OPTIMAL GARDENING WIKI

This is a complete and thorough walkthrough of the gardening system the Group 2 Logic Project will aim to represent. Additionally, there is a complete list of all used constraints and propositions.

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GARDEN WALKTHROUGH

* The garden takes place on a grid of arbitrary size. Each cell within the grid contains a plant that, at any given time, will be either alive or dead. All cells within the grid must contain a plant of some type. No cells may be empty.
* The garden will change over time depending on its configuration of plant types. The garden will contain one unique grid for each time interval out of a certain number of time intervals. The ‘initial configuration’ of a garden will be a configuration *t0* in which all plants are alive. All proceeding time intervals (*t1, t2, t3, … tn*) will recursively relate to the initial configuration.
* Each plant in each cell (in each interval) will be alive or dead depending on what its surroundings were in the previous interval (except, of course, the initial interval, in which all are alive).
* An “optimal garden” is a garden for which all intervals contain only living plants. That is, no plants die at any given point in time.

ADDED EFFECTS

* You may choose to build a fence around any *single* cell in the initial configuration. This fence will remain standing for all future time intervals. The fence prevents any outside plants from affecting the fenced plant, and also prevents the fenced plant from affecting any outside plants.
* Each time interval, you may choose to water any *single* cell within the grid. This will force the plant in that cell to be alive (for that time interval) regardless of any factors.

PLANT RELATIONSHIPS

* There are five plant types: Pine trees, Tomatoes, Beans, Corn, and Peppers.
* There are two negative relationships and two positive relationships:
  + Tomatoes and Corn will hurt each other if adjacent.
  + Beans and Peppers will hurt each other if adjacent.
  + Corn and Beans will help each other if adjacent.
  + Tomatoes and Peppers will help each other if adjacent.
  + Pine trees kill all adjacent plants except for themselves.
* If a plant is both helped and hurt, it will remain alive. If it is only hurt, it will die. That is, all plants obtain the most positive possible state at each time interval.

GARDEN FEATURES TO EXPLORE

* The following features or calculations may be explored as part of a logical exploration of the optimal garden system detailed above:
  + How many optimal gardens are there given a certain configuration of pine trees?
  + How resilient is a garden? (That is, what is the least number of waterings/fencings that must be done in order for the garden to be optimal?)
  + What is the likelihood of a certain plant cell being alive? (That is, the percentage of all time intervals in which a certain plant cell is alive)
  + Given that a garden is optimal, what must the plant at cell (x,y) be?

LOGICAL REPRESENTATION OF A GARDEN

| PROPOSITIONS | |
| --- | --- |
| PT(x, y) | Whether the cell at (x,y) has a pine tree |
| C(x,y)  B(x,y)  T(x,y)  P(x,y) | Whether the cell at (x,y) has a plant of the given type:  C - Corn, B - Beans, T - Tomatoes, P - Peppers |
| h(x,y,t) | If the plant at (x,y) is being helped by adjacents at time interval t |
| k(x,y,t) | If the plant at (x,y) is being killed by adjacents at time interval t |
| a(x,y,t) | If the plant at (x,y) is alive at time interval t |
| w(x,y,t) | If the cell at (x,y) is being watered at time interval t |
| f(x,y) | If the cell at (x,y) is fenced off |

| GENERAL CONSTRAINTS | |
| --- | --- |
| For any cell:  xor(PT, C, B, T, P) | A cell must have one, and only one, plant at any given time. |
| For any cell at (x,y):  C(x,y,t) ∧ C(x±1,y,t) **→** k(x,y,t)  C(x,y,t) ∧ C(x,y±1,t) **→** k(x,y,t)  … same for (T,P,B) | Non-tree plants are killed if they are horizontally or vertically adjacent to another of the same kind. |
| C(x,y,t) ∧ B(x±1,y,t) **→** h(x,y,t)  … | Non-tree plants are helped if they are horizontally or vertically adjacent to a helpful plant (i.e. Corn helps Beans). |
| C(x,y,t) ∧ T(x±1,y,t) **→** k(x,y,t)  … | Non-tree plants are killed if they are horizontally or vertically adjacent to a deadly plant (i.e. Corn kills Tomatoes). |
| h(x,y,t) ∨ ¬k(x,y,t) **→** a(x,y,t) | A plant will remain alive if it is helped OR nothing is killing it. |
| For any time interval *t*:  xor(w(0,0,t), w(0,1,t), … w(x,y,t))  ∨ ¬(w(0,0,t), w(0,1,t), … w(x,y,t)) | At any given time interval, there must be at most 1 cell being watered. |
| For at most 1 cell (x,y):  f(x,y,t) true for all intervals *t* | There must be at most one “fenced off” plant cell, and this cell will remain fenced off across all time intervals. |

LOGICAL REPRESENTATION OF A GARDEN (cont.)

| GENERAL CONSTRAINTS | |
| --- | --- |
| For all cells (x,y) at all times *t*:  a(x,y,t) | The model is intended to describe a board in which all cells contain a plant that is alive. |

ADDITIONAL LINKS

GitHub repo: <https://github.com/sirivanbiscuit/optimal-gardening>