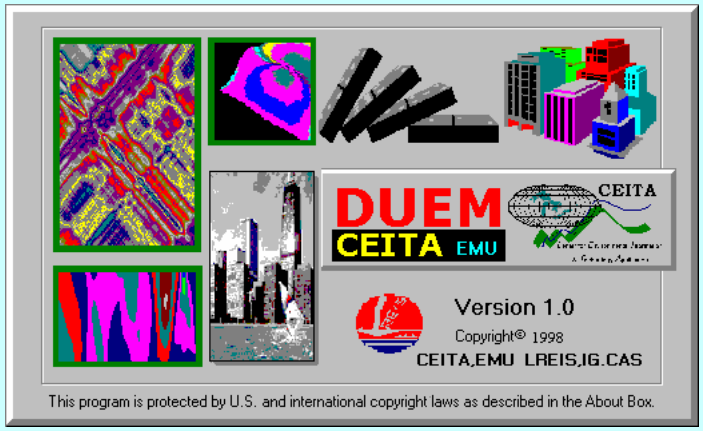
Projecting Urban Land Use Changes:

DUEM - Dynamic Urban Evolution Modeling



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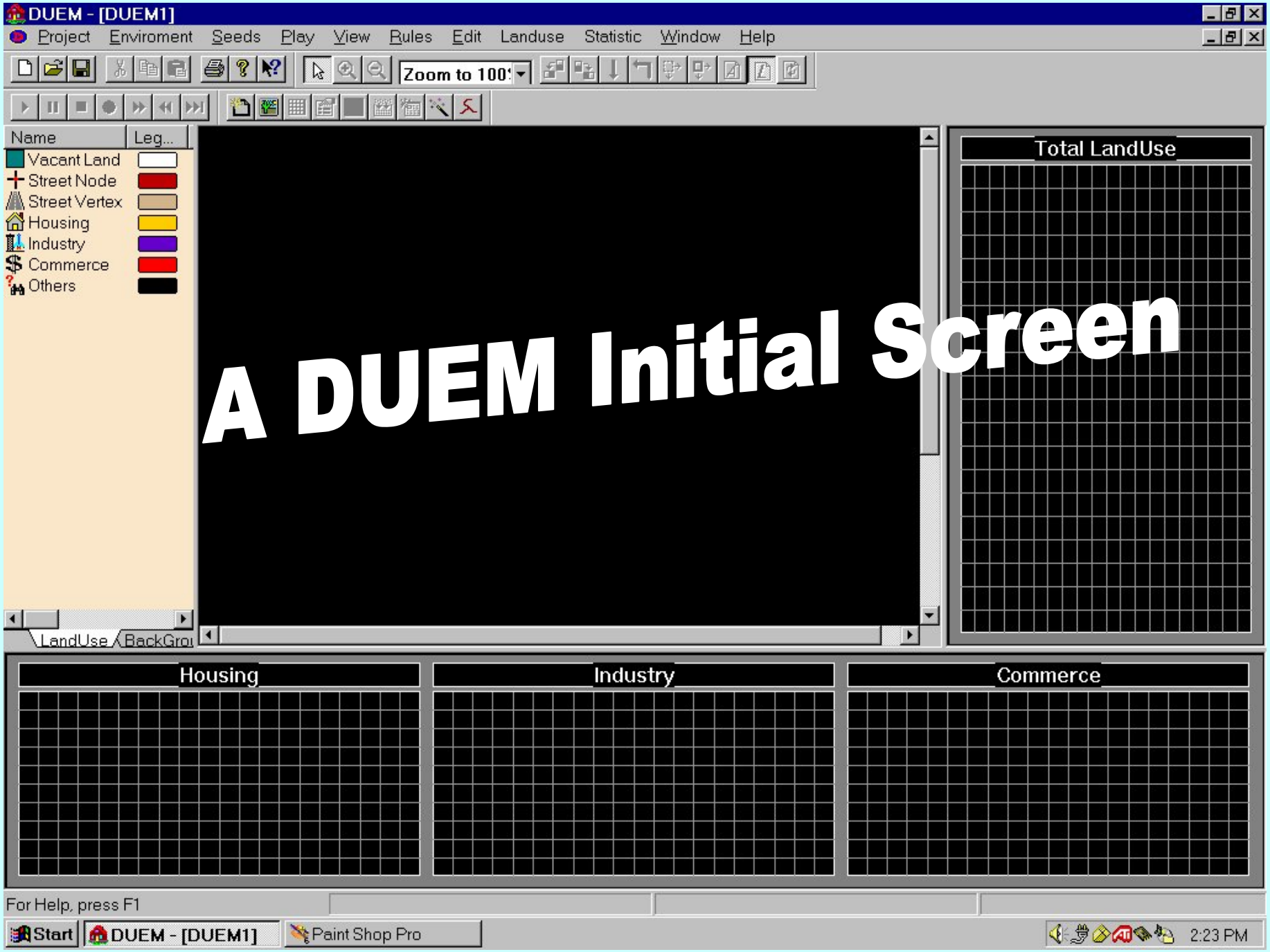
Institute for Geospatial Research and Education

Eastern Michigan University

USGS-GLSC, Ann Arbor, MI

December 12, 2002


DUEM - [DUEM1]
Project Enviroment Seeds Play View Rules Edit Landuse Statistic Window Help
Zoom to 100
Name Leg...
Vacant Land
Street Node
Street Vertex
Housing
Industry
Commerce
Others
LandUse BackGrou
A DUEM Initial Screen
Total LandUse
Housing
Industry
Commerce
For Help, press F1
Start
DUEM - [DUEM1]
Paint Shop Pro
2:23 PM

What are CA?

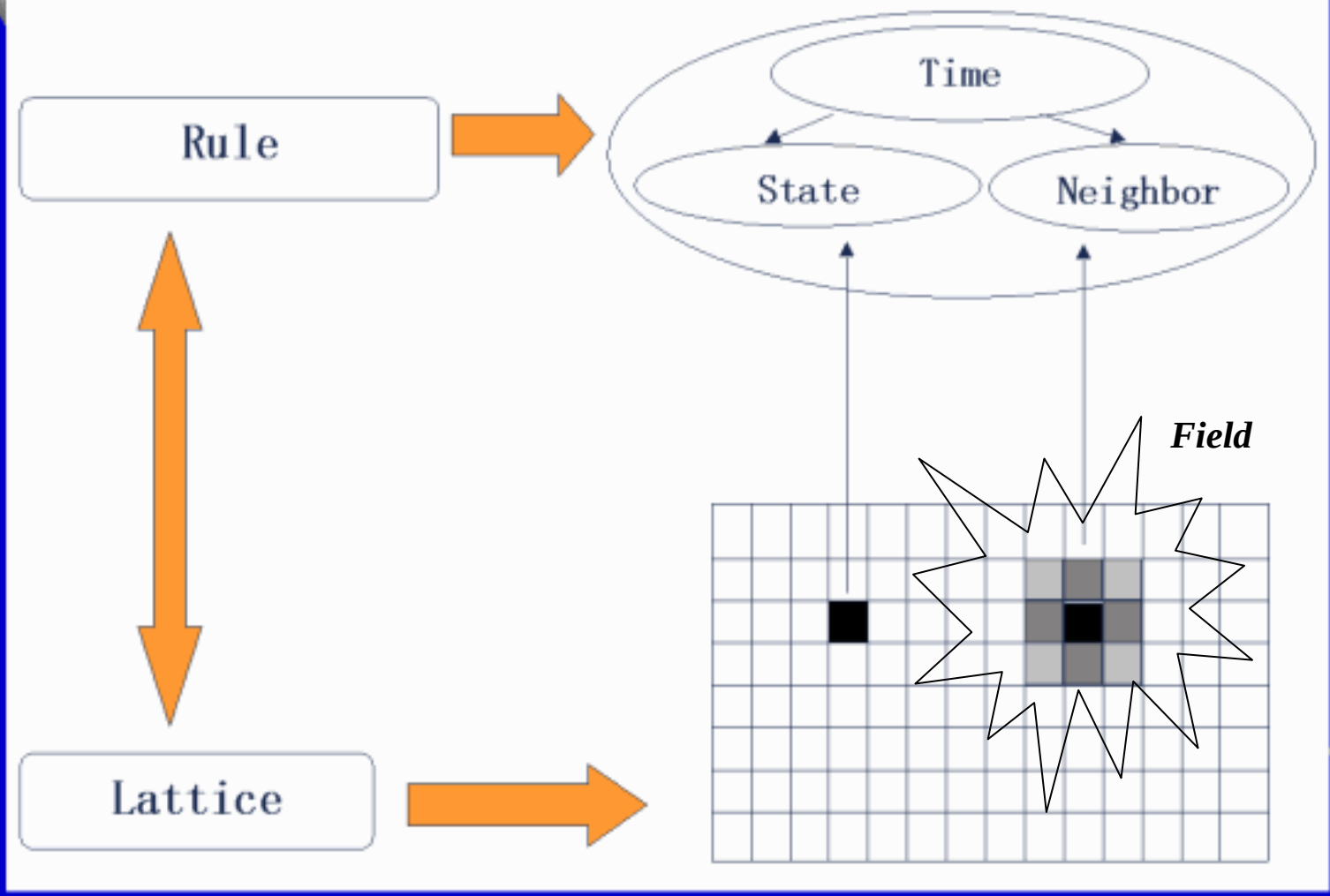
- Cellular automata (CA) were originally conceived by Ulam and von Neumann in the 1940s to provide a formal framework for investigating the behavior of complex, extended systems. CAs are dynamical systems in which space and time are discrete. A cellular automaton consists of a regular grid of cells, each of which can be in one of a finite number of k possible states, updated synchronously in discrete time steps according to a local, identical interaction rule. The state of a cell is determined by the previous states of a surrounding neighborhood of cells

