HW4 M2IF CR07 Molecular Programming

2023.10.27 - Due on Tue. 11.07 before 10:15

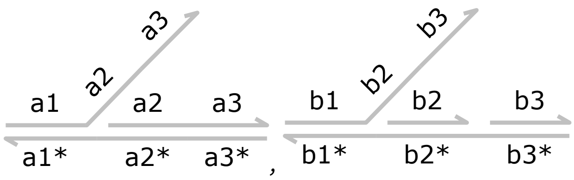
You are asked to complete the exercise marked with a [★] and to send me your solutions to:
nicolas.schabanel@ens-lyon.fr
as a PDF file named **HW4-Lastname.pdf** on **Tue. 11.07 before 10:15**.

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

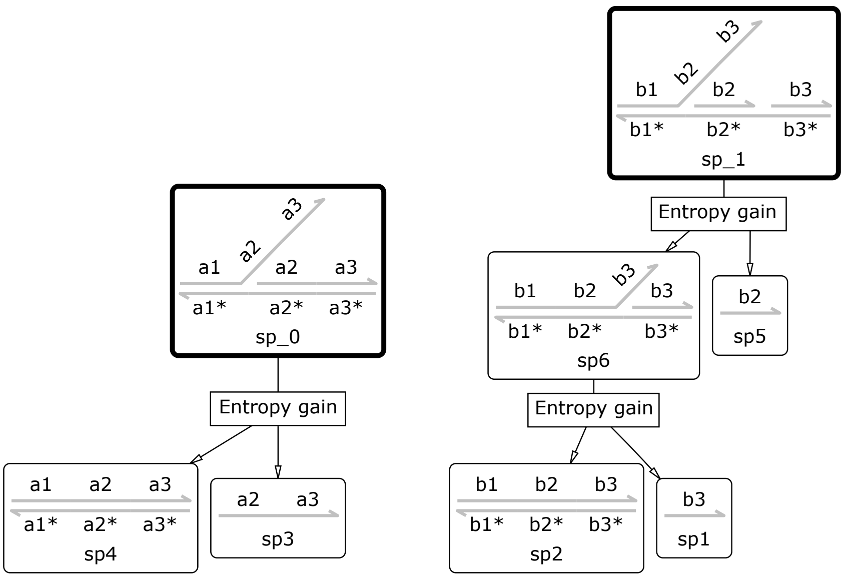
Assume a binding rate of 0.116 and unbinding rate of 0.003 for the short domains (toeholds), compute the graph of all possible evolutions for the following mixes. Gives the main path of the evolution. What are the output(s)? Explain what each mix computes.

▶ **Question 1.1)** *Mix 1*

Complexes:



Answer. ▷



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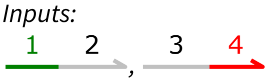
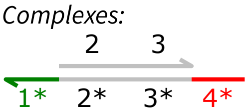
▶ **Question 1.2)** *Mix 2*

