Spaces, Places and Species

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Supervisor: Prof. Yaneer Bar-Yam

Submitted by:
Terry Harrison
Aravind Elango
Soma Vemulapalli
Bill Baykan

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Abstract

We are working on the long term preservation of electronic records (files of any type) on networks. Our aim is make these records aware of their environment and to give them rules for maximum survivability. We are modeling a network environment as places (servers), spaces (location for a record on a server), and species (record) . We seek to determine the optimum number of species for a given number of spaces and places existing under harsh conditions. This optimum will be the carrying capacity of the system. We hope to be able to use these results to predict such factors as the interplay between species redundancy and biodiversity. In the real world, this will help us configure more optimized facilities for document preservation.

System

The system to be modeled is a network consisting of a number of records, servers and places for records (assuming they are all of a standard size), on each server.

In our model, we may think of the records as single-cell asexually reproducing organisms. This is analogous to our real world ability to replicate a electronic document. Our servers shall be thought of as islands and our places may be thought of as the maximum capacity per island. Due to time constraints, all islands shall be created having the same number of places on each (This may be thought of as servers with identical storage capacity). In this land, all species are fully aware of the distribution of all species and may move at will from island to island (no barriers).

Goal (in terms of model)

We are seeking to find the optimum number of species that we may add to a given system to maximize the chances for the survivability of all species given a number of available spaces and places. So long as there is one member of a species, it is alive. If there are none, it has gone extinct, which would translate that the records have been permanently destroyed on the system.

Rules

I. Initialization Phase

Parameters setting
1.Local comfort: How many copies of itself a species seeks to have on each island.
2.Global comfort: How many islands the species feels compelled to be on.
3.Number of islands
4.Number of places on each island (All shall be set to the same number)
5.Number of species desired to test system with

II. Population Phase

At this point, species shall be added, one species at time, into the system. Each shall obey the predefined set of rules, which will determine where they will go, and how they replicate themselves in order to "balance" the system for the maximum survival of the species present.

All species obey the following rules:

(note: new species= no copy of itself is yet on island in question)

On each island:
1.A new species may replicate itself on the island if empty places are available.
2.Each species introduced will seek to achieve the predetermined local and global comfort level for itself.
3.A new species may replace a duplicate(multiple) copy of another species on island.
4. A new species may replace a solo species if the solo species is above its global comfort level and new species is not at its global comfort level.

III. Disturbance Phase

At this point the system has been populated and we begin to introduce disruptions into the system (robustness testing). Here a random island will disappear (taking away all inhabitants) and new islands will form. This act would be analogous to a server going down and a new one coming online. The system will be given the opportunity to balance and shall be evaluated to determine if any species have gone extinct. Due to time constraints, this testing will only go through 100 iterations. The system configuration (number of places, spaces and species) shall be said to "pass" if it no species have gone extinct.

Procedure:
1.Delete a randomly chosen island.

2. Let global population attempt to balance.
3. Create new island.
4. Repeat.

IV.Extinction Phase
Each "turn" of the simulation is measured on a Pass / Fail metric. If any species goes extinct, the system has failed. This result would lead to a re-evaluation of the comfort thresholds that were set and to a re-running of the system.

Simulation stops if a species goes extinct.

Variance Testing

We decided to first run a basic set of tests to see how the carrying capacity would change under a variety of physical conditions.

Test 1:
Number of places fixed at 5;
Local Comfort set to 2
Global Comfort set to 30%
Determine how carrying capacity changes as number of islands in increased.

Test 2: (varying number of places)
Number of places fixed at 10;
Local Comfort set to 2
Global comfort set to 30%
Determine how carrying capacity changes as number of island is increased.