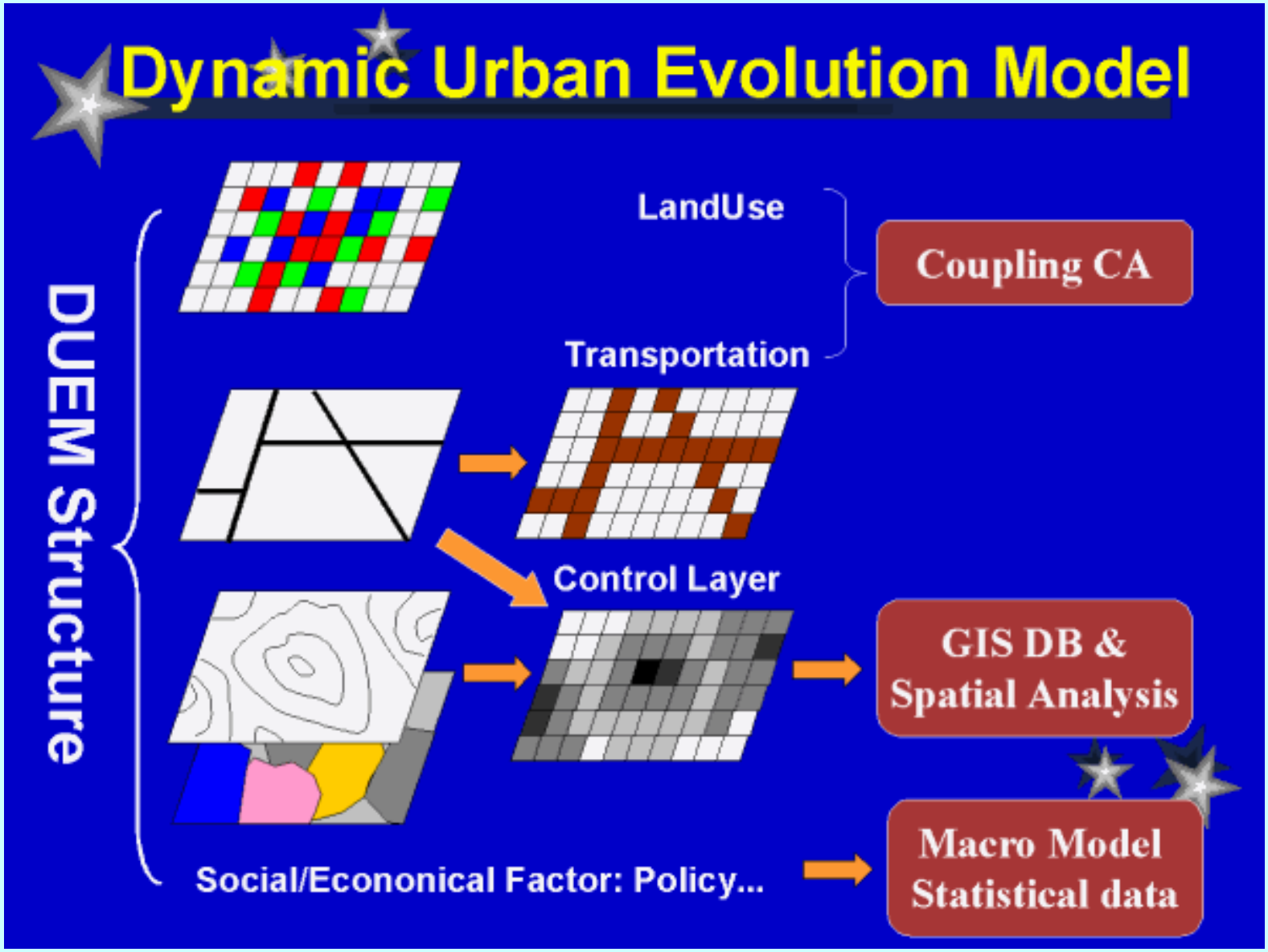
Informal Definition

CA are characterized by the following fundamental properties:

- They consist of a regular discrete lattice of cells.
- The evolution takes place in discrete time steps.
- Each cell is characterized by a state taken from a finite set of states.
- Each cell evolves according to the same rule which depends only on the state of the cell and a finite number of neighboring cells.
- The neighborhood relation is local and uniform.

CA Componets



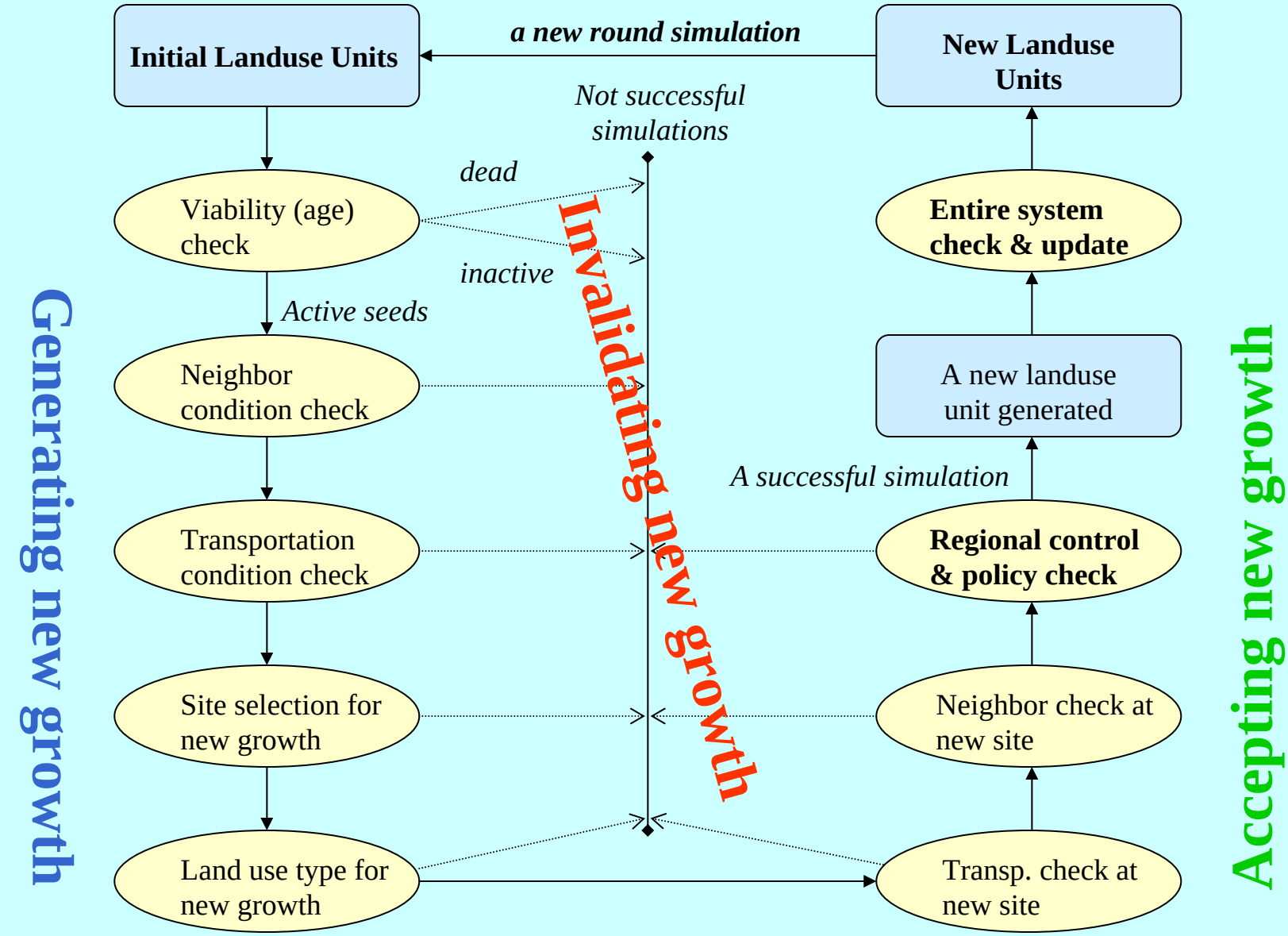

Dynamic Urban Evolution Model
DUEM Structure
LandUse
Coupling CA
Transportation
Control Layer
GIS DB &
Spatial Analysis
Social/Econonical Factor: Policy...
Macro Model
Statistical data

