

S1 Text. Simulation methods and codes

Efficient switches in biology and computer science

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I. METHODOLOGY

The data to generate all time-course diagrams have been obtained by using Visual GEC software (<http://lepton.research.microsoft.com/webgec/>). The ODEs have been solved using a Runge-Kutta Method (RK547M), included in the software.

Graphics have been created by using ggplot2 package, from R.

All wiring diagrams of figures 3-7 and below are condensed versions. Each node (molecule) of each network represents the three states of the molecule: inactive form, non-decided form and active form. Thus, each node is showing up by three traces in simulation plots.

II. LBS CODE FOR THE MODELS

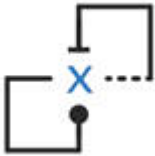
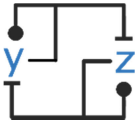
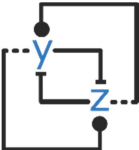
AM	Figure 3		<pre>directive sample 5 100 directive simulation deterministic rate k = 1; init x 1.001 init xb 1 init xi 1 x + xi ->{k} xi + xb xi + x ->{k} x + xb xb + x ->{k} x + x xb + xi ->{k} xi + xi</pre>
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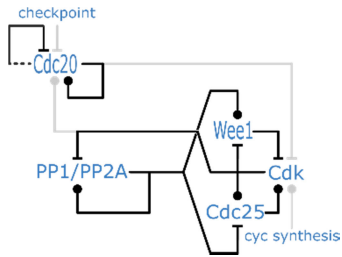
	Figure 5A		<p>directive sample 5 100 directive simulation deterministic</p> <p>rate k = 1;</p> <p>init x 2.001 init xb 0 init xi 2 </p> <p>M + A ->{k} M + U A + x ->{k} M + U U + x ->{k} M + M U + A ->{k} A + A</p>
MI	Figure 5B		<p>directive sample 10.0 100 directive simulation deterministic</p> <p>rate k = 1;</p> <p>init z0 2.001 init z1 0 init z2 2 init y0 2 init y1 0 init y2 2.001 </p> <p>z2 + z0 ->{k} z0 + z1 z1 + z0 ->{k} z0 + z0 y0 + z0 ->{k} z0 + y1 y1 + z0 ->{k} z0 + y2 </p> <p>y2 + y0 ->{k} y0 + y1 y1 + y0 ->{k} y0 + y0 z0 + y0 ->{k} y0 + z1 z1 + y0 ->{k} y0 + z2</p>
SI	Figure 5C		<p>directive sample 10.0 100 directive simulation deterministic</p> <p>rate k = 1;</p> <p>init z0 2.001 init z1 0 init z2 2 init y0 2 init y1 0 init y2 2.001 </p>

			$z_0 + y_0 \xrightarrow{\{k\}} y_0 + z_1 \mid$ $z_1 + y_0 \xrightarrow{\{k\}} y_0 + z_2 \mid$ $z_2 + y_2 \xrightarrow{\{k\}} y_2 + z_1 \mid$ $z_1 + y_2 \xrightarrow{\{k\}} y_2 + z_0 \mid$ $y_0 + z_0 \xrightarrow{\{k\}} z_0 + y_1 \mid$ $y_1 + z_0 \xrightarrow{\{k\}} z_0 + y_2 \mid$ $y_2 + z_2 \xrightarrow{\{k\}} z_2 + y_1 \mid$ $y_1 + z_2 \xrightarrow{\{k\}} z_2 + y_0 \mid$
CC	Figure 3		directive sample 40 100 directive simulation deterministic rate k = 1; init CDK 1.001 init CDC25 1.001 init WEE1 1 init CDKb 1 init CDC25b 1 init WEE1b 1 init CDKi 1 init CDC25i 1 init WEE1i 1.001 init a 1 init i 1 CDC25i + CDK $\xrightarrow{\{k\}}$ CDK + CDC25b CDC25b + CDK $\xrightarrow{\{k\}}$ CDK + CDC25 WEE1 + CDK $\xrightarrow{\{k\}}$ CDK + WEE1b WEE1b + CDK $\xrightarrow{\{k\}}$ CDK + WEE1i CDKi + CDC25 $\xrightarrow{\{k\}}$ CDC25 + CDKb CDKb + CDC25 $\xrightarrow{\{k\}}$ CDC25 + CDK CDK + WEE1 $\xrightarrow{\{k\}}$ WEE1 + CDKb CDKb + WEE1 $\xrightarrow{\{k\}}$ WEE1 + CDKi CDC25 + i $\xrightarrow{\{k\}}$ i + CDC25b CDC25b + i $\xrightarrow{\{k\}}$ i + CDC25i WEE1i + a $\xrightarrow{\{k\}}$ a + WEE1b WEE1b + a $\xrightarrow{\{k\}}$ a + WEE1

