Advanced Statistical Methods in Bioinformatics
Bioinformatics Research Center **Asger Hobolth**
Aarhus University **November 13, 2018**

Handout 11

Lectures in Week 46

Thank you to all of your for three very informative and nice presentations about the core NMF (or NLS or NQP) algorithms. I very much appreciate your effort!

Monday, November 12:
Discussion of Alexandrov *et al.* (2013, Cell Reports).

Wednesday, November 14:
Guest lecture by Johanna Bertl. Finish discussion of Alexandrov *et al.* (2013, Cell Reports).

Lectures in Week 47

The final topic of the course is statistical models for molecular evolution. We begin with the material in EG Section 11.7 (Continuous-Time Markov Chains) and EG Section 14.3 (Continuous-Time Evolutionary Models).

Exercises in Week 46

First you should solve Exercise 1 below. Second you should read EG Section 11.7 pages 403-407. Third you should solve Problem 11.10 in EG Section 11.7 page 407.

Exercise 1

The differential equation

$$f'(t) = af(t)$$

is the most important differential equation (ever!).

1. Show that $f(t) = Ke^{at}$ is a solution where K is any constant.

2. Show that *there are no other solutions.*
   Hint: Let $g(t)$ be any solution and show that the derivative of $g(t)e^{-at}$ equals zero:
   $$\frac{d}{dt}\Big(g(t)e^{-at}\Big) = 0.$$
   Conclude that $g(t)e^{-at} = K$ and therefore $g(t) = Ke^{at}$.

Note that the constant K is determined if the solution $f_0 = f(t_0)$ to the differential equation is specified in a single point t_0.

3. Now consider the differential equation
   $$f'(t) = a\Big(f(t) + b\Big).$$
   Show that the solution is
   $$f(t) = -b + Ke^{at},$$
   where K is any constant.

4. Show that if $f(0) = 1$ we have

$$f(t) = -b + (1-b)e^{at},$$

and if $f(0) = 0$ we have

$$f(t) = -b + be^{at} = b(e^{at} - 1).$$