**Omdugga2, Juni 2015**

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 + k3  
   d/dt(x2) =  k1\*x1 - k2\*x2   
   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 difference between a local and global optimization function?
3. Consider the following system:  
     
   d/dt(x1) = -k1\*x1  
   d/dt(x2) =  k1\*x1 - k2   
   yhat = (x1)\*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 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 have two hypotheses that can explain all available data. How can you use modelling to design an experiment that ensures that no matter what the outcome of the experiment is, you will be able to reject at least one of the models?