Dynamic Urban Evolution Model

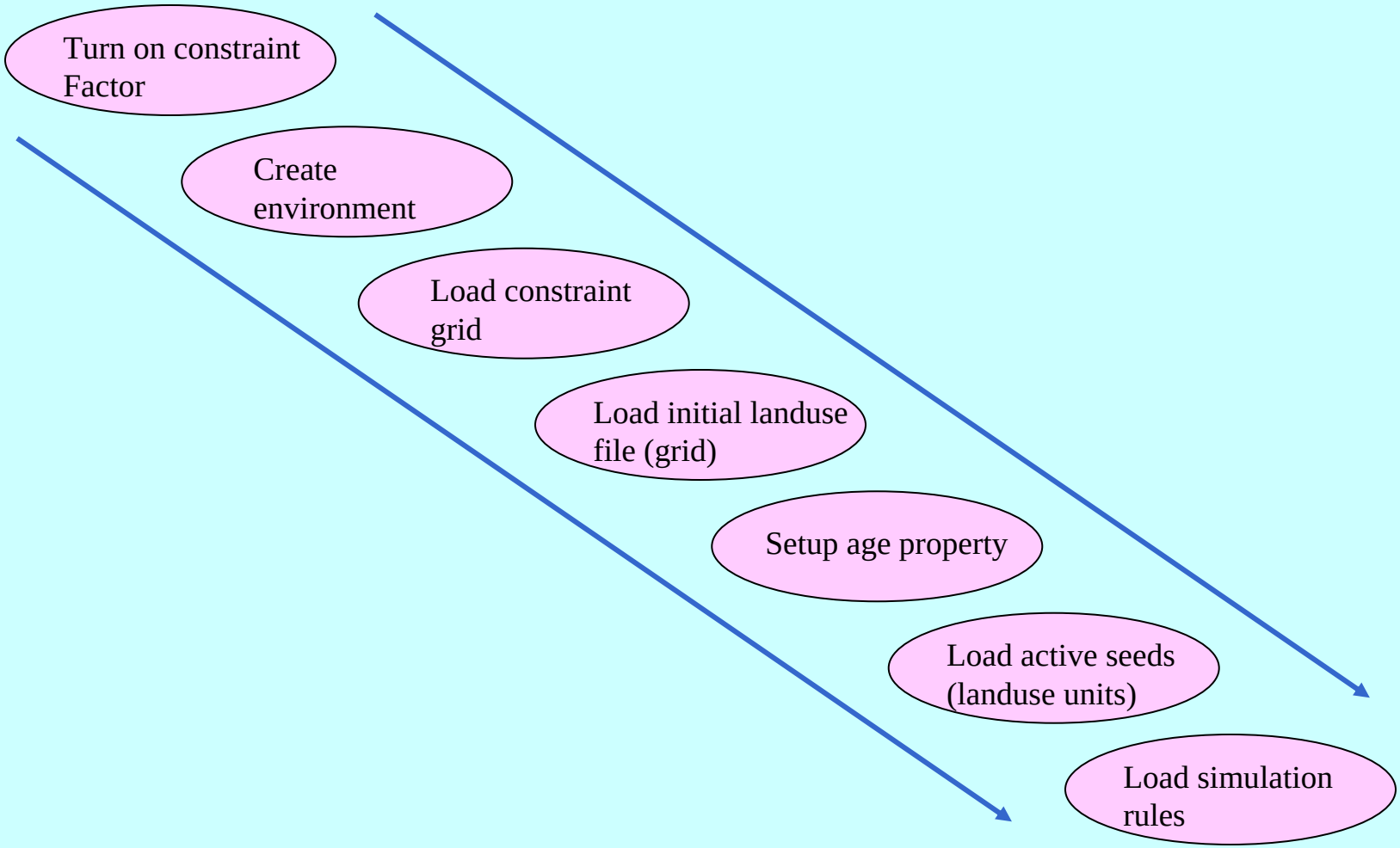
- **Cell States**
  - Housing, Industrial, Commercial, Special Landuse and Vacant
- **Rule**
  - Cell Actions: Duplicate, Mutate, Survive, Die

  - Affect Factors:
    - Age
    - Neighbor Cells: Landuse & Street/Road Cells
    - Constraint Map
    - Policy

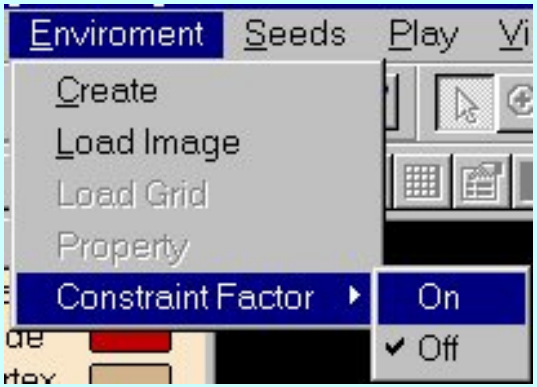
A Flowchart of DUEM Simulation Procedures



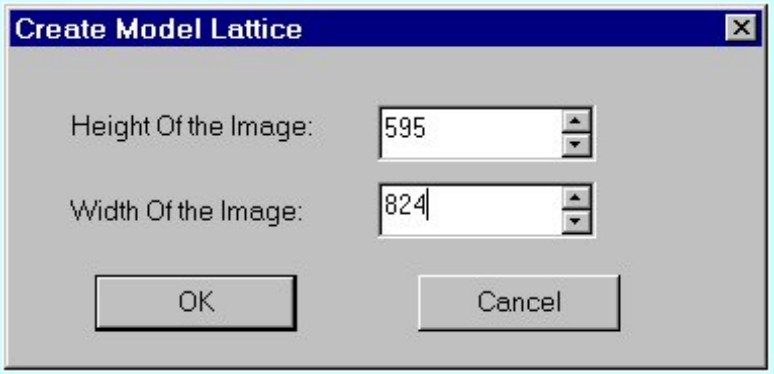
A Flowchart of DUEM Software Running Procedures



