PySB modeling project

Cancer Systems Biology Class 2023

You will be making your own PySB model based on a system of your choosing. If you need examples, sample models can be found here:

<https://bionetgen.org/applications>

You’re welcome to pick a model from this list, but be warned that most of them are pretty difficult. You can also use these as a starting place and simplify them according to the specifications below.

Your model should have at least:

1. 8 rules
2. 10 species
3. 10 rate parameters (i.e. some of your reactions will need to be reversible, because you’ll have more rate parameters than rules)
4. At least one binding and/or phosphorylation event

Once you have built a model of your system, answer the following questions/prompts and make associated plots for your presentation. These questions should be used to guide how you build your presentation, but feel free to focus more on one or two of them when you present if you find something you think is interesting.

1. **Network.** Draw out the network model of your system and identify any hubs (high in-degree and out-degree). Are there any “external” nodes (nodes with in-degree of 0) or purely “observable” nodes (nodes with out-degree of 0)? Are there feedback loops? Identify any key feedback loops that you expect to be important for the dynamics of the system.
2. **Rate parameters.** How can you logically pick values for rate parameters? Is there literature associated with your model that you could use to find these rates? Try to fit your model to the literature and simulate it with varying initial conditions. Explain what the initial conditions you picked mean biologically (i.e. are any of them disease states?). Does your model do what you expect? Plot any interesting observables and comment on any unexpected dynamics you see.
3. **Sensitivity.** Try varying rate parameters for at least 4 separate rules (independently). How does changing these rate parameters affect the model? Which change is the model most sensitive to? What does this mean biologically?
4. **Experiment.** Run an *in silico* experiment. Based on your model, what is a question that would be difficult or expensive to answer in a real experiment but might be easy to simulate? You can answer a question that has already been answered in the literature and try to check your results against that paper, or answer a question that no one knows the answer to (and possibly write a paper on the answer yourself!). If you need help coming up with a good question to answer, feel free to ask.
5. **Limitations.** What might be missing in your model? How could you theoretically make your model better if you had time to do experiments, do a more in depth literature search, or add more species? What are some limitations of modeling your system using ODEs?
6. **Benefits.** What are some of the benefits of using ODEs to model your system? How has PySB made it easier to make your model?

Specifics about the presentation:

1. The presentation should be 15-20 minutes with questions.
2. It should include background information on your model system, and conclusions you made from your *in silico* experiment.
3. Your grade will be based on your contribution to model building during class, presentation style and content, and participation/questions you ask during the other groups’ presentations (just like the last few presentations were).