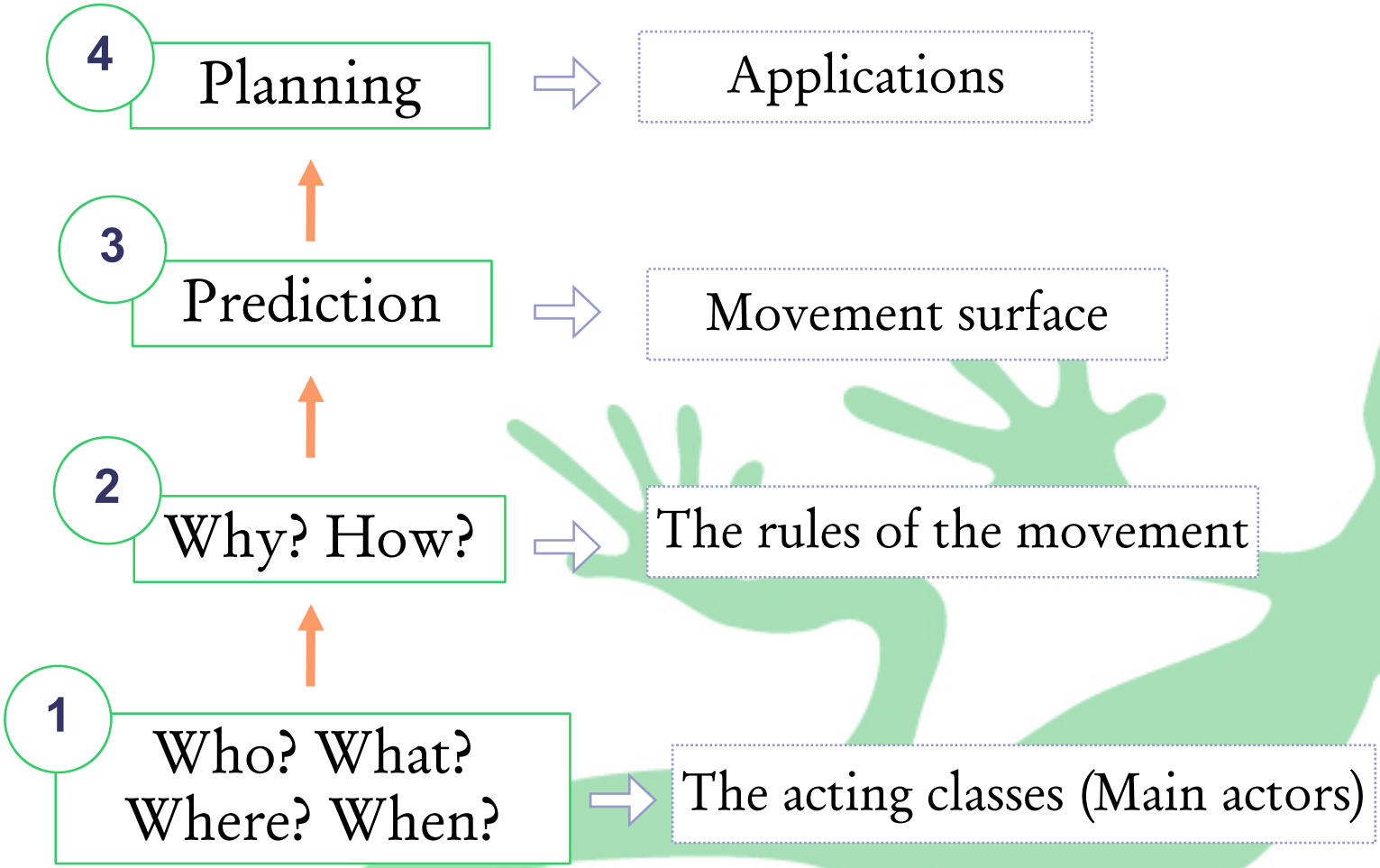
- It represents the attraction forces over all the environment. (Not only at the destination point)
- It is individualized for each person. (Each person has different displacement preferences)
- It is a dynamic surface, it varies along the time.

Objectives

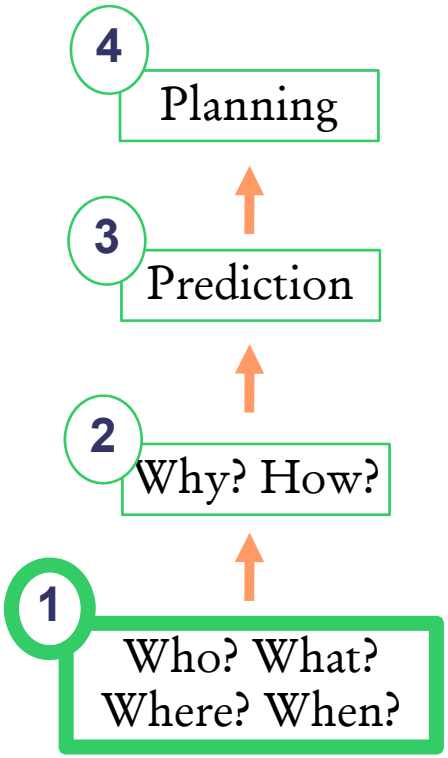
- Predict the human movement by modelling movement surfaces.
- Demonstrate how to implement a movement surface in different application scenarios.

