Omdugga 2012

Omdugga 1, questions 1-3. Omdugga 2, questions 3-5. Omdugga both, questions 1-5.

Good luck! ☺

1 Consider the following little system:

d/dt(x1) = -k1*x1 + k2*x2
d/dt(x2) = k1*x1 - k2*x2 - k3
yhat = x1 + x2 + kmeas
x1(0) = 0.5, x2(0) = 0.6
k1 = 1, k2 = 2, k3 = 3
kmeas = 5

a) Which are the states in this system?
b) Which are the reaction rates?
c) Are any of the reactions reversible/irreversible? Why/why not?

2 Cost functions and optimization

a) What is the input and output of a cost function. What does it do?
b) What are the residuals? Both give a formula, and say in words what they "do".
c) What is the input and output of an optimization algorithm? What does it do?

3 Consider the following system:

d/dt(x1) = -k1*x1 + u
d/dt(x2) = k1*x1 - k2
yhat = (x1 + x2)*kmeas
x1(0) = 0.5, x2(0) = 0.6
k1 = 1, k2 = 2
kmeas = 5

a) Assume that the k1-reaction is saturated, with a Michaelis-Menten expression. What changes in the model?
b) What is the residual at time t=0, if the measurement is y(0) = 4
c) What are the reactions in the following model?

d/dt([A]) = k1 - Vmax*[A]/(Km + [A]) + k2*[B]
d/dt([B]) = + Vmax*[A]/(Km + [A]) - k2*[B] - k3*[B]
yhat = ky*[A]

4 Statistical tests:

a) What do you conclude if you do not reject a whiteness test?
b) What is the null hypothesis of a chi-square test?
c) Assume that you have two acceptable models, but where one of them has a slightly lower cost than the other. How can you test whether this difference is significant? What is the test, and what should happen (reject/not reject)?

5 Closing the loop, predictions and experimental tests.

a) What is the problem with parameters in biological models describing complex systems? How does this affect the quality of the predictions, compared to e.g. the situation in physics?
b) Name one type of conclusion that you can draw using a model. How can that conclusion be stronger because of the model, compared to if you didn't have it, and just looked at the data?
c) You are sitting at the table at the end of the project, discussing with the customer. Your analysis of the model(s) have shown that a certain experiment would be a good idea; e.g. measuring the amount of a protein after 10 minutes. What could be a possible reason for doing that measurement? Also specify what the corresponding model prediction would be to that argument; is it a core prediction?