

Modeling complex systems with Cellular Automata

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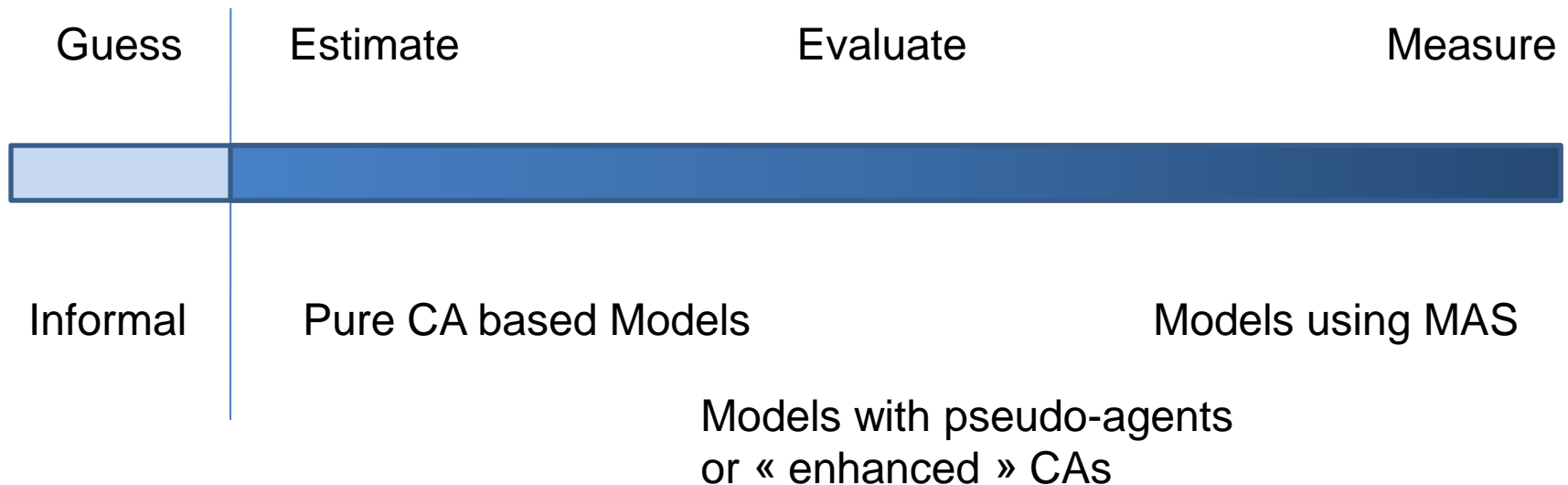
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A step by step approach to model reality

From unstructured uncertainty to structured uncertainty and probability



CAs are:

- Simpler to develop and program
- Simpler to interpret and tune
- More flexible and controllable

CAs allow:

- To better follow-up the process
- To have a rule by rule control
- To analyze social phenomena

Modeling violence

- ❑ **We try to model the violence spreading**
- ❑ **Violence is a complex phenomenon due to:**
 - Individual characteristics and behaviour of the involved persons
 - Groups characteristics and behaviour
 - Persons interactions (type and duration)
 - Number of persons involved
 - Situation and persons' position in an environment
 - Environment itself (which is generally complex)
 - ...
- ❑ **The price for such type of modelling is high**

The ingredients of the Model

The environment (or world)

- ❖ A town with neighborhoods, access points, communications
- ❖ A square cells world with 8 neighbors for each cell

The actors we have chosen in a first step:

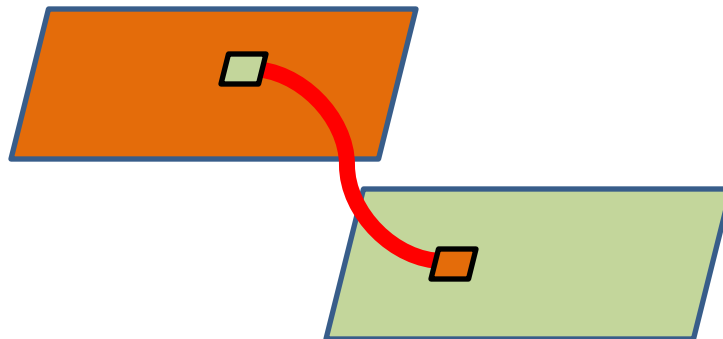
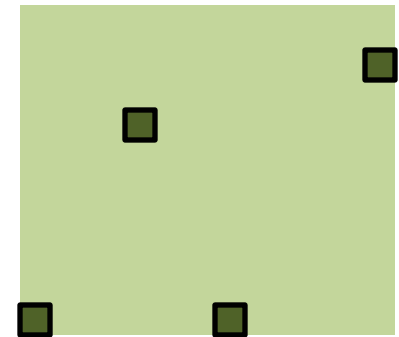
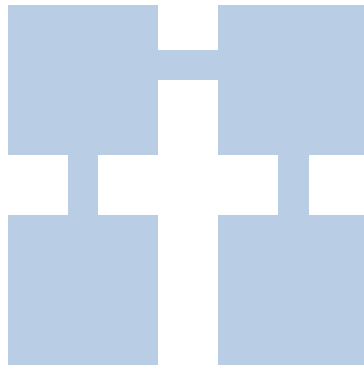
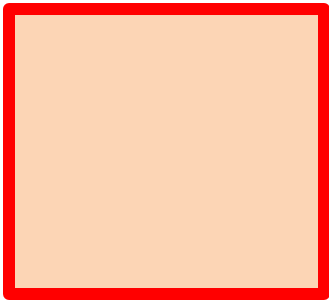
- Neutral citizen
- Violent citizen
- Police agent
- Educator
- Prisoner
- Informator
- Poor citizen

A set of rules to make actors interact

Specifics of the World

Possibility of having :

- ❖ Flat limited world
- ❖ Torus shaped world (no edges)
- ❖ Points of « emergence » of a state in the world (eg: airports, havens)
- ❖ Communication « roads » between otherwise unrelated parts
- ❖ Wormholes -borrowed from cosmology – to model underground comm.

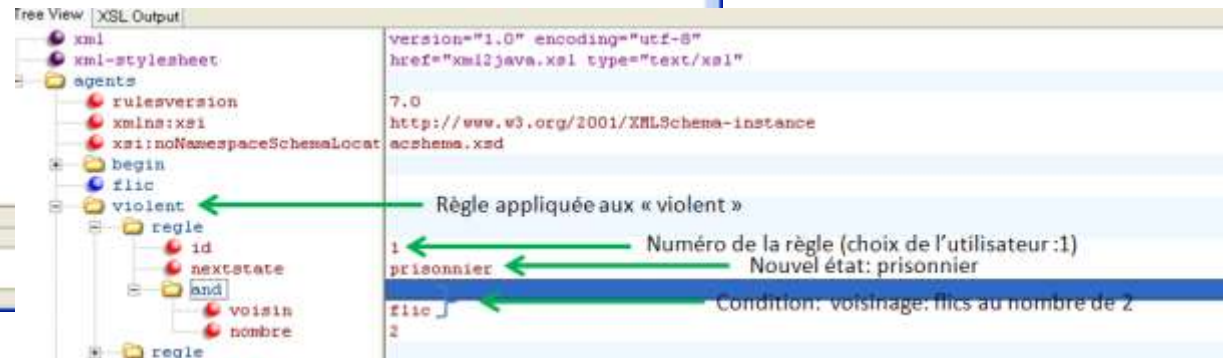
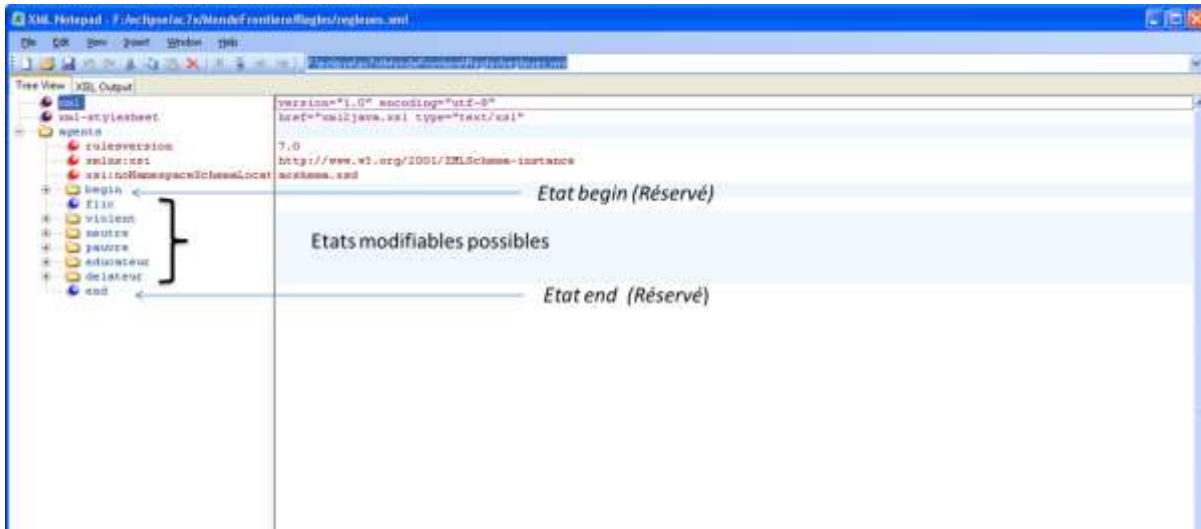