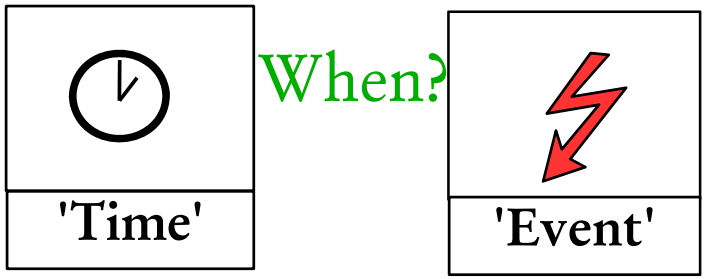
Spatio-temporal model design

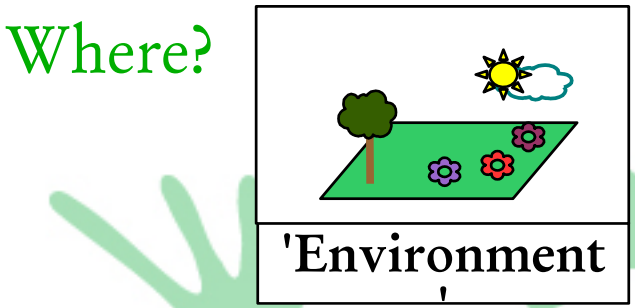
Modelling Phases

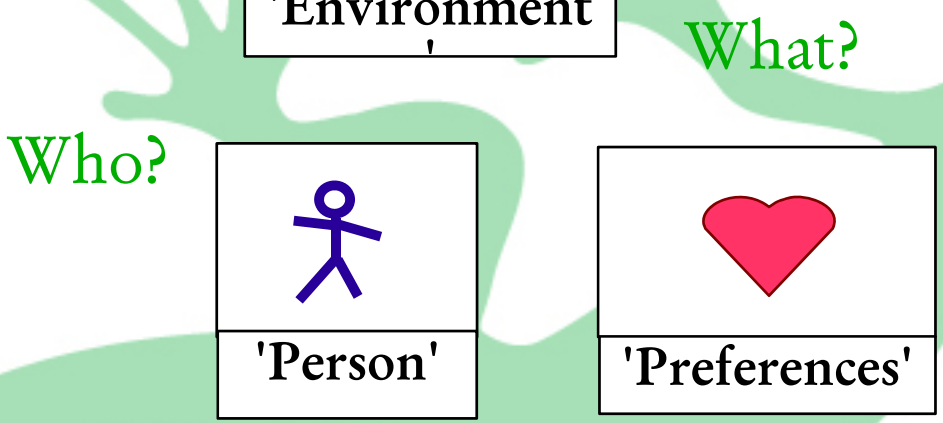


