Project Milestone 2

Due 11:59pm on May 09

One of the challenges with the world3 model is that due to its complexity, it is difficult to visualize the components of the model and gain an understanding of the overall model structure. To help us better understand this complex model, we will translate the systems dynamics model into a network.

Network analysis as a tool has many potential use cases, as we discuss in the course. Analyzing the structure of system dynamics models is a very specific application of network analysis, but nevertheless it enables us to gain an appreciation for the capabilities of network analysis.

Loading the world3 model as a network

Your first step is to load the world3 model structure as a directed network using networkx. Nodes represent the different variables in the model (stocks, flows, and parameters/variables), and edges represent the influence from one variable to another.

You may use the following code to load your network. The variables of the model are listed in the "world3-03_variables.json" file, available on Moodle. The code reads the file and creates a directed network, where an edge originates at a certain variable and ends at the variable that is influenced by the origin variable.

```
import json
import networkx as nx

json_file = open('world3-03_variables.json')
w3_vars = json.loads(json_file.read())
json_file.close()

G = nx.DiGraph()
for name, val in w3_vars.items():
    G.add_node(name, var_type=val['type'])
    if val['dependencies'] != None:
        G.add_edges_from([(dep, name) for dep in val['dependencies']])
```

Note that when the nodes are added, they are added along with a variable called "`var_type`." The nodes that represent stocks have the value "`stateful`" as their `var_type`.

Analyzing the network (60 pts)

Now that you have your network loaded, use the tools discussed in class (and any other network analysis tools that you learn about on your own) to analyze the network. Here are some questions to get you started but be sure to go beyond these questions in your project.

- Which variables are considered "important" in the network? How does your specific measure of "importance" affect this consideration?
- Can you identify any cycles? What do these cycles represent? What about the length of the cycles?
- Are there any natural communities in the network structure?

Note that some network analysis tools require that the network be undirected rather than directed. In networkx it is possible to translate a directed graph to an undirected one.

Implications for system dynamics policy development (40 pts)

Considering your network analysis of the system dynamics model, think about how the policy development you proposed in the first milestone could be updated or informed by your findings. Include a discussion of this, with a view toward your final project presentation.

Resources

networkx documentation

What to submit

- Max 8-page narrative describing your methodology for analyzing the network, the results, and how you plan to incorporate your network analysis findings into your sustainable policy development
- Your source code (Jupyter notebook)