Instruction Manual

Network Effect Model Study Tool

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Step1: Install Anaconda

This program is written in Python. A popular IDE for Python is Spyder. It can be installed from Anaconda Distribution, which can be downloaded here: https://www.anaconda.com/download/

Step2: Specify distribution, function and parameter inputs

There are 2 main files of the program, with 4 modules. Inputs should be specified in the 4 module files.

utility.py:

No need to change anything here. The utility function is specified here. However, in this version, this utility function is not explicitly used in the main files. Nonetheless, all the analyses were based on and derived from this function. If wanted, the utility function can be used to calculate the agents' utility in Part 2-1 of the main file.

distribution.py:

A cumulative density function and its inverse function (very important!) of the distribution of the type of agents is specified here. Default CDF:

$$G(x) = \frac{\gamma+\beta}{1+\beta}\frac{(1+\beta)e^{-\alpha'/x}}{\gamma+\beta e^{-\alpha'/x}} \qquad G^{-1}(U) = \frac{-\alpha'}{log(\frac{\gamma U}{\gamma+\beta-\beta U})}$$

Other distributions can also be used. When changing into other distributions, both CDF and the inverse function of the CDF have to be specified explicitly in this file. An alternative of normal distribution is provided in the code.

typeFunction.py:

A network effect function (defined as an increasing function in the model) is specified here. Default function:

$$h(S) = S$$

Any other increasing function of S on the interval [0,1] may be used as the network effect function here. To use other functions, simply modify the function $h(S)$.

There is no need to change type_function.

parameters.py:

2 constant parameters are specified here:

c: cost of taking action $s = 1$ (default: 0.5)
λ: weight of the network effect from the previous period (default: 0.0)

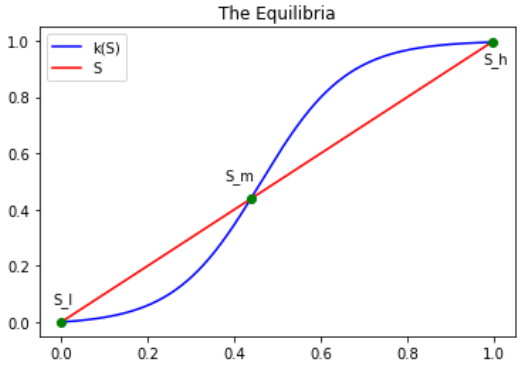
Step3: Run the main file and get the equilibria

The program will compute the equilibria under your specified inputs and tell you whether the equilibria are stable according to a rule of thumb (See picture in the next step). You can verify them in the following steps.

Step4: Choose the tool

After the program has calculated the equilibria for you, you will be asked to choose a tool to use. Please follow the input instructions.

```
The Equilibria under the functions (utility, distribution, type) you defined is:
S_low: 0.0, and it is STABLE
S_medium: 0.43774309224116237, and it is UNSTABLE
S_high: 0.9952125446663229, and it is STABLE
```




```
Please select which tool you want to use (For finite agents simulation, please enter "agent"; For analytical form analysis,
please enter "ana"; If you want to do both, enter "both"):
```

Step5: Finite Agent Simulation

If you have entered “agent” or “both” in the previous step, you will be brought to the Finite Agent Simulation interface.

1) First, the program will ask for the number of agents you want to have:

```
-----------------------------------
      Finite Agents Simulation
-----------------------------------

Please enter the number of agents in this simulation (suggested: 100000):
```

   You can enter any integer you want. The larger the number of agents is, the more accurate the result may be, but also the slower the program will be. A suggested number is 100,000. It will give a relatively good accuracy while still ensuring the speed of the program.

2) Then, the program will ask for an initial state you want to test:

```
Please enter an initial state of the fraction that applies strategy s=1 (if you want to test the equilibria solved above, enter
"S_l", "S_m", or "S_h"):
```

   You may enter any number between 0 and 1. If you want to test any of the equilibria computed earlier, just follow the input instructions.

3) Next, the program will ask for a small perturbation ε to the initial state:

```
Please enter a small perturbation from the current state (can be either positive of negative):
```

You may also enter any number you want. However, for Finite Agent Simulation, it is suggested that the absolute value of the input to be greater or equal to 0.01. Otherwise, you may obtain incorrect results.

4) The program will then confirm everything you entered, and ask for a maximum iteration where the program will stop if it still has not reached to the equilibrium. The suggested number is 100, but it usually will not use up the maximum iterations:

```
The number of agents you entered is: 100000
The initial state you entered is: 0.437743092241162
The perturbation you entered is: 0.01

Now enter the maximum iterations that you wish the program to perform to get started (suggested: 100):
```

5) The program will start running and report the results when the equilibrium is reached:

```
Number of agents choosing s=1 at time 1 is: 0.44796
Number of agents choosing s=1 at time 2 is: 0.46116
Number of agents choosing s=1 at time 3 is: 0.47845
Number of agents choosing s=1 at time 4 is: 0.5158
Number of agents choosing s=1 at time 5 is: 0.58321
Number of agents choosing s=1 at time 6 is: 0.70322
Number of agents choosing s=1 at time 7 is: 0.85953
Number of agents choosing s=1 at time 8 is: 0.96153
Number of agents choosing s=1 at time 9 is: 0.98927
Number of agents choosing s=1 at time 10 is: 0.99444
Number of agents choosing s=1 at time 11 is: 0.99533
Number of agents choosing s=1 at time 12 is: 0.9955
Number of agents choosing s=1 at time 13 is: 0.99551
Number of agents choosing s=1 at time 14 is: 0.99552
Number of agents choosing s=1 at time 15 is: 0.99552
Number of agents choosing s=1 at time 16 is: 0.99552

The equilibrium state is: 0.99552
The time spent to achieve the equilibirum is: 14
```

Step6: Finite Agent Analysis

If you have entered “ana” or “both” in the previous step, you will be brought to the Analytical Form Analysis interface.

1) First, the program will ask for an initial state you want to test:

```
Please enter an initial state of the fraction that applies strategy s=1 (if you want to test the equilibria solved above, enter
"S_l", "S_m", or "S_h"):
```

You may enter any number between 0 and 1. If you want to test any of the equilibria computed earlier, just follow the input instructions.

If you have done Finite Agent Simulation before, you will have the option to simply enter “same” to test the same input as in Finite Agent Simulation:

```
Please enter an initial state of the fraction that applies strategy s=1 (if you want to test the equilibria solved above, enter
"S_l", "S_m", or "S_h"; if you want to use the same number as before, please enter "same"):
```

2) Next, the program will ask for a small perturbation ε to the initial state:

```
Please enter a small perturbation from the current state (can be either positive of negative):
```

You may also enter any number you want.

If you have done Finite Agent Simulation before, you will have the option to simply enter “same” to test the same input as in Finite Agent Simulation:

```
Please enter a small perturbation from the current state (can be either positive of negative; if you want to use the same number
as before, please enter "same"):
```

3) The program will then confirm everything you entered, and ask for a maximum iteration where the program will stop if it still has not reached to the equilibrium. The suggested number is 100, but it usually will not use up the maximum iterations.

```
The initial state you entered is: 0.437743092241162
The perturbation you entered is: 0.01

Now enter the maximum iterations that you wish the program to perform to get started (suggested: 100):
```

4) The program will start running and report the results when the equilibrium is reached.