The acting classes









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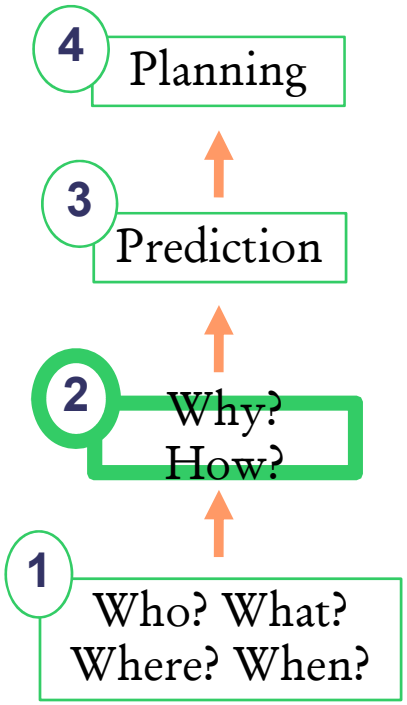
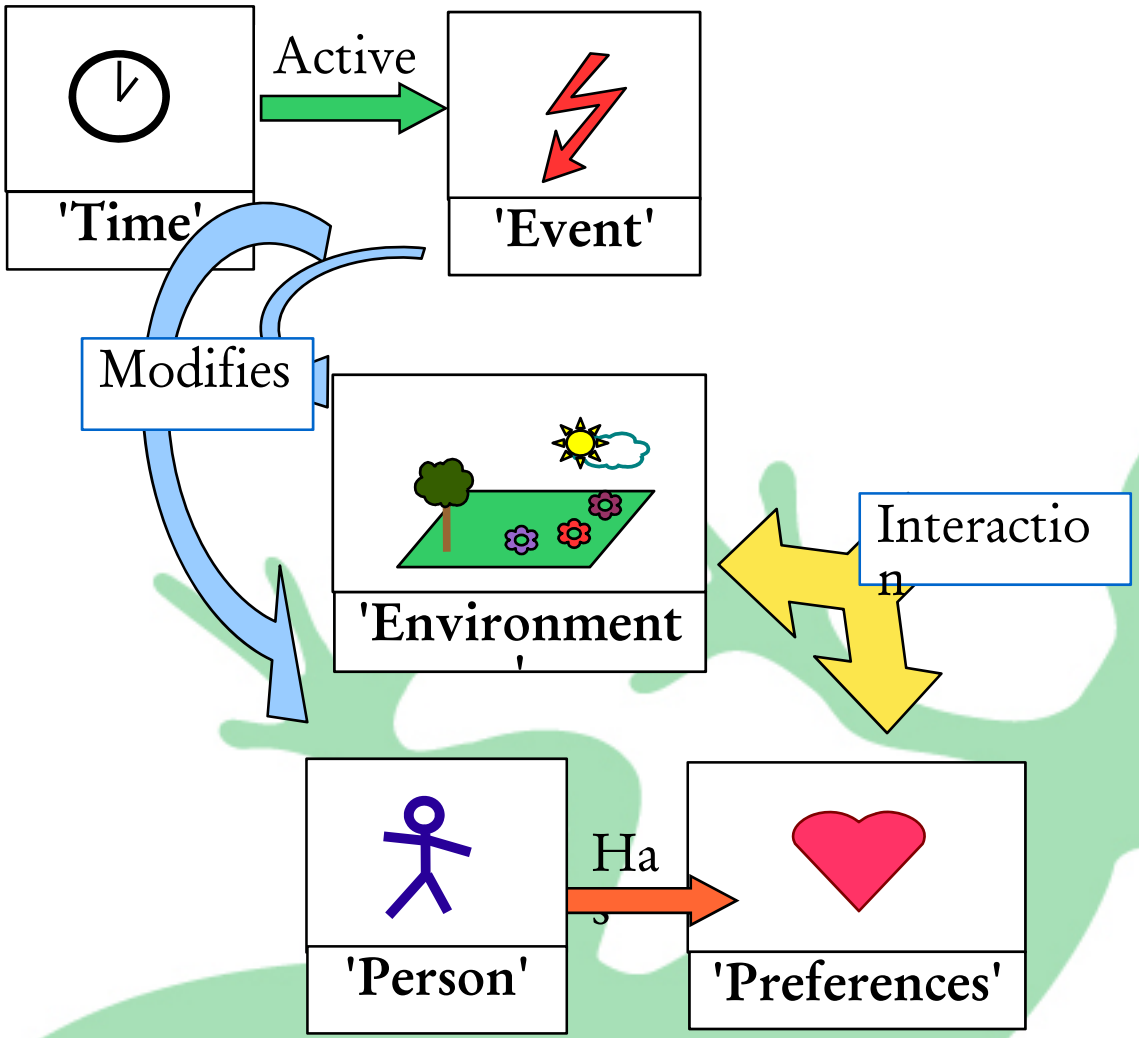
The rules





