A Multi-Agent Simulation Environment of Hereditary Diseases

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Slides Index

The Questions

- In a society of healthy persons, a person with a hereditary disease enters. How is this spread with time?
- A person who is carrier of a disease, falls in love with another person, also a carrier. How does this changes the marriage selections?

Current Research

Different Approaches

- Medicine – Genetics
- Demography – Human Ecology
- Mathematics – Statistics
- Psychology

Pursue of a *unified model* for the research of the *epidemiological behaviour of hereditary diseases in a society.*

Goals

- Build a model which will :
  - Simulate the Demographical Growth of a Population
  - Instantiate and Study of the Spread of a Disease
- Build necessary tools to observe the model
- Output and store data for meta-analysis

Technologies Used

Multi Agent Systems

- Genetic Algorithms
- Reinforced Learning
- Cellular Automata

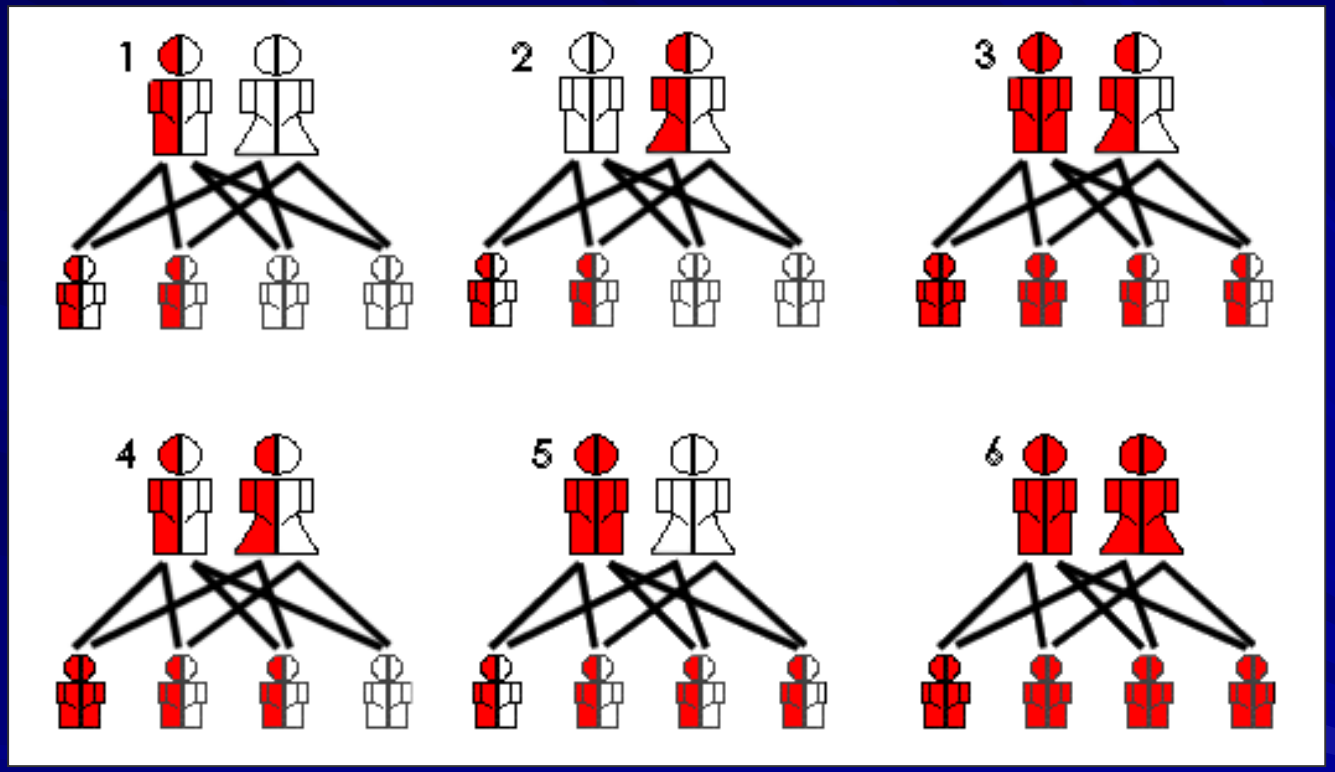
Transmit Methods

- *Autosomal Recessive*:
  heterozygote (or carrier) **Healthy**,
  homozygote **Patient**
- *Autosomal Dominant*:
  heterozygote and homozygote **Patient**
- *X-Linked (Sex Related)*:
  man and X-mutation **Patient**