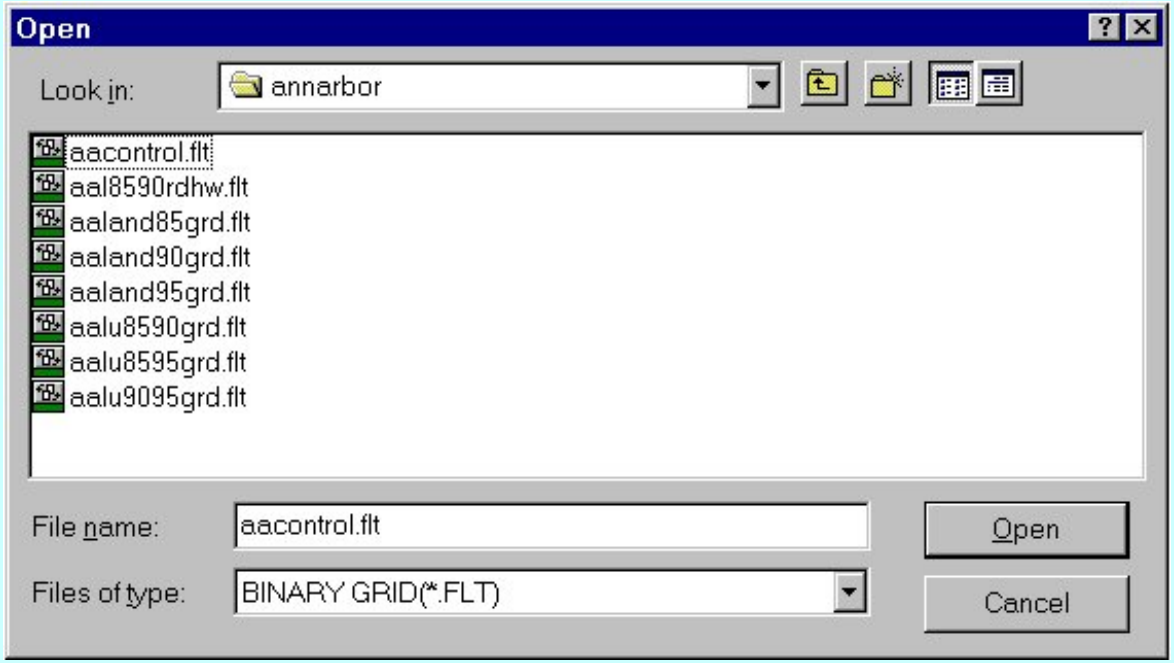
Turn on constraint Factor



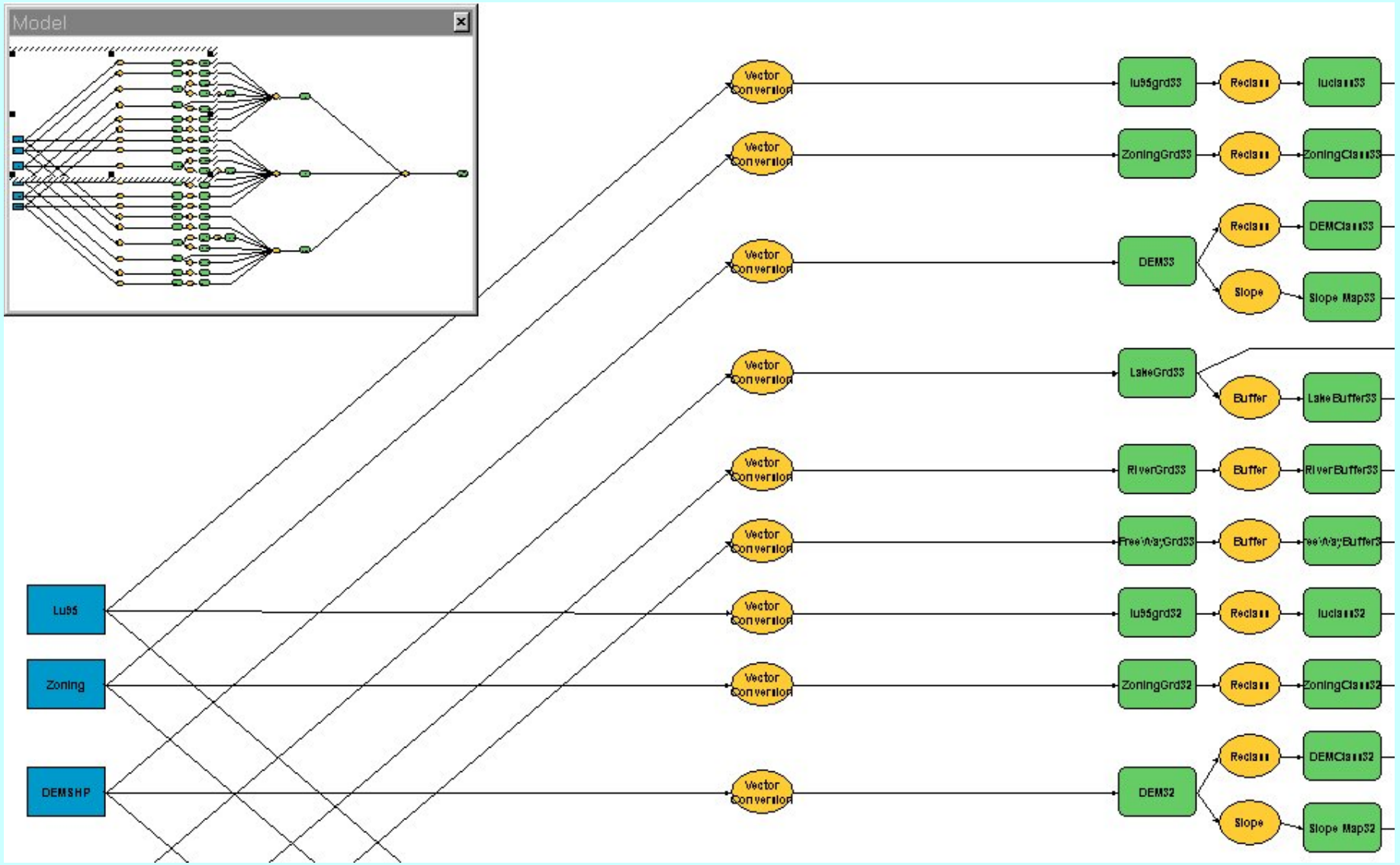
Create environment



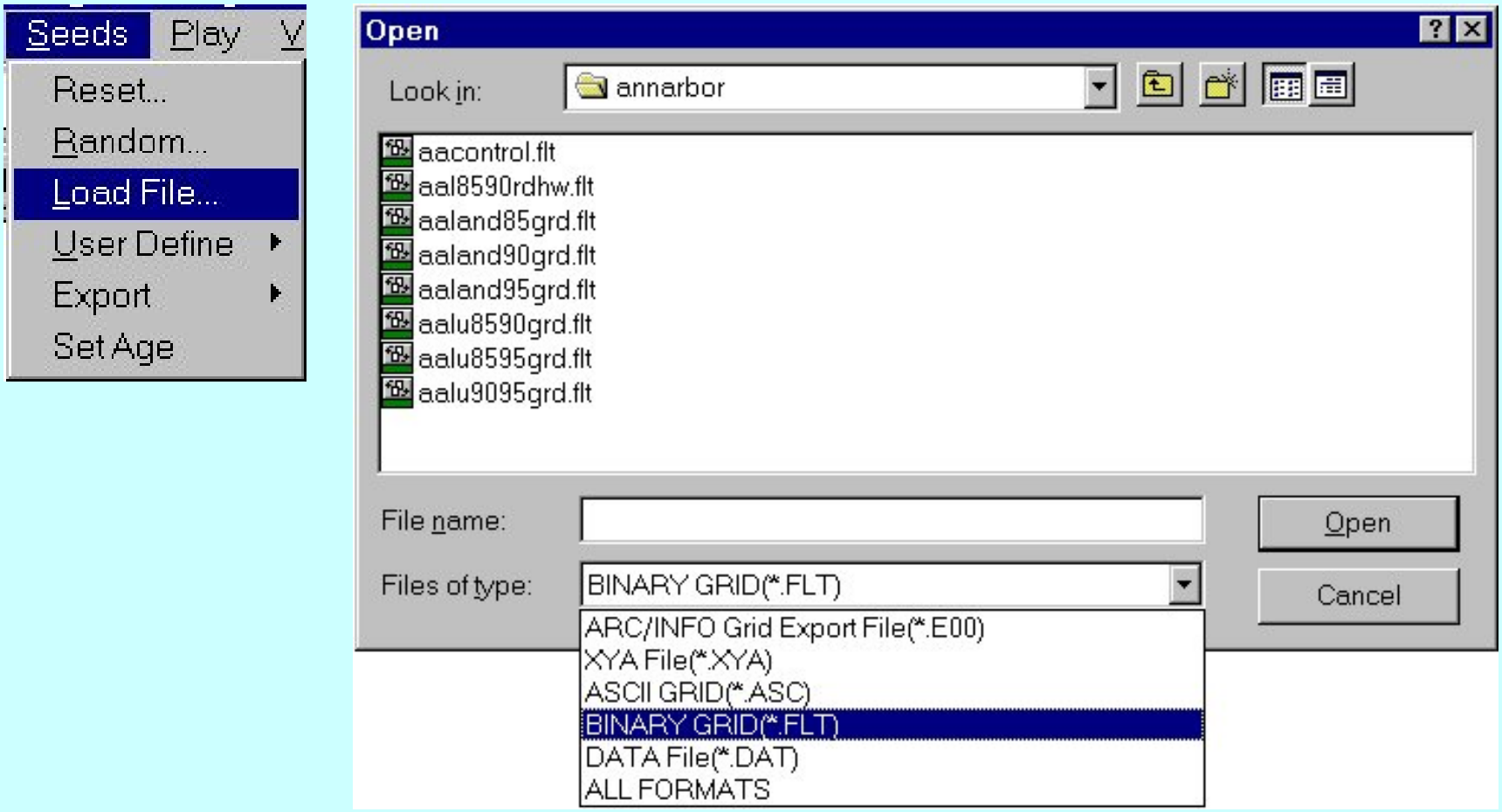
Load constraint grid



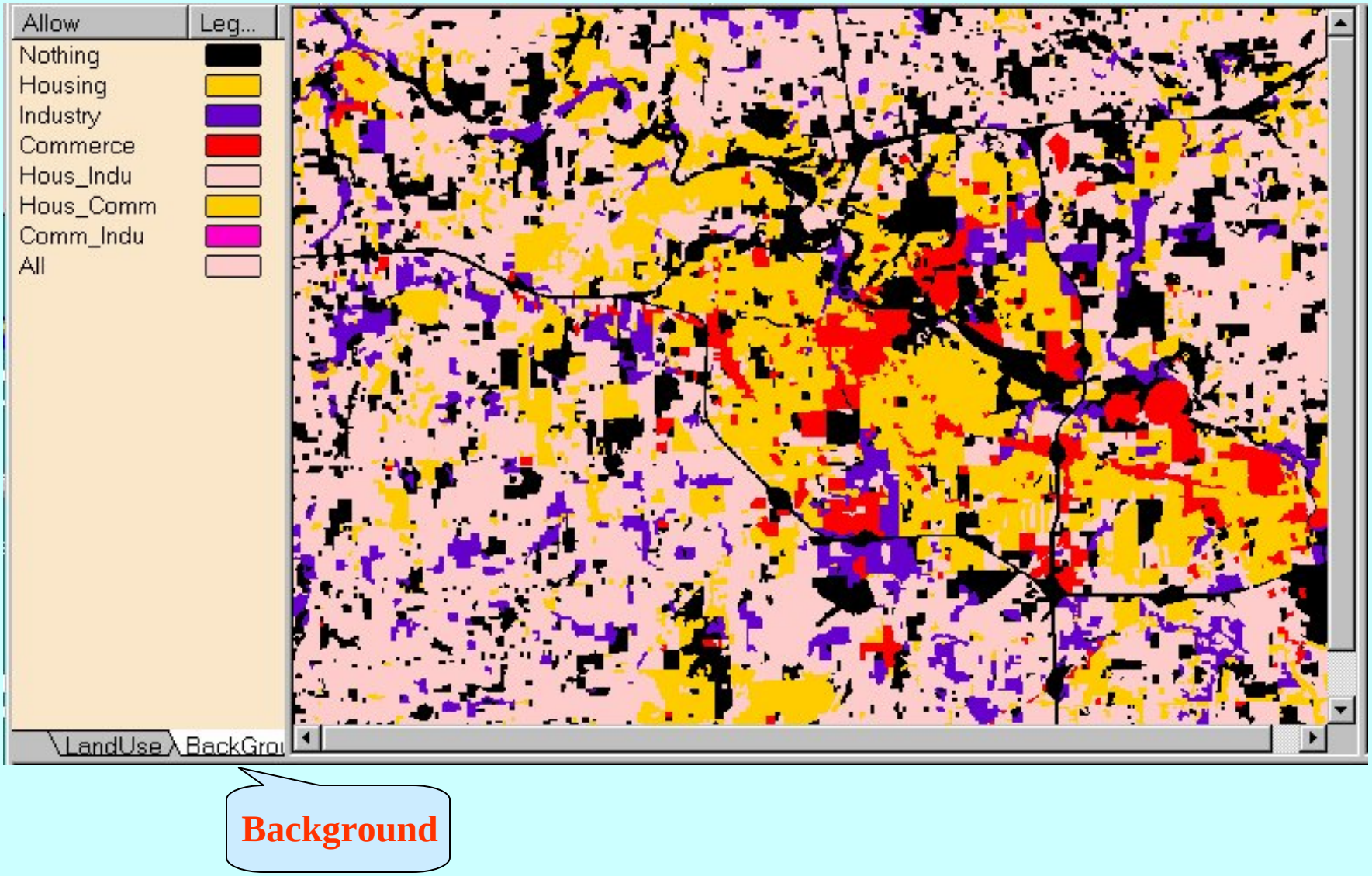
A Flowchart of Creating the Regional Constraint Grid through Spatial Analysis



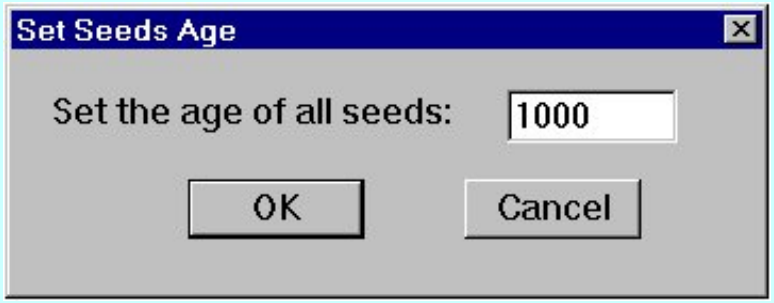
Load initial landuse file (grid)

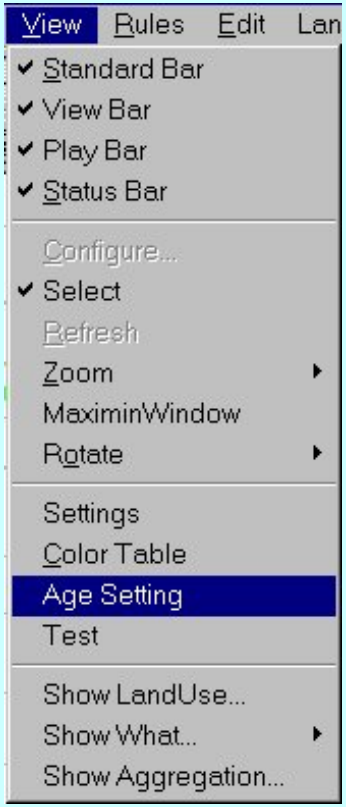


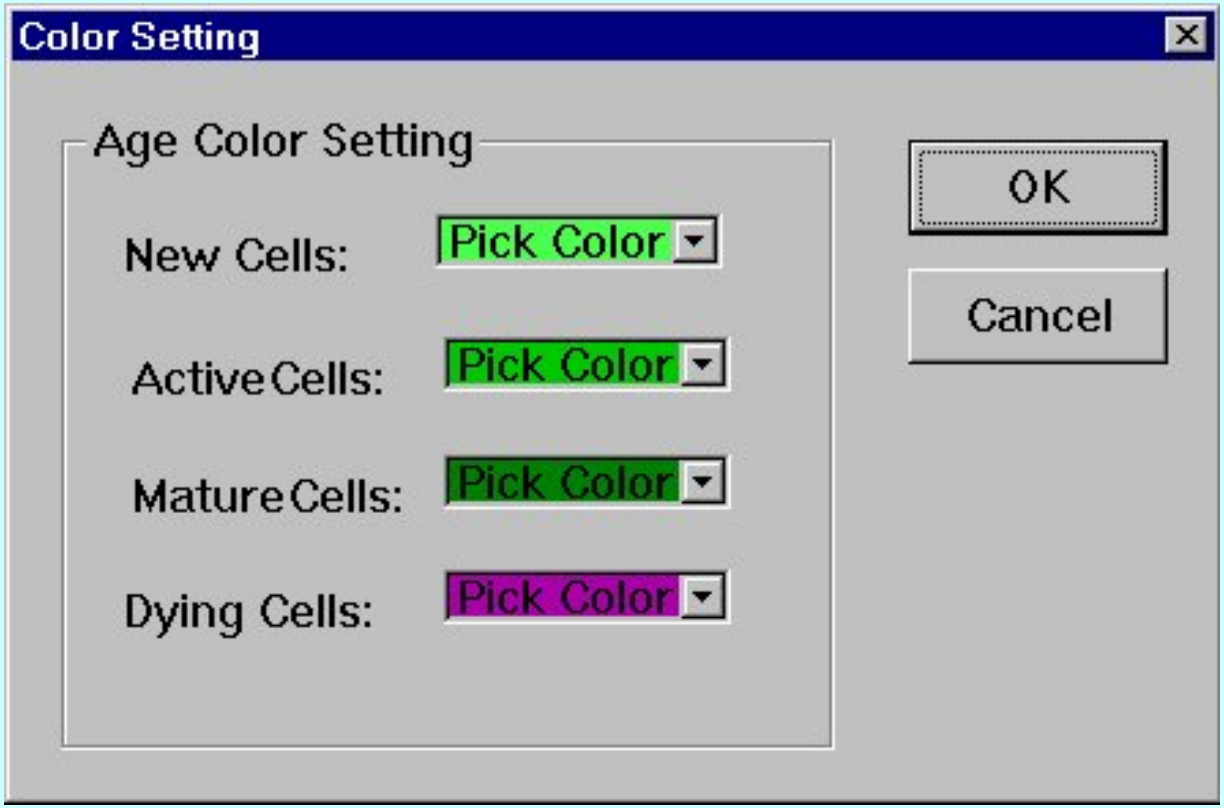
The Initial Landuse File Defines the Background of a Simulation