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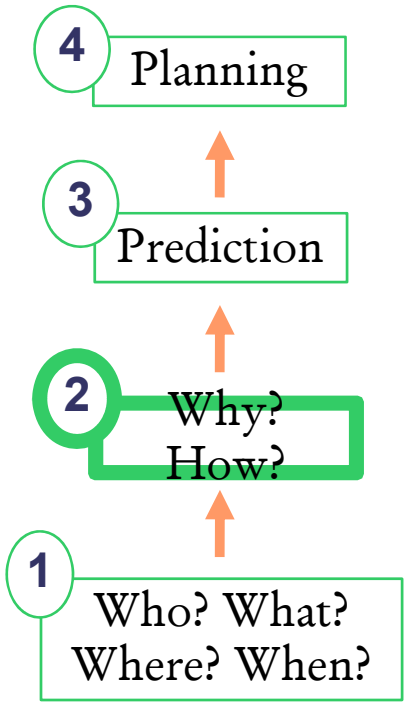
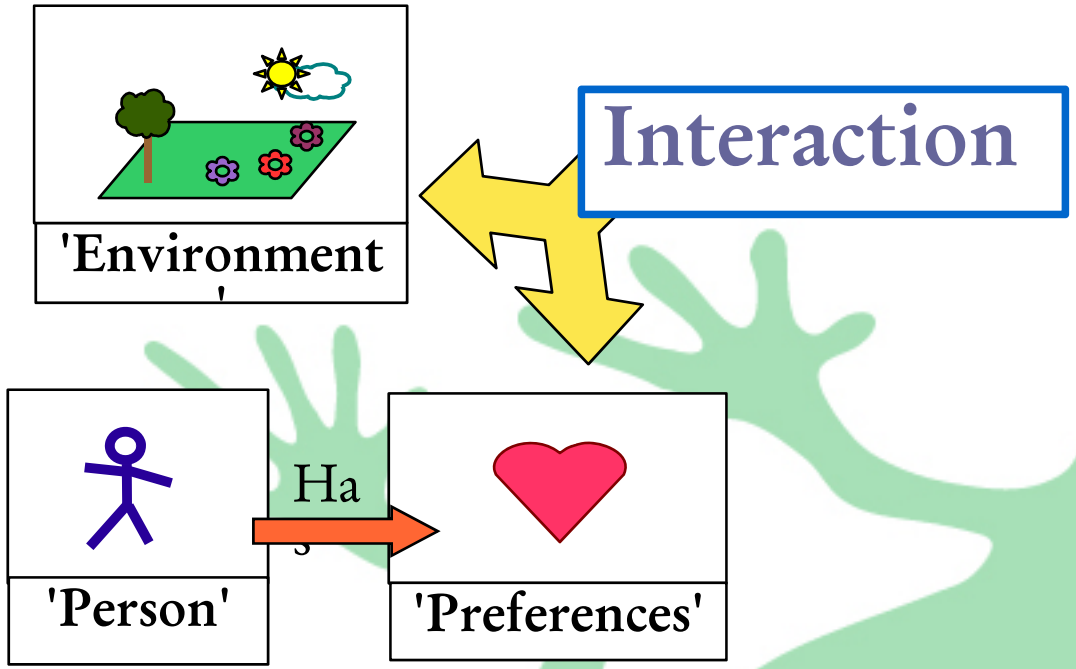
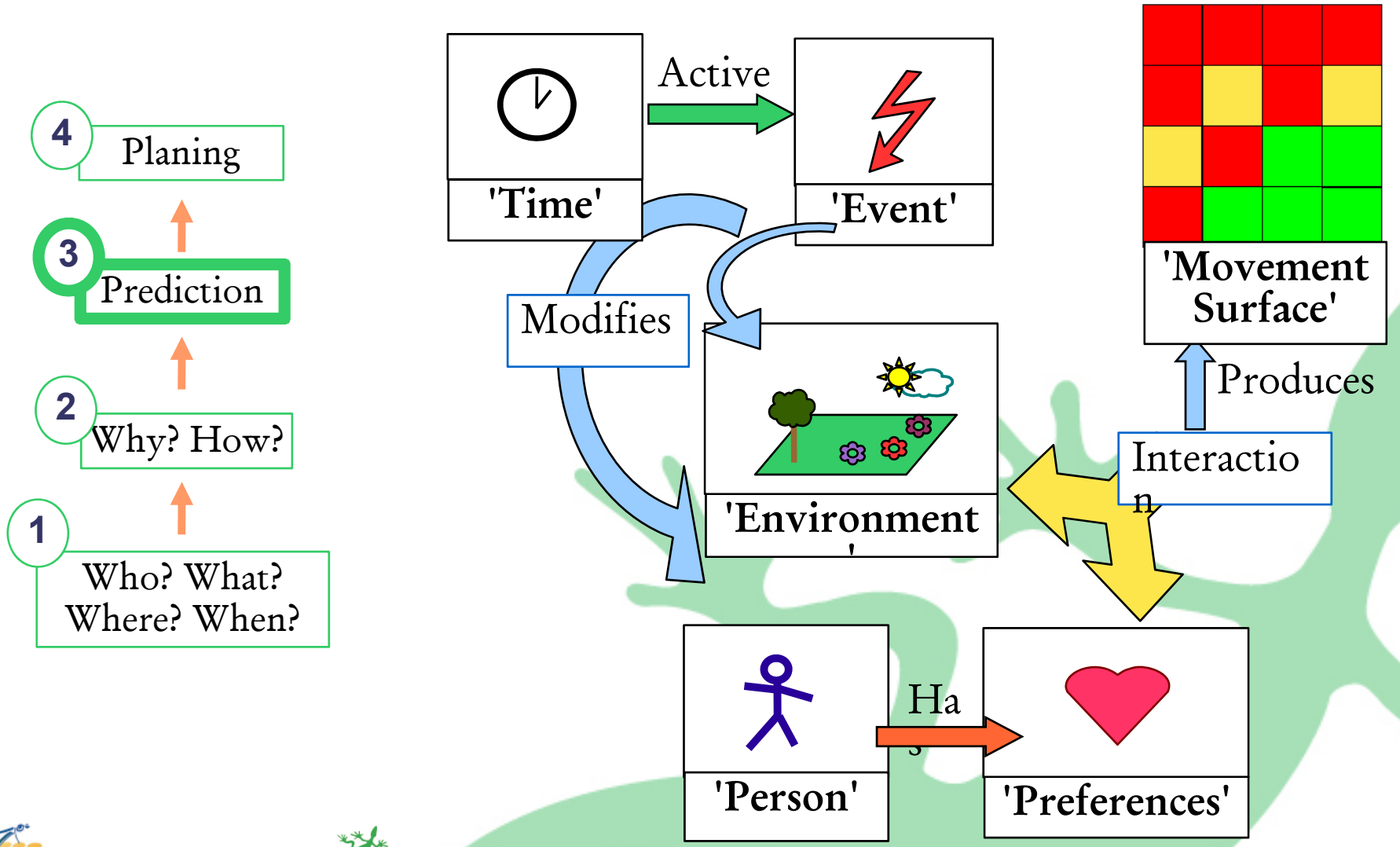
The rules

Each person moves in a way that his satisfaction is maximized according to his preferences.