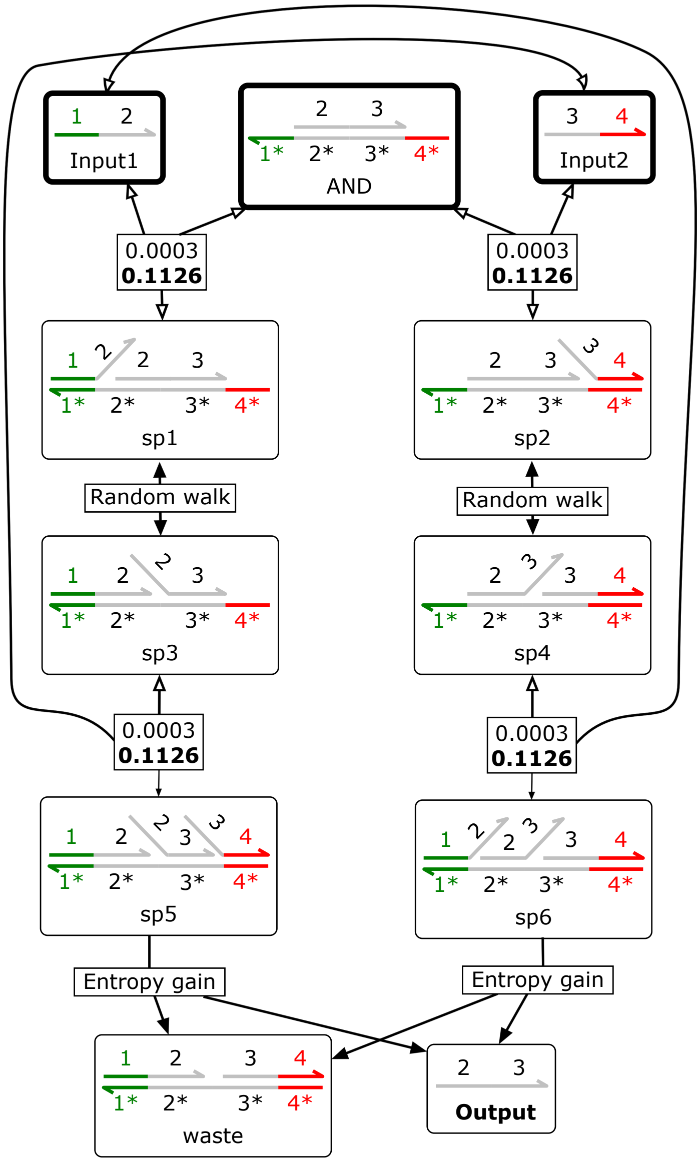
Inputs:



Complexes:



Answer. ▷



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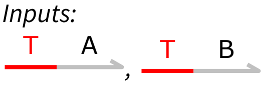
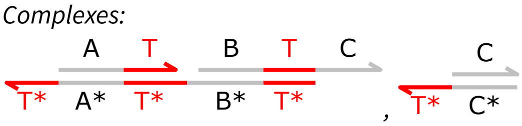
▶ **Question 1.3)** *Mix 3*

