# Algorithms for Bioinformatics (Autumn 2012)

## Exercise 3 (Thu 27.9, 10-12, B119, Niko Välimäki)

1. **Understanding costs and scores.**

   Consider the alignment below:

   ```
   ACGATGAT--CT
   A-GA-CATAAAT
   ```

   What is the cost of the alignment in the unit cost edit distance model? What is the global alignment score the alignment defines, with the mismatch and indel penalties $-1$ and match premium $+1$? What is the best local alignment score inside the given global alignment?

2. **Understanding matrix filling.**

   Compute the edit distance between `ACGTA` and `AGAA` by filling the dynamic programming matrix, and output the optimal alignment(s).

3. **Implementing approximate string matching.**

   Write a python program that implements the approximate string matching algorithm (page 19 of the lecture slides).

4. **Overlap alignments: tricks with zeros.**

   We are interested in *overlap alignments* of strings $A$ and $B$ such that suffix of $A$ is aligned against prefix of $B$. For example, an overlap alignment of `ACGATGAT` and `GACATAAAT` is

   ```
   ACGATGAT
     GA-CATAAAT
   ```

   a) Derive a variant of global alignment recurrence that gives the best scoring overlap alignment of $A$ and $B$.

   a) Derive a variant of edit distance recurrence that gives the overlap alignment of $A$ and $B$ with minimum cost, with the restriction that overlap should be at least of length $\ell$. (Why is such restriction required?)

5. **Developing a dynamic programming recurrence.**

   The Change Problem is to convert some money $M$ into given denominations, using the smallest possible number of coins. For example, given the euro cent denominations $\{50, 20, 10, 5, 2, 1\}$, the smallest number of coins to make up 46 cents is $\{20, 20, 5, 1\}$. More formally:

   **Input:** An amount of money $M$ and an array of $d$ denominations $c = \{c_1, c_2, \ldots, c_d\}$ in decreasing order of value $\{c_1 > c_2 > \ldots > c_d\}$.

   **Output:** A list of $d$ integers $i_1, i_2, \ldots, i_d$ such that $c_1 i_1 + c_2 i_2 + \ldots + c_d i_d = M$ and $i_1 + i_2 + \ldots + i_d$ is as small as possible.

   Show how dynamic programming can be used to solve the Change Problem.

   *Hint.* Fill an array of size $M$ from left to right.