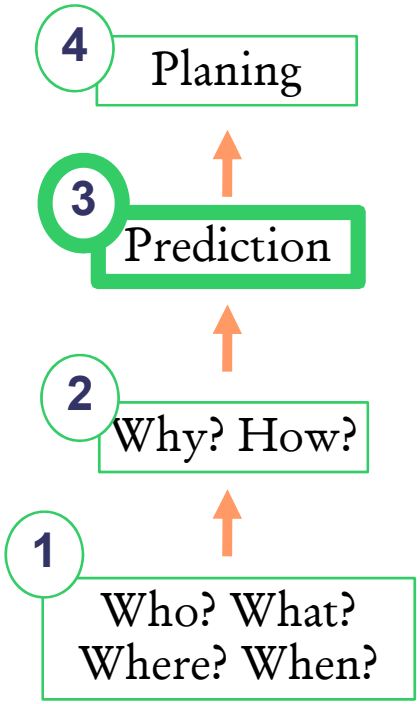




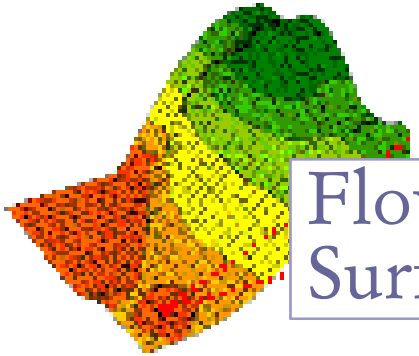
Movement surface



Movement surface

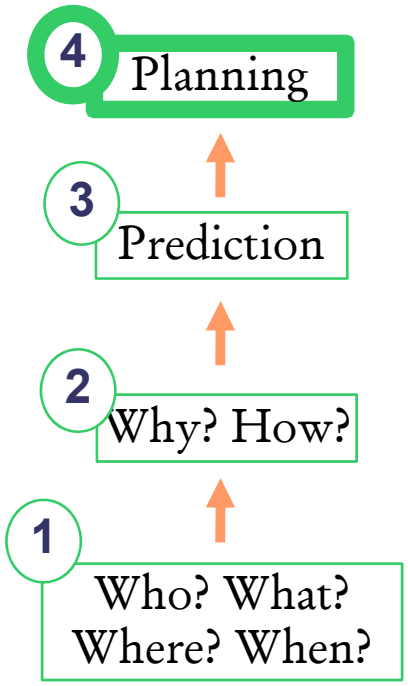


As a raindrop flows over a surface looking for the maximum slopes, people flow over their correspondent movement surface looking for the maximum utility



Flow Confluence Surface

Planning



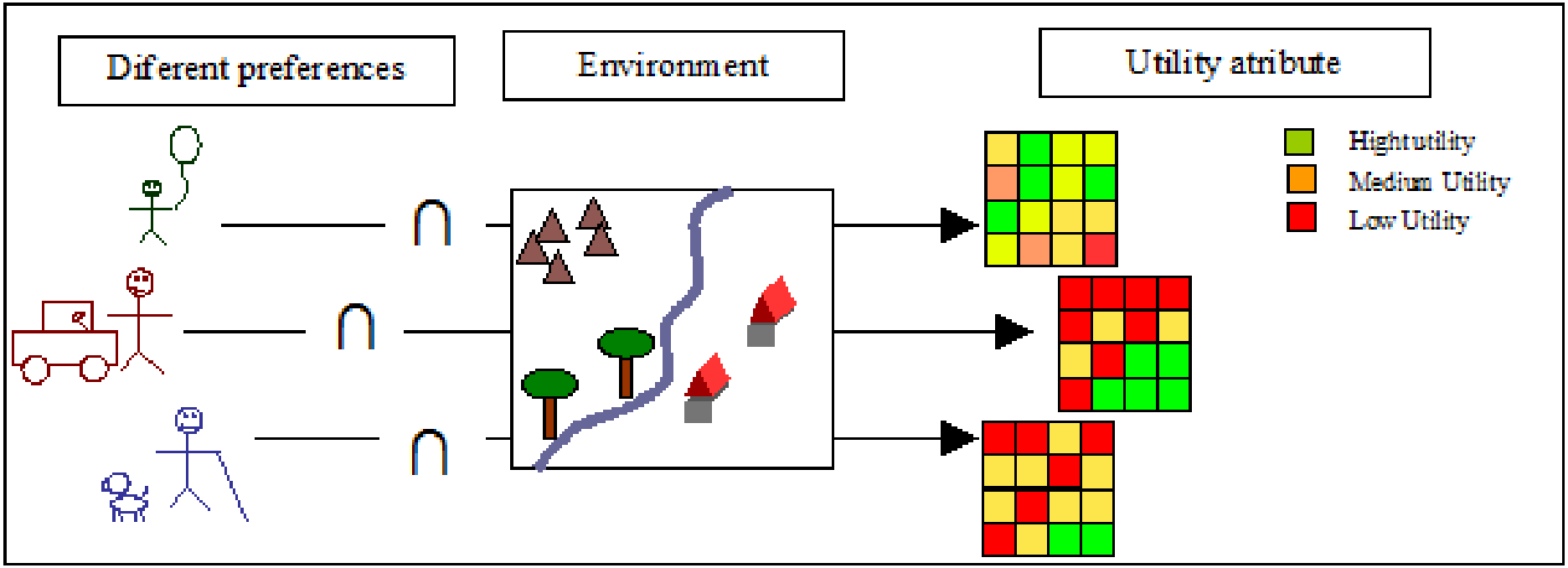
- Location-allocation problem: Find the optimal location for a specific public (stand, supermarket)

- Optimal routes which are individualized per each person

Implementation

How can this movement surface be generated?