<p>GW</p>	<p>Figure 3</p>	<pre> graph TD Wee1 -- Gwl Gwl -- Cdk Cdc25 --> Cdk Cdk -- Wee1 Cdk -- Cdc25 </pre>	<pre> directive sample 20 100 directive simulation deterministic rate k = 1; init CDK 1.001 init cdc25 1.001 init wee1 1 init PP1PP2A 1 init CDKb 1 init cdc25b 1 init wee1b 1 init PP1PP2Ab 1 init wee1i 1.001 init cdc25i 1 init CDKi 1 init PP1PP2Ai 1.001 cdc25i + CDK ->{k} cdc25b + CDK cdc25b + CDK ->{k} cdc25 + CDK PP1PP2A + CDK ->{k} PP1PP2Ab + CDK PP1PP2Ab + CDK ->{k} PP1PP2Ai + CDK wee1 + CDK ->{k} wee1b + CDK wee1b + CDK ->{k} wee1i + CDK CDK + wee1 ->{k} CDKb + wee1 CDKb + wee1 ->{k} CDKi + wee1 CDKi + cdc25 ->{k} CDKb + cdc25 CDKb + cdc25 ->{k} CDK + cdc25 PP1PP2Ai + PP1PP2A ->{k} PP1PP2Ab + PP1PP2A PP1PP2Ab + PP1PP2A ->{k} PP1PP2A + PP1PP2A wee1i + PP1PP2A ->{k} wee1b + PP1PP2A wee1b + PP1PP2A ->{k} wee1 + PP1PP2A cdc25 + PP1PP2A ->{k} cdc25b + PP1PP2A cdc25b + PP1PP2A ->{k} cdc25i + PP1PP2A </pre>
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**Extended
GW**

Figure
4AC. No
oscillations



directive sample 20 1000
directive simulation deterministic

rate k = 1;
rate k2 = 1;
rate re = 1;
rate k0 = 1;

init ch 3 |
init cs 3 |

init cdc20 3 |
init cdc20i 4 |
init cdc20b 2 |

init cdk1 3 |
init cdk1b 3 |
init cdk1i 3 |

init cdc25 3 |
init cdc25i 3 |
init cdc25b 3 |

init wee1 3 |
init wee1i 3 |
init wee1b 3 |

init PP1PP2A 3 |

			<pre> init PP1PP2Ab 3 init PP1PP2Ai 3 wee1i + PP1PP2A ->{k} wee1b + PP1PP2A wee1b + PP1PP2A ->{k} wee1 + PP1PP2A wee1 + cdk1 ->{k0} wee1b + cdk1 wee1b + cdk1 ->{k0} wee1i + cdk1 cdc25i + cdk1 ->{k0} cdc25b + cdk1 cdc25b + cdk1 ->{k0} cdc25 + cdk1 cdc25 + PP1PP2A ->{k} cdc25b + PP1PP2A cdc25b + PP1PP2A ->{k} cdc25i + PP1PP2A PP1PP2A + cdk1 ->{k} PP1PP2Ab + cdk1 PP1PP2Ab + cdk1 ->{k} PP1PP2Ai + cdk1 PP1PP2Ai + PP1PP2A ->{k} PP1PP2Ab + PP1PP2A PP1PP2Ab + PP1PP2A ->{k} PP1PP2A + PP1PP2A cdk1i + cdc25 ->{k0} cdk1b + cdc25 cdk1b + cdc25 ->{k0} cdk1 + cdc25 cdk1i + cs ->{k0} cdk1b + cs cdk1b + cs ->{k0} cdk1 + cs cdk1 + wee1 ->{k0} cdk1b + wee1 cdk1b + wee1 ->{k0} cdk1i + wee1 cdk1 + cdc20 ->{re} cdk1b + cdc20 cdk1b + cdc20 ->{re} cdk1i + cdc20 cdc20i + cdk1 ->{re} cdc20b + cdk1 cdc20b + cdk1 ->{re} cdc20 + cdk1 cdc20 + ch ->{re} cdc20b + ch cdc20b + ch ->{re} cdc20i + ch cdc20i + cdc20 ->{k0} cdc20b + cdc20 cdc20b + cdc20 ->{k0} cdc20 + cdc20 cdc20 + cdc20i ->{re} cdc20b + cdc20i cdc20b + cdc20i ->{re} cdc20i + cdc20i </pre>
Extended GW	Figure 4BD. Oscillations		<pre> directive sample 20 1000 directive simulation deterministic rate k = 1; rate k2 = 1; rate re = 1; rate k0 = 1; init ch 3 init cs 3 init cdc20 3 init cdc20i 4 init cdc20b 2 init cdk1 3 </pre>

			<p>init cdk1b 3 init cdk1i 3 </p> <p>init cdc25 3 init cdc25i 3 init cdc25b 3 </p> <p>init wee1 3 init wee1i 3 init wee1b 3 </p> <p>init PP1PP2A 3 init PP1PP2Ab 3 init PP1PP2Ai 3 </p> <p>wee1i + PP1PP2A ->{k} wee1b + PP1PP2A wee1b + PP1PP2A ->{k} wee1 + PP1PP2A wee1 + cdk1 ->{k0} wee1b + cdk1 wee1b + cdk1 ->{k0} wee1i + cdk1 </p> <p>cdc25i + cdk1 ->{k0} cdc25b + cdk1 cdc25b + cdk1 ->{k0} cdc25 + cdk1 cdc25 + PP1PP2A ->{k} cdc25b + PP1PP2A cdc25b + PP1PP2A ->{k} cdc25i + PP1PP2A </p> <p>PP1PP2A + cdk1 ->{k} PP1PP2Ab + cdk1 PP1PP2Ab + cdk1 ->{k} PP1