46 Chromosomes:

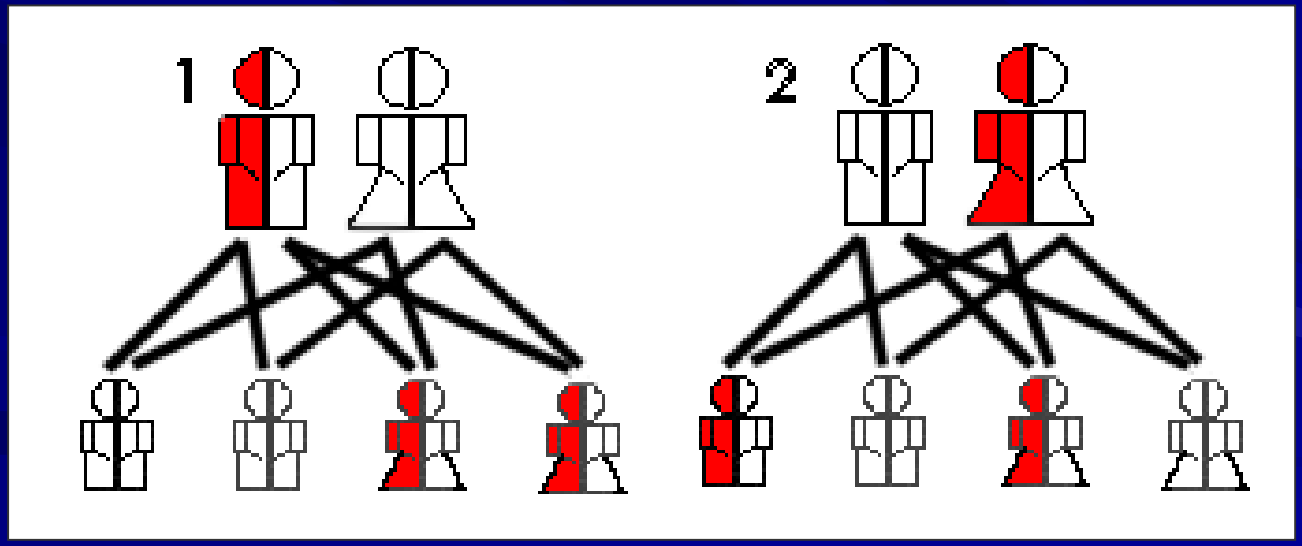
- **22 Pairs Autosomes**
- **2 Sex *{Male XY, Female XX}***

Autosomal

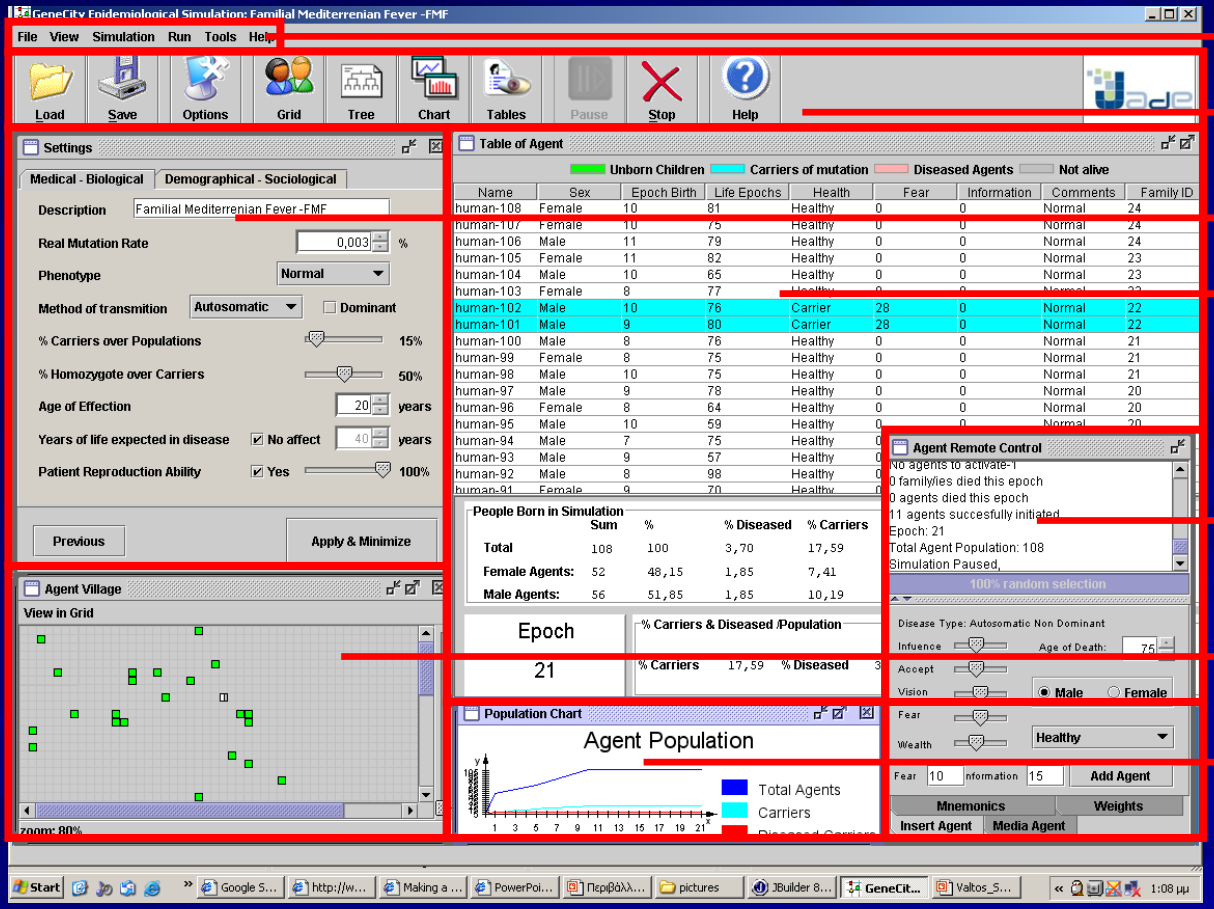


X-Linked

- Male:
  - *XY* healthy
  - ***x****Y* patient
- Female:
  - *XX* healthy
  - ***x****X* healthy
  - *X****x*** healthy



Genecity Environment



Main Menu

Selection Buttons

Configuration

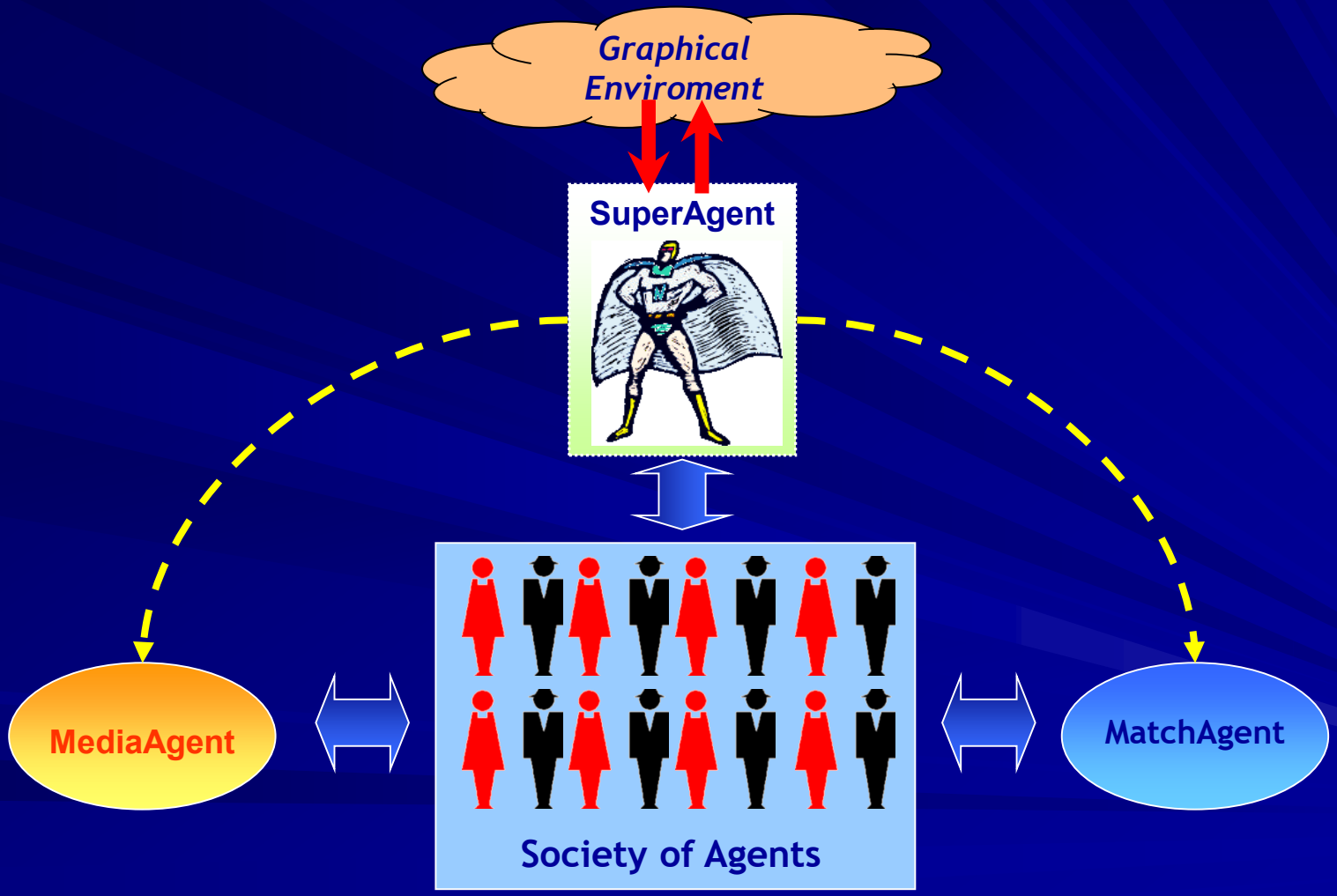
Tables of Data

Remote Control

Agent Grid

Dynamic Graphs

Agent Communication



Agent Representation


Healthy Woman

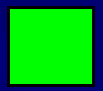
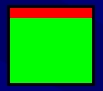
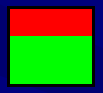
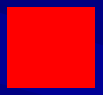

Healthy Man


Carrier Woman


Carrier Man


Patient Woman


Patient Man

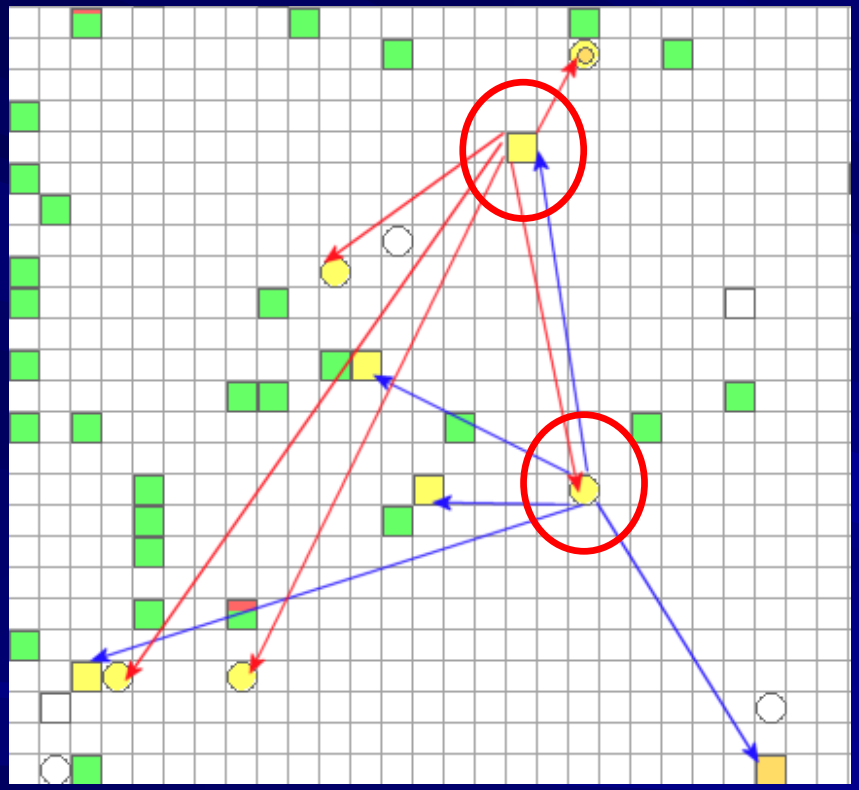





Families Representation

Green: %Healthy

Red: %Diseased

Partner Choice



- Agent Chosen Randomly
- Exchange of Information about themselves
- If marriage, then removed from Grid and return as family
- Use a variation of the Stable Marriage Problem Algorithm

Criteria of Selection

- Is the other person a patient?
- What is the probability of having patient children if in marriage;
- Is the disease deadly;
- Does the other person have “negative Phenotype”;

Extra criteria

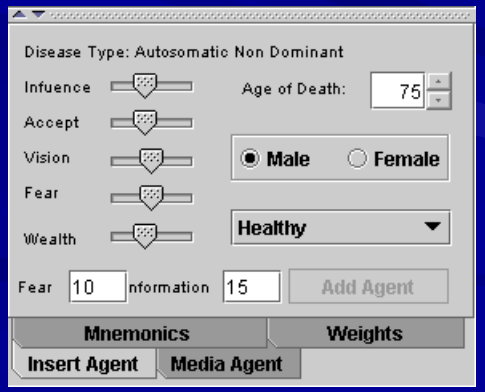
- Distance in Grid (social, natural)
- Wealth (beauty, money)
- Age Difference (etc)

What is Measured

- Population of society
- Populations of diseased and carriers
- Mean value of exchange information
- Mean number of people informed for disease
- Mean amount of information by Media Agent
- Births and Deaths per epoch
- Mean number of new families

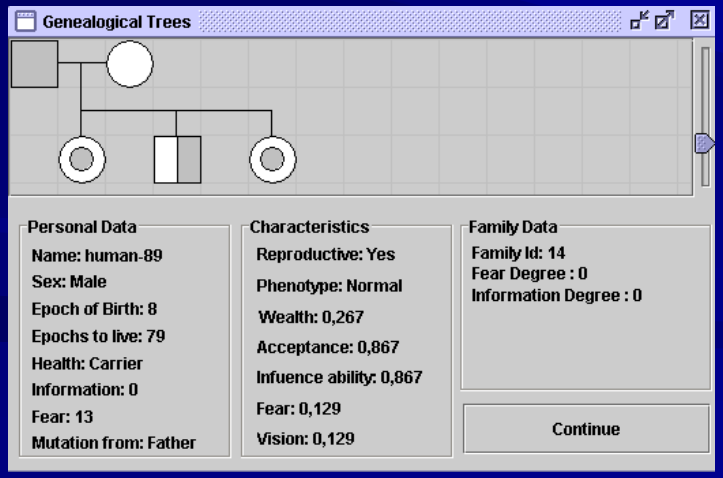
Novelties

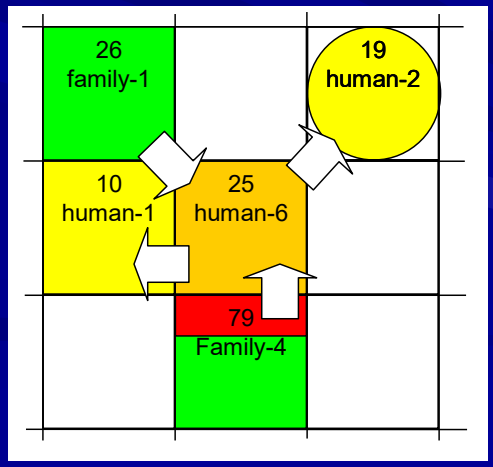
- Media – Agent: Provides information about a disease (as Media or Health Education)
- Dynamic Instantiation of Agent in the system, with its characteristics pre-defined



Novelties

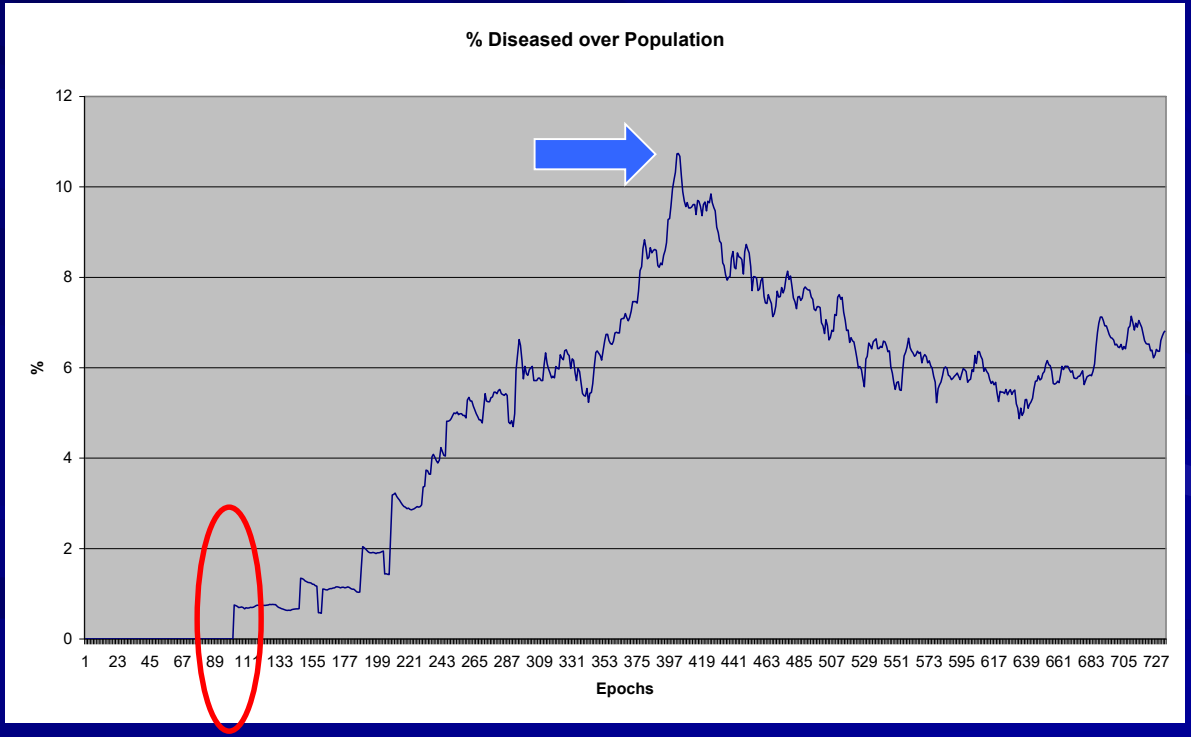
- Medical Genealogical Tree
- Information for the disease form Neighbourhood
- Total and Real-time change of Setup





Example A

- Entrance of an Autosome Dominant diseased person in a healthy population:



Example B

- Prejudice society for the X-link patients