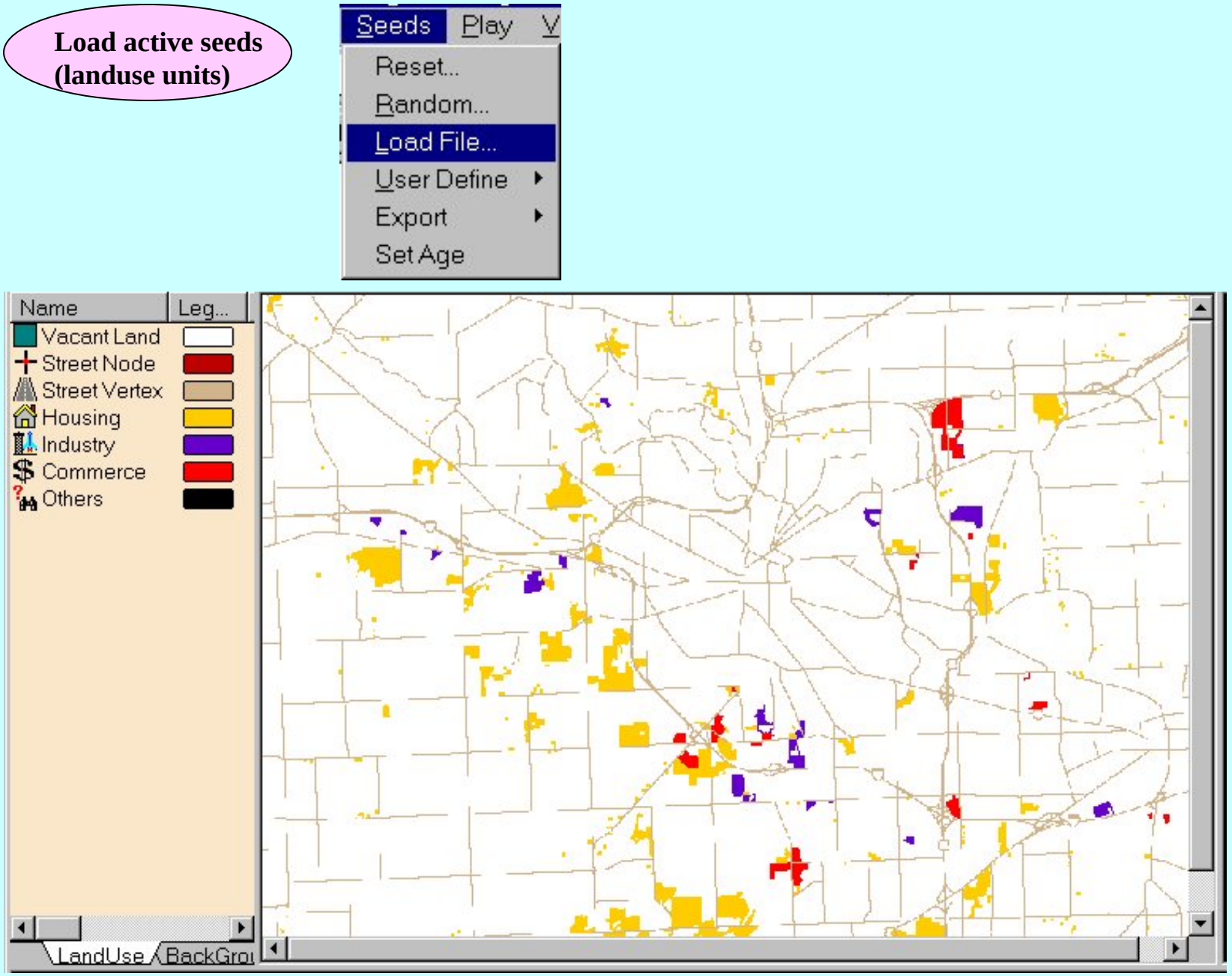
Setup age property



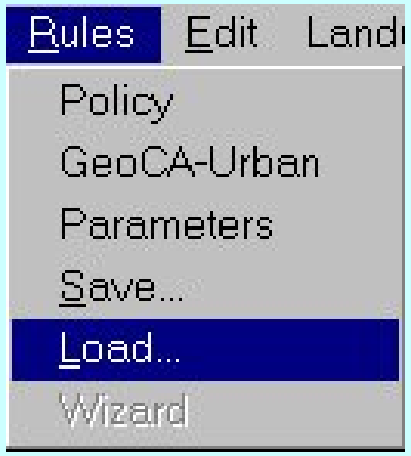




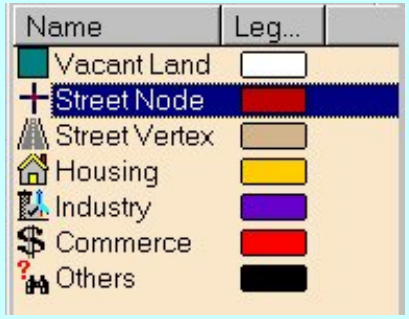
Load active seeds (landuse units)



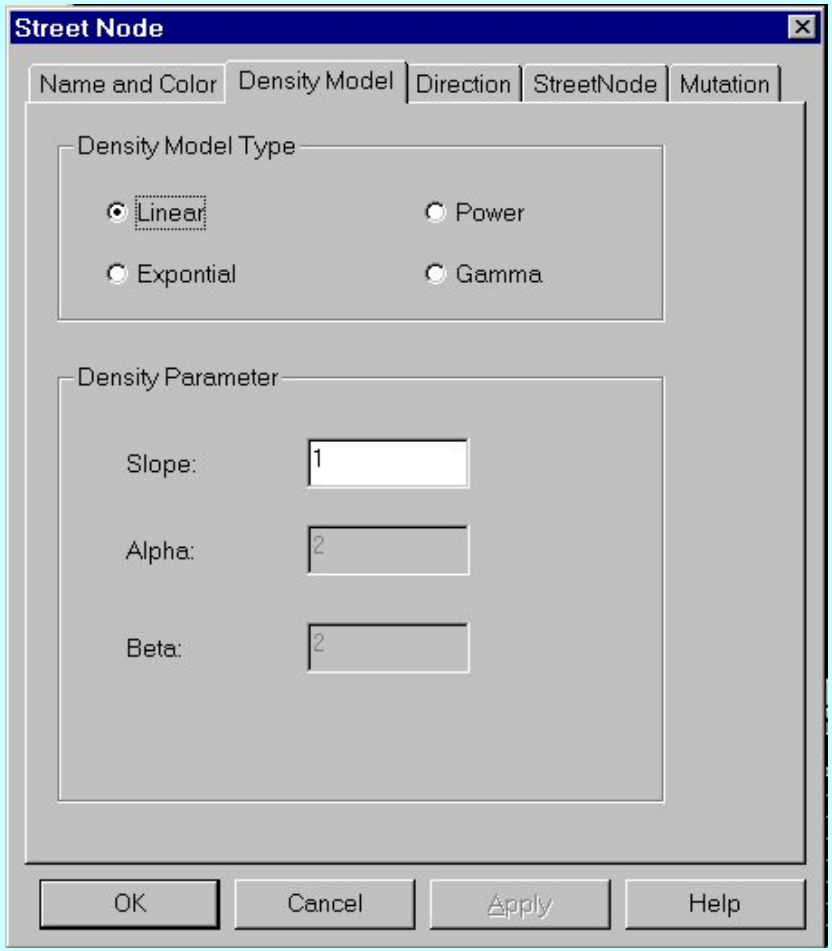
Load simulation rules

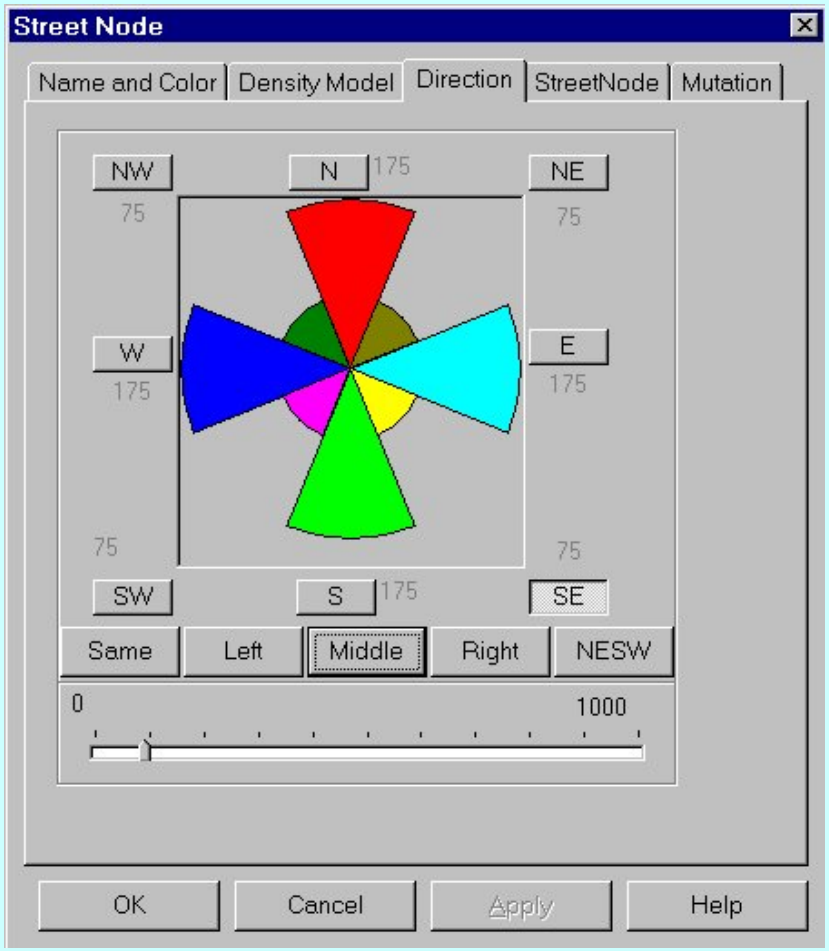


% GeoCA-Urban Rule Parameters:
Blank Vacant Land 255255255
StreetNode Street Node 139000000 0 0 1.00 2.00 2.00 150 100 150 100 150 100 150 100 4 3 2 10 60 70T 4100 50 0
StreetVertex Street Vertex 139000000
House Housing 255173091 8 30 3000 0 1.00 2.00 2.00 125 125 125 125 125 125 125 125 5 2 0 95 0 5 95 0 5
Industry Industry 123123192 25 20 3000 0 1.00 2.00 2.00 125 125 125 125 125 125 125 125 15 15 40 10
Commerce Commerce 255000000 30 10 3000 0 1.00 2.00 2.00 125 125 125 125 125 125 125 125 10 15 0 10
Others Others 000000000