Main rules

- ❖ Rules are parametric
- ❖ There are extensions, like the « vision »
- ❖ A rules editor (XML based) helps users to do rapid changes

Rule	Status at T	Nb	Type of surround	Status at T+1
1	Violent	2	Police	Prisoner
2	Neutral	2	Violent	Violent
3	Neutral	3	Police	Police
4	Neutral	3	Informers	Informer
5	Neutral	3	Poor	Poor
6	Poor	3	Violent	Violent
7	Informer	3	Violent	Neutral
8	Educator	2	Informer	Informer

A first step towards a rules editor

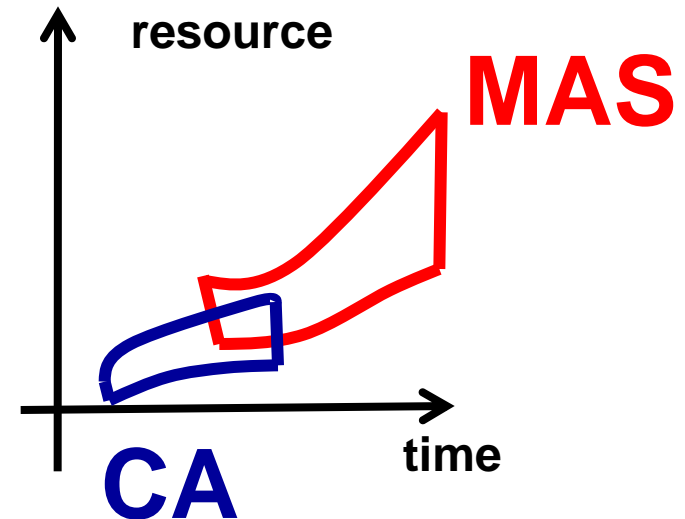


Traduction équivalente XML:

```
<violent>  
<regle id="1" nextstate="prisonnier">  
<and voisin="flic" nombre="2"/>  
</regle>  
</violent>
```

Discussion and Comparison with MAS (1)

- ❖ **The frontier between the two approaches is fuzzy**
CAs could be extended and MAS could be restricted
- ❖ **For a successful full MAS implementation , the need:**
 - highly qualified technical personnel
 - considerable financial resources :
software,
personnel,
field tests,
 - long development and testing time



Discussion and Comparison with MAS (2)

- There are many cases where CA or enhanced CA are sufficient for getting the necessary information to solve the problem at hand
- Even full MAS do not provide the guarantee of a reliable result
- MAS could be developed by minimizing the global resource only once a convenient conceptual model and an architecture are decided upon

What remains to be done

- **A full functionality tool-box for non-computer Specialists including :**
 - **a full functionality rules editor,**
 - **a worlds builder,**
 - **a comprehensive agent types collection**
 - **a memory to store past configurations and runs**

- **A way to be able to obtain a « time reversible » model**

- **An Internet site to help faster and more fruitful exchanges with people interested in such research**

What remains to be done

- **An extensive test campaign using different sets of rules, worlds, types of agents/status,**
- **Building comprehensive partnerships with Sociologists and complexity research people to augment the credibility and usability of the model.**

To conclude

- ✓ **This research continues within the framework of the GREC-O hosted by the IMA/UCO research laboratory,**
- ✓ **The wormhole concept (borrowed from physics) is a powerful amplifier of the model,**
- ✓ **We affirm that the use of such a CA to better understand violence spreading, ways to reduce it and help creating better living conditions, notably in a town, is a valid and affordable approach,**
- ✓ **We are ready to share our know-how with other research teams to make faster global work progress and by enabling the creation of an open dedicated Internet site freely accessible.**

Thank you for your attention and patience!

**Now, if your patience is not ended, a short
Demonstration of the software will follow**