By assigning a utility value to the environment



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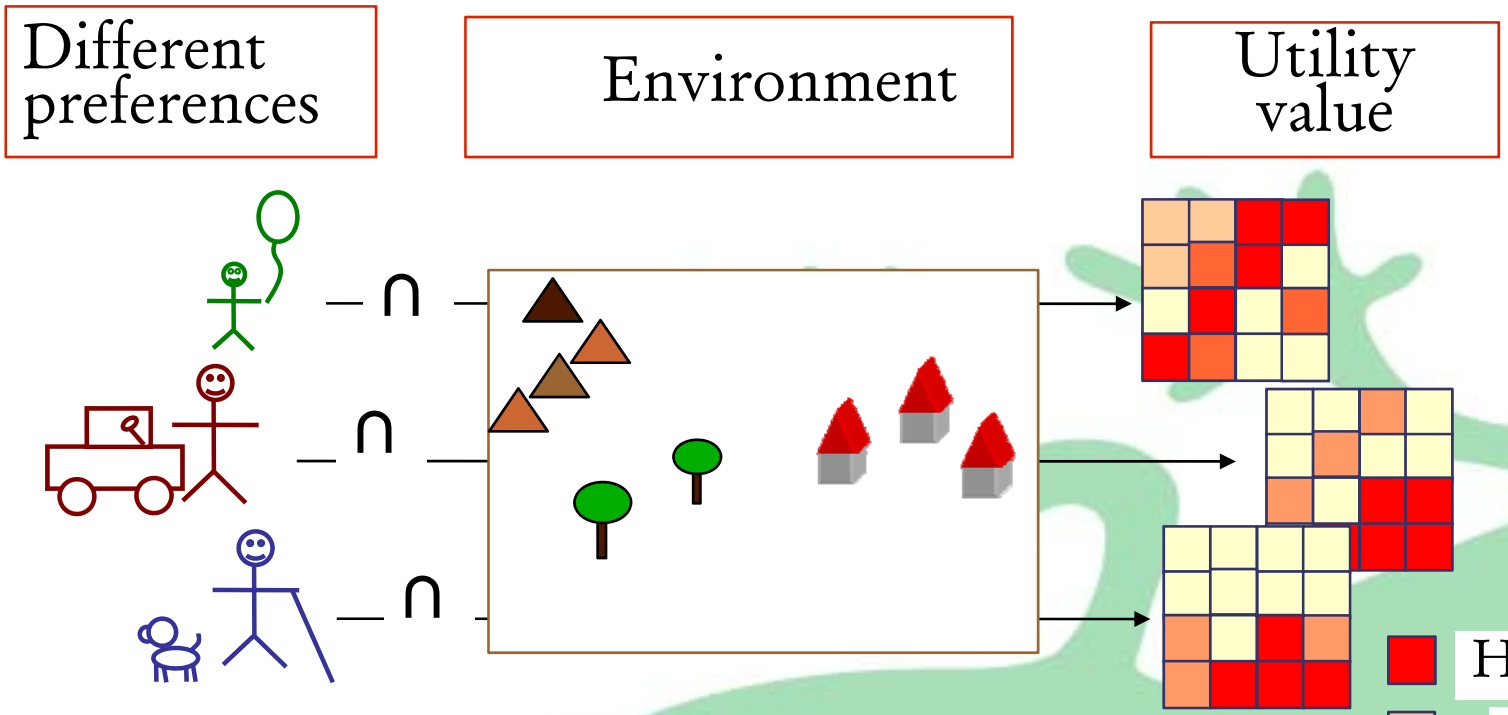
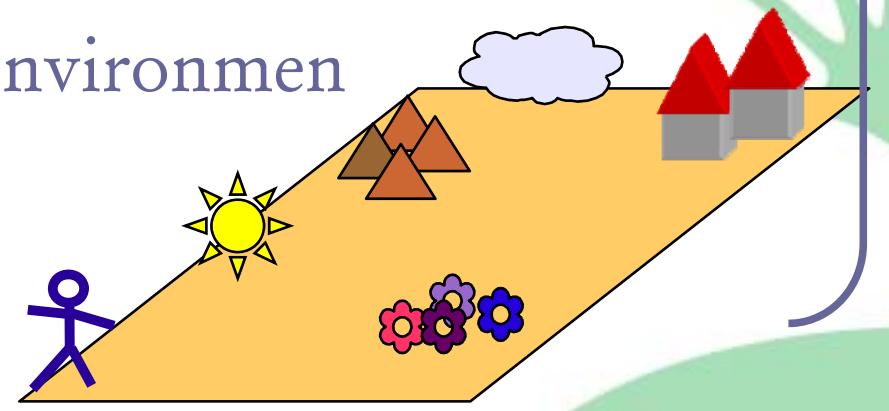