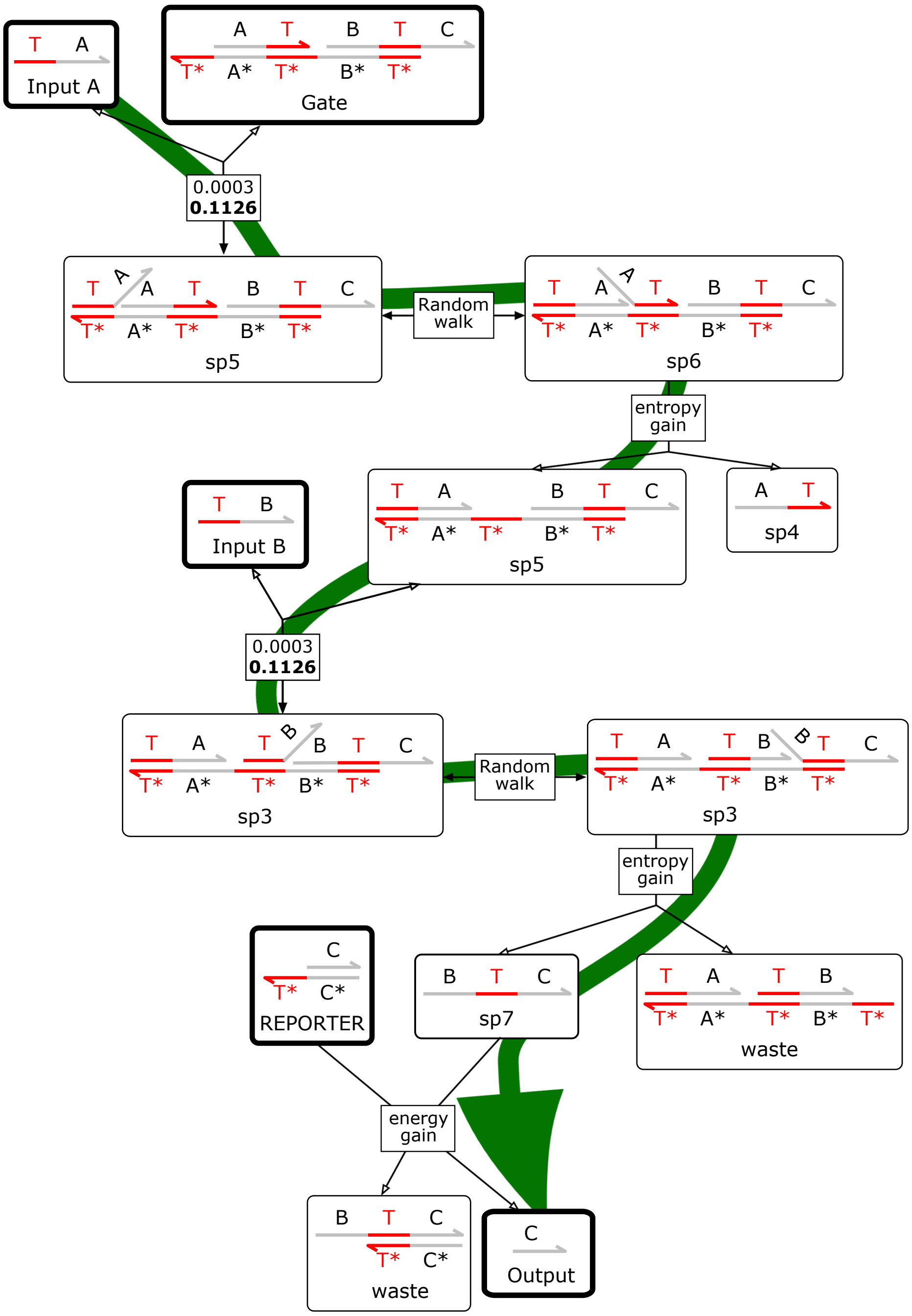
Inputs:



Complexes:



Answer. ▷



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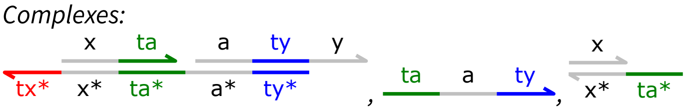
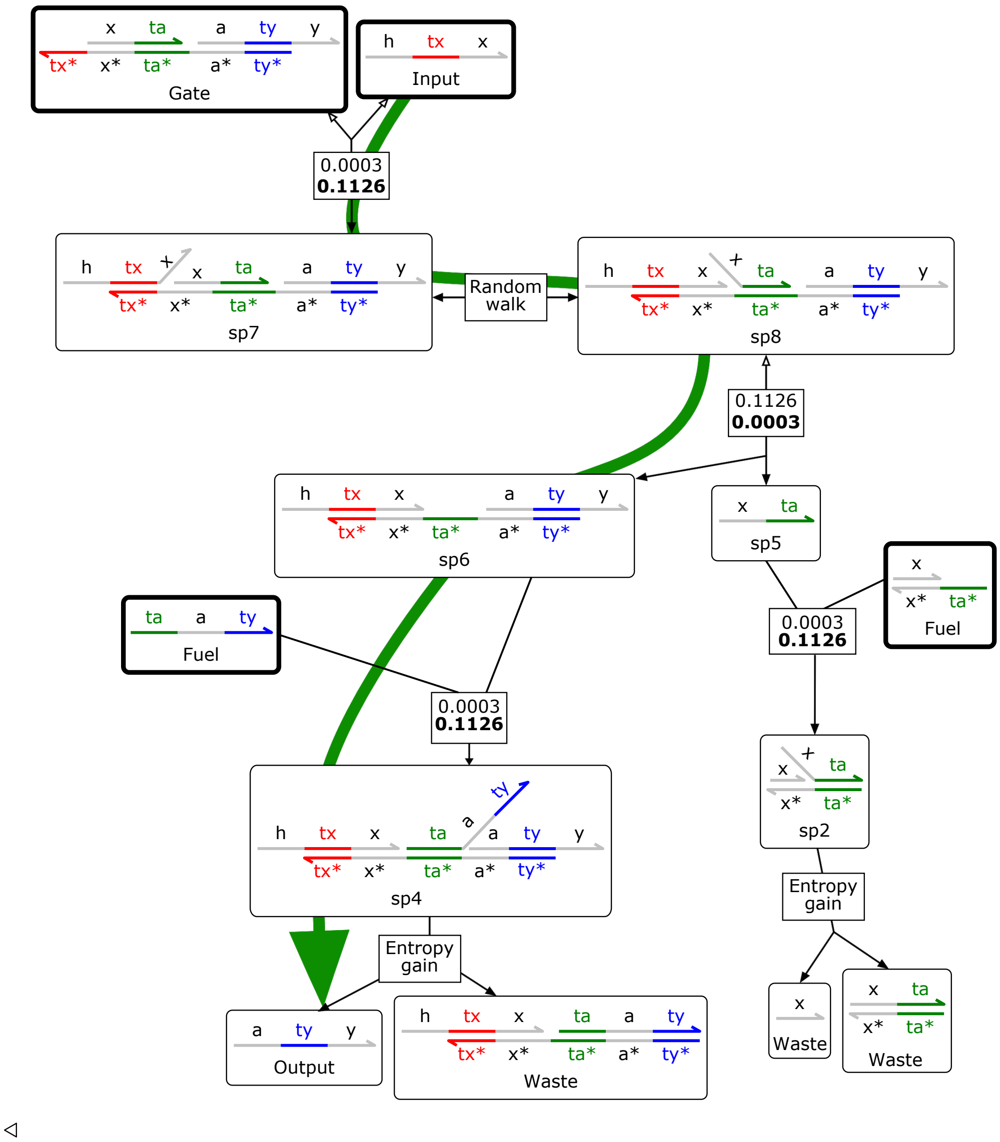
▶ Question 1.4) *Mix 4*

Inputs:

Complexes:



Answer. ▷


x ta a ty y
tx* x* ta* a* ty*
Gate
h tx x
Input
0.0003
0.1126
h tx + x ta a ty y
tx* x* ta* a* ty*
sp7
Random walk
h tx x + ta a ty y
tx* x* ta* a* ty*
sp8
0.1126
0.0003
h tx x a ty y
tx* x* ta* a* ty*
sp6
x ta
sp5
x
x* ta*
Fuel
ta a ty
Fuel
0.0003
0.1126
0.0003
0.1126
h tx x ta a ty a ty y
tx* x* ta* a* ty*
sp4
x + ta
x* ta*
sp2
Entropy gain
Entropy gain
a ty y
Output
h tx x ta a ty
tx* x* ta* a* ty*
Waste
x
Waste
x ta
x* ta*
Waste

[★] Exercise 2 (PEN toolbox - binary counter). Our goal is to propose a PEN toolbox circuit that would implement a 3-bits binary counter with a periodic circuit. Here is a suggestion:

- An increment signal should be sent periodically
- Each bit should be implemented as a bistable PEN tool network
- The increment signal should flip the first bit which should send a carry signal to the next bit if it was flipped to 0; this carry signal should then flip the next bit and so on.

► **Question 2.1)** *Give an activation/inhibition/auto-catalyse network implementing a 3-bits binary counter.* Answer. ▷ To be done. ◁

► **Question 2.2)** *Give the corresponding network of DNA strands and templates, giving names to the different orthogonal domains (assuming the presence of appropriate polymerase, nickase and exonuclease).*
Answer. ▷ To be done. ◁

► **Question 2.3)** *Propose a mechanism to report the value of the binary counter using reporting strands equipped with a fluorophore/quencher.*
Answer. ▷ To be done. ◁