HW4 Molecular Programming

07.10.2020 - **Due on Wed. 28/10 before midnight**

You are asked to complete the exercise marked with a [★] and to send me your solutions to:

nicolas.schabanel@ens-lyon.fr

as a PDF file named **HW4-Lastname.pdf** on **Wed. 28/10 before midnight**.

■ **Exercise 1 (DNA circuits).** In the following, long domains are represented in grey and toeholds in color.

Assume a binding rate of 0.116 and unbinding rate of 0.003 for the short domains (toeholds), compute the graph of all possible evolutions for the following mixes. Gives the main path of the evolution. What are the output(s)? Explain what each mix computes.

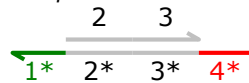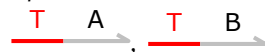▶ *Question* **1.1***)* *Mix 1*
Complexes:
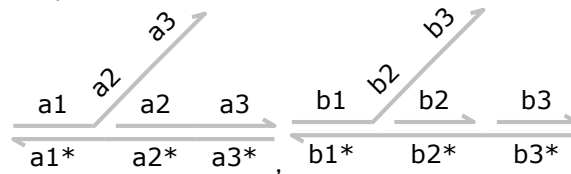
▶ *Question* **1.2***)* *Mix 2*
Inputs:

Complexes:
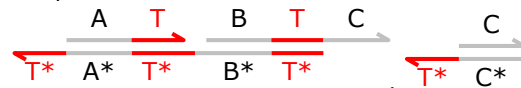

▶ *Question* **1.3***)* *Mix 3*
Inputs:

Complexes:

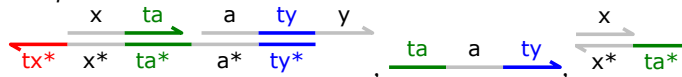▶ *Question* **1.4***)* *Mix 4*
Inputs:

Complexes:

[★] Exercise 2 (DNA gate). In the following, long domains are represented in grey and toeholds in color.

▶ **Question 2.1)** *Assume a binding rate of 0.116 and unbinding rate of 0.003 for the short domains (toeholds) (precise values 0.116 and 0.003 do not matter, only that binding rate>>unbinding rate>> 0 matters), compute the graph of all possible evolutions for the following mix. Indicate where the energy/entropy increases/decreases. Highlight the main path of the evolution. Explain what this mix computes.*

Inputs: T A , T B

Complexes: A T C , B T C , C
   T* A* T*   T* B* T*   T* C*

Output: C
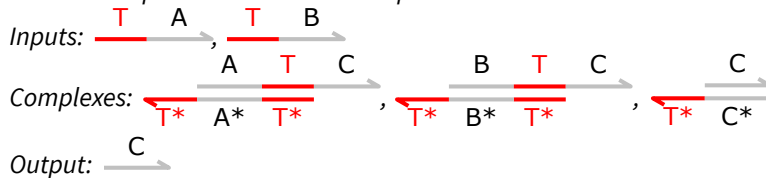
[★] Exercise 3 (Scale the wall). Recall that a tile assembly system $\mathcal{T} = (T, \sigma, \tau)$ consists of a tile set T, a seed tile $\sigma \in T$ and a temperature $\tau \in \mathbb{N}$. Consider the situation in Fig. 1 consisting of a wall of height h.
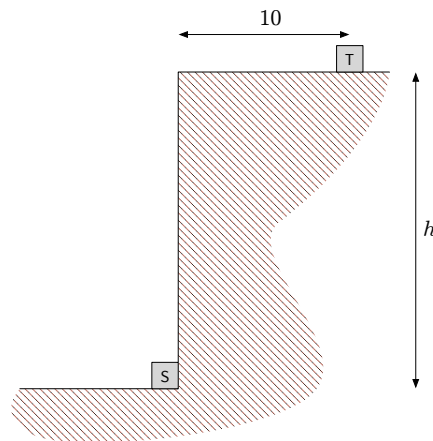

Figure 1: A wall of height h.

▶ **Question 3.1)** *Can you find a tile assembly system $\mathcal{T}$ for the abstract Tile Assembly Model (aTAM) where the rules are as follows?*

- *The seed tile is placed at position $S = (0, 0)$*
- *For all $h \in \mathbb{N}$, every terminal assembly of $\mathcal{T}$ should place a tile at the target position $T = (10, h)$ and be of finite size*
- *$\mathcal{T}$ may not place tiles to the right and below the cut of the plane shown in Figure 1.*
- *You may give an infinite sequence of glues such that the h-prefix of that sequence will appear on the wall, to help the tiles 'climb up'.*