Preferences

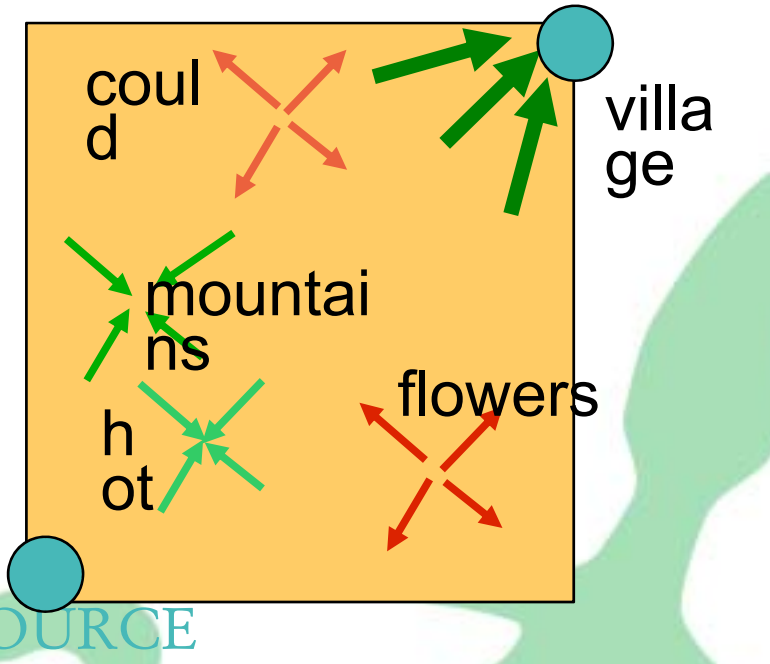
- I need to get the village
- I am allergic to flowers
- I love mountain
- I like hot

Person

Environment



Attraction forces are proportional to utility

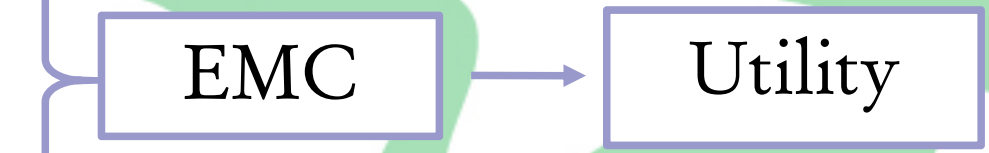


How is this utility value calculated?

The utility is the measure of the compliment level of the person preferences in the environment

EMC techniques
(Simple Additive Weighting, SAW)

- Person preferences (= criterias)
- Environment



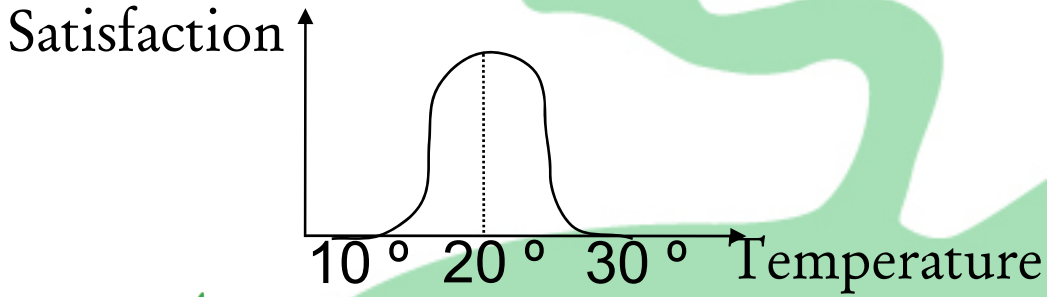
How are the preferences defined?

Preferences are represented by using two concepts:

- Preference matrix: The weight of each criteria.

(= Relevance of the preference)

- Satisfaction function: Satisfaction produced to one person by one variable value of the environment.



Application Scenario: Emergency Call

Moving Object: Ambulance

Humidity	Slope	Soil type
0%	40%	60%

Preference matrix

Slope	Satisfaction
Level	Maximum
Slight	Medium
Scarp	Minimum

Satisfaction Functions

Land	Satisfaction
Grass	Minimum
Soil	Medium
Pavement	Maximum

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Application Scenario: Recreation

Moving Object: Mushroom Picker

Preference matrix

Humidity	Slope	Land type
30%	5%	65%

Satisfaction Functions

Humidity	Satisfaction
Low	Minimum
Normal	Medium
High	Maximum

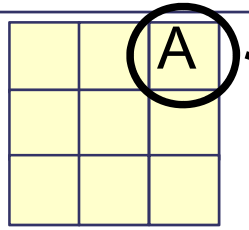
Slope	Satisfaction
Level	Maximum
Slight	Medium
Scarp	Minimum

Land	Satisfaction
Grass	Maximum
Soil	Medium
Pavement	Minimum

Utility Calculus Example

For the mushroom picker

Environment

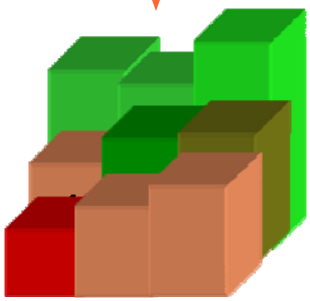


- Slope value = 5%
- Humidity value = 80%
- Land type = Soil

Satisfaction normalization

- High => 10
- Medium => 5
- Minimum => 0

EMC (SAW)



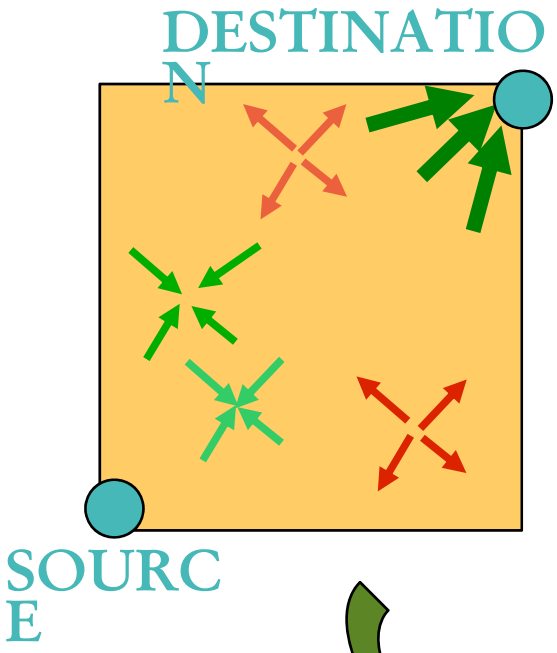
Movement Surface

Calculus for A cell

$$\text{Utility} = \sum (\text{Weight} * \text{Satisfaction}) \text{ for all criterias}$$

$$U = \left\{ \begin{array}{c} (Wslope * Sslope) \\ + \\ (Whumid * Shumid) \\ + \\ (Wland * Sland) \end{array} \right\} = \left\{ \begin{array}{c} (5\% * 10) \\ + \\ (30\% * 10) \\ + \\ (65\% * 5) \end{array} \right\} = 6{,}75$$

Flow direction calculus



1

Satisfaction due to destination point

+

Satisfaction due to environment

4	6	9	10
4	7	5	6
5	2	4	2
0	3	3	3

2

Looking for high satisfaction

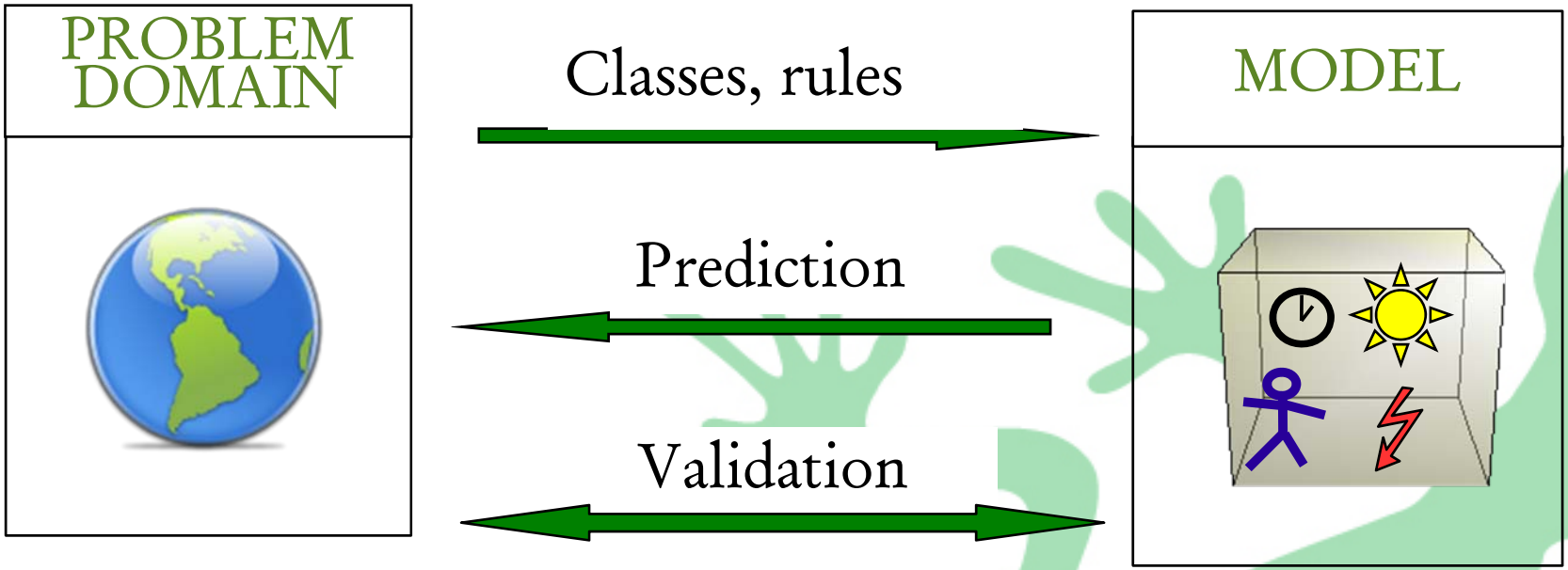
4	6	9	10
4	7	5	6
5	2	4	2
0	3	3	3

Conclusions

- Each singular movement of a person is the consequence of the forces acting over him/her.
- If we know about an environment and the preferences of one person we can simulate his/her movements through the modelling of movement surfaces.
- Movement surfaces are the analogue to surface confluence in flow water phenomena.

Future Work

Model validation



¿Questions?

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