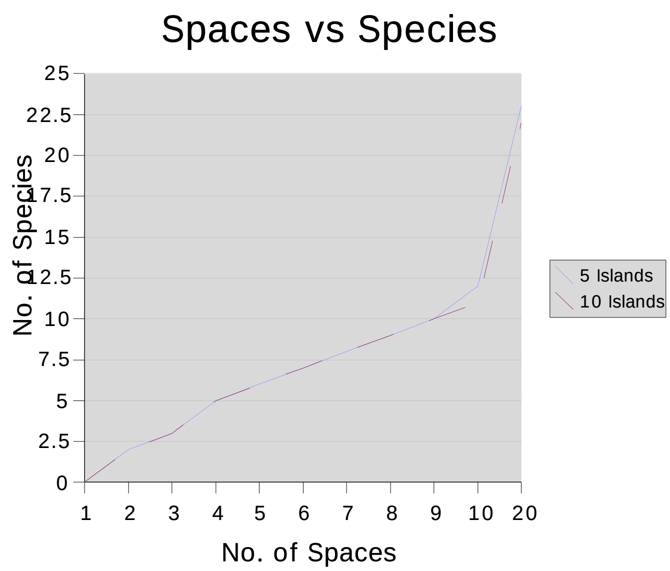
Test 3: (varying Global Comfort)
Examine the effects of changing the comfort levels (globally) for the species. One might think of this as adjusting a "paranoia knob".

Number of places fixed at 5
Local Comfort set to 2
Global Comfort set to 10%,30%,50%
Determine how carrying capacity changes as number of islands is increased

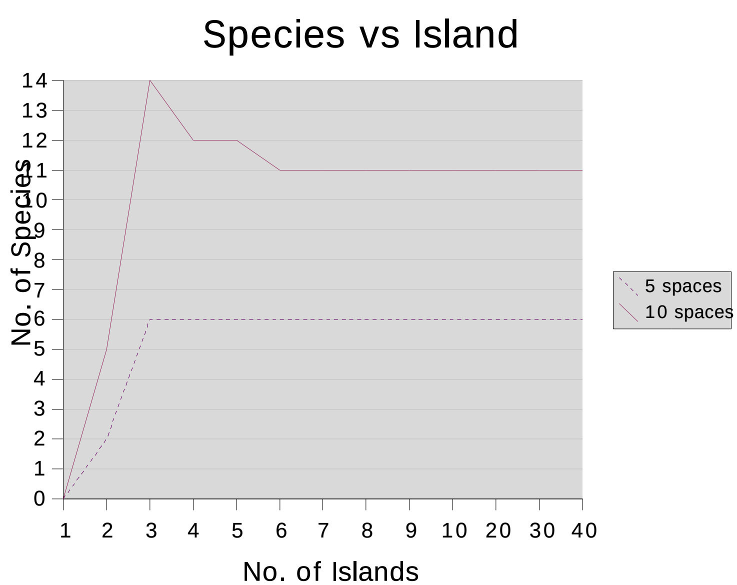
Results

The system was tested with a variety of test cases for species, spaces and islands. The stability of the system is reasonably high when the number of spaces, species and places is the same.

The following graph plots the maximum number of species which can be effectively sustained when the number of spaces is varied between one and twenty. The number of islands is kept constant. The Global Comfort Level is maintained at >30%.



The following graph plots the maximum number of species which can be effectively sustained when the number of spaces is varied between one and forty. The number of spaces is kept constant. The Global Comfort Level is maintained at >30%.



Observation

The maximum number of species which can be sustained by 3 islands is greater than a larger number of islands because the global comfort level is maintained at >30%. Changing the Global Comfort Level would alter the Number of Islands which provide maximum survivability and diversity.

Conclusion

1. With a constant number of islands, the number of species which can be maintained increases linearly with the number of spaces. The differences in carrying capacity varies negligibly between five or ten spaces

2. With a fixed number of spaces, the carrying capacity increases up to a certain number of islands (depending upon the algorithm and the global comfort level) and then saturates. This observation needs to be analyzed further.

Future Possibilities

Though the modeling environment built could test the variance of several parameters, time for testing limited us to the testing described above. An interesting real world application of this is in how a system could be tuned to the perceived level vulnerability adjusted in times of threat.

This also opens up wide wide range of possibilities that could be introduced for further optimization on both a system and record level. One variation of this might be the introduction of individual paranoia knobs, which could be set according to the importance of a record (for example, no need for multiple redundancies of minimally important records). Another possibility would be a self adjusting paranoia knob that adjusts itself according to the amount of perceived danger present in the system.