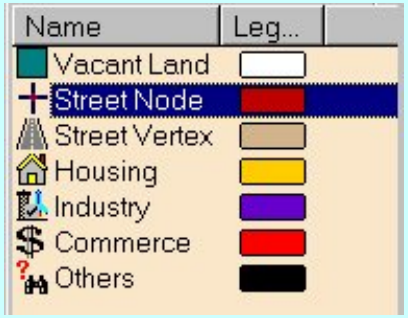


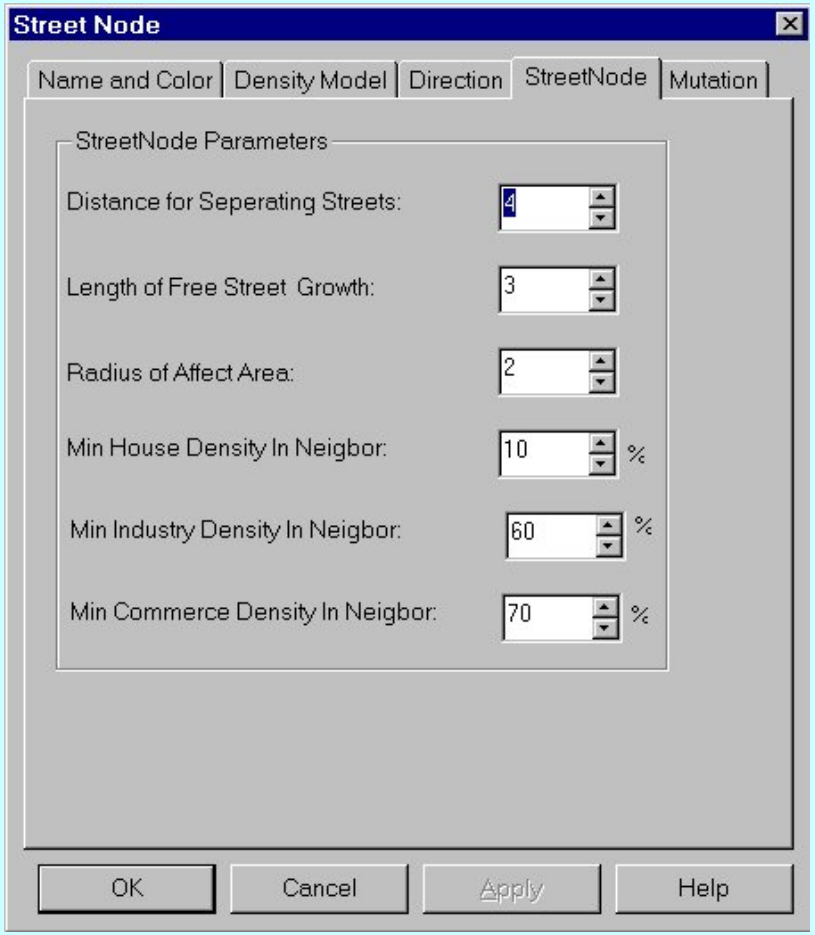
How to Define Simulation Rules Graphically - Street Node As an Example - 1

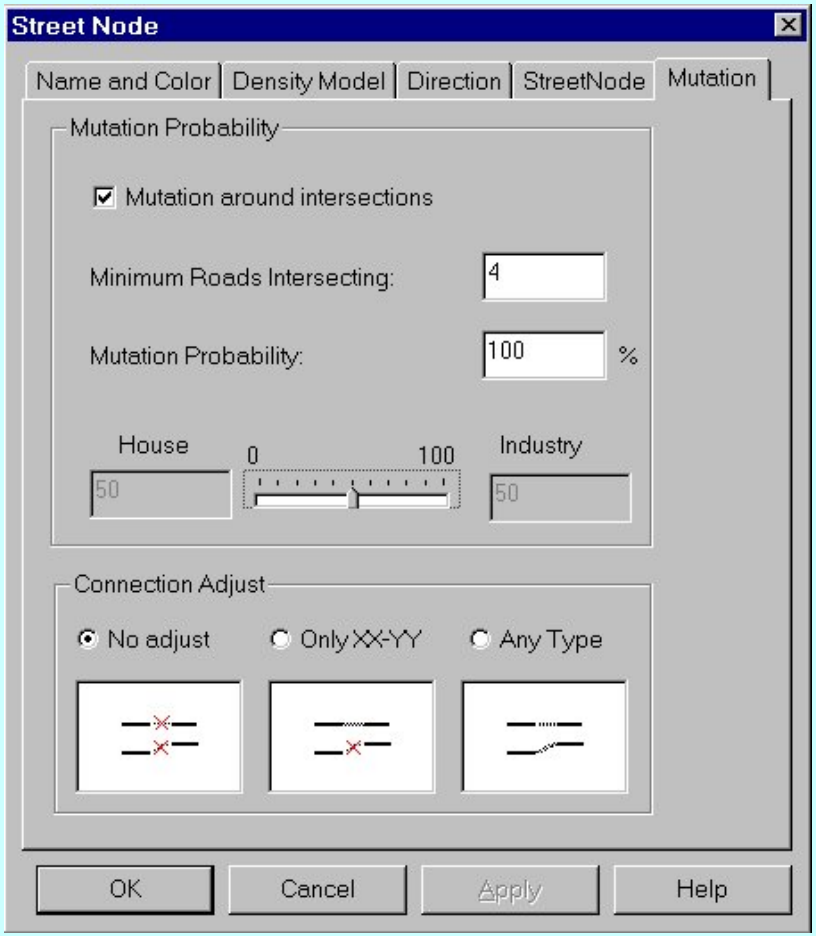


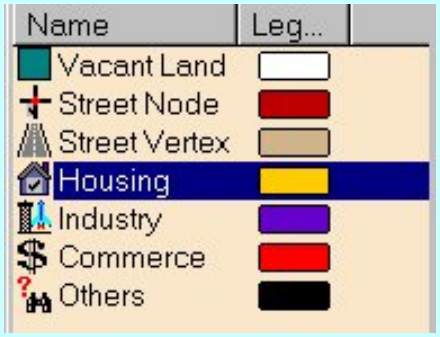


How to Define Simulation Rules Graphically - Street Node As an Example - 2

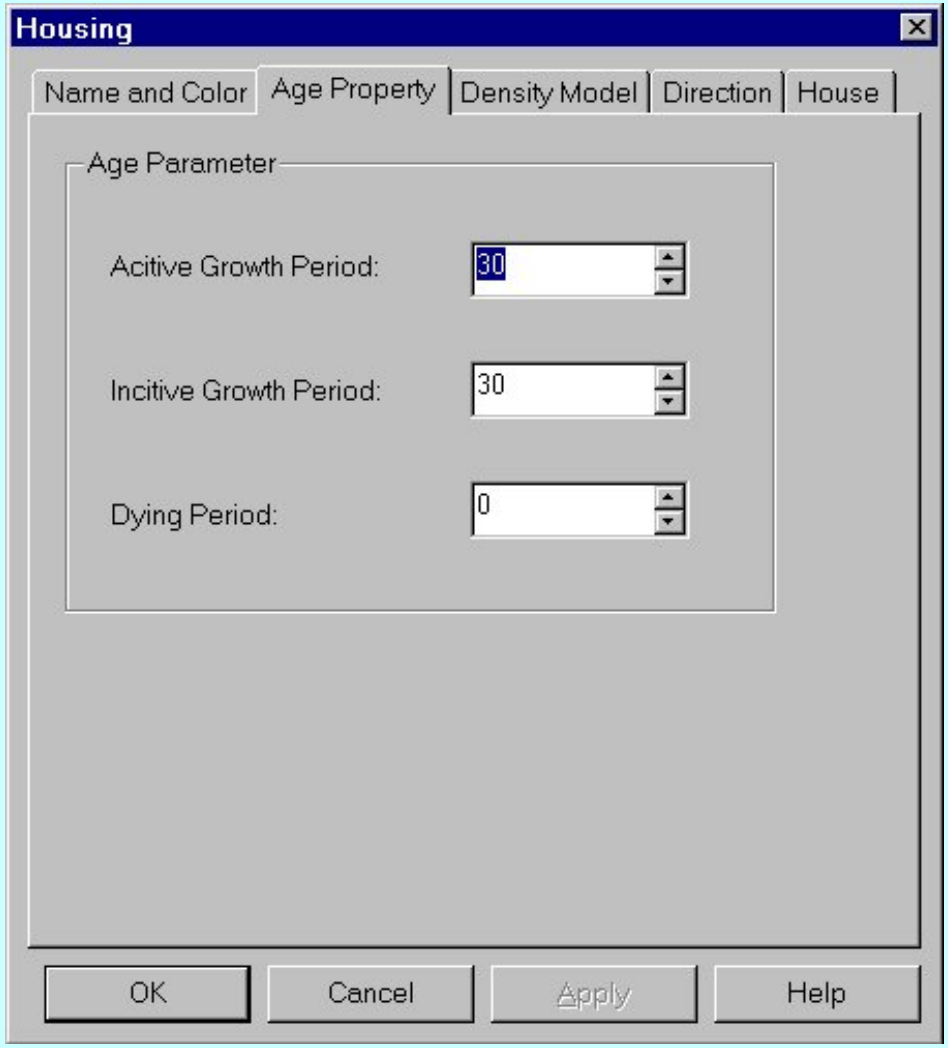


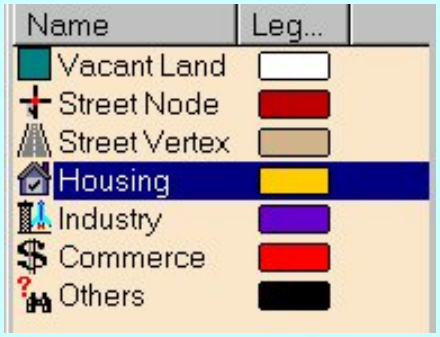




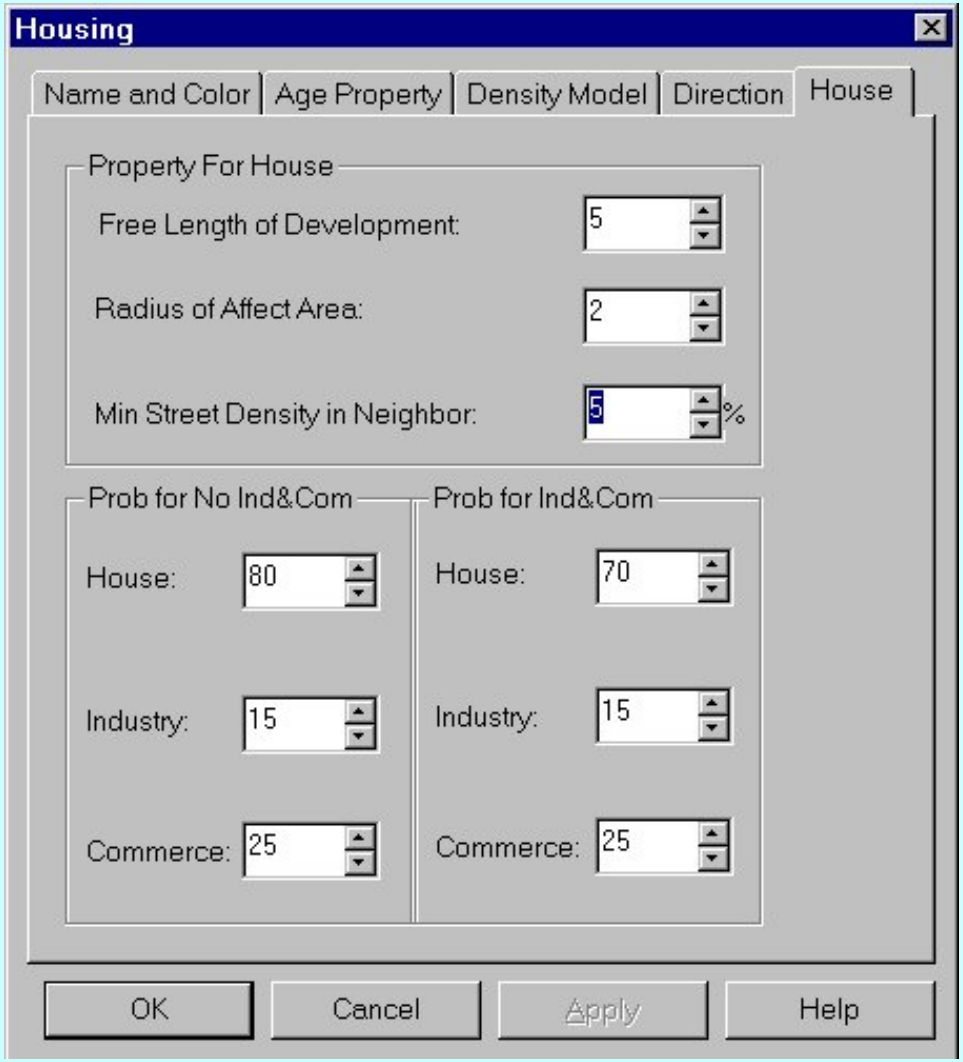


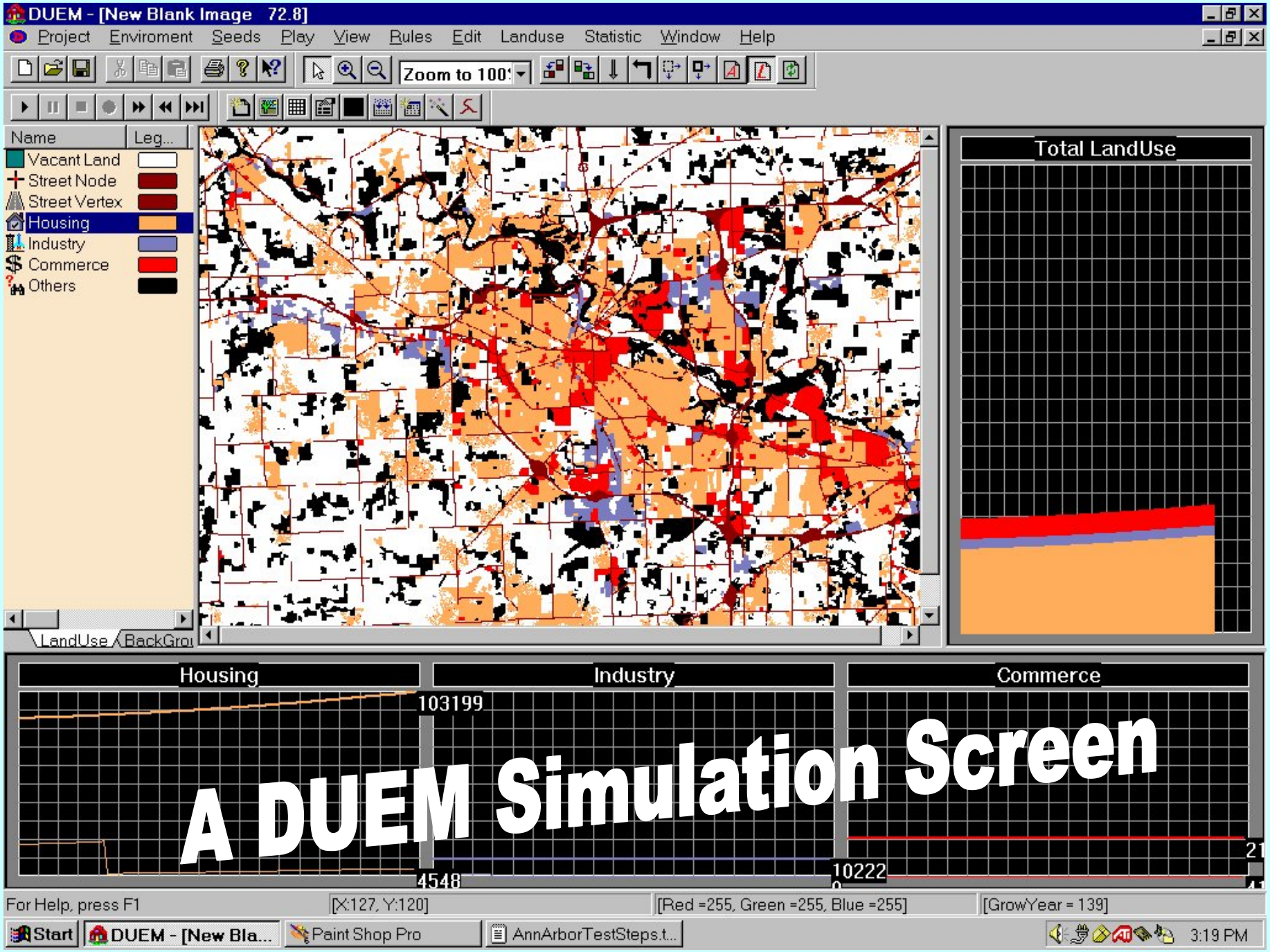
How to Define Simulation Rules Graphically - Housing Landuse As an Example - 1





How to Define Simulation Rules Graphically - Housing Landuse As an Example - 2




DUEM - [New Blank Image 72.8]
Project Enviroment Seeds Play View Rules Edit Landuse Statistic Window Help
Zoom to 100
Name
Leg...
Vacant Land
Street Node
Street Vertex
Housing
Industry
Commerce
Others
LandUse
BackGrou
Total LandUse
Housing
Industry
Commerce
103199
4548
10222
A DUEM Simulation Screen
For Help, press F1
[X:127, Y:120]
[Red =255, Green =255, Blue =255]
[GrowYear = 139]
Start
DUEM - [New Bla...
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AnnArborTestSteps.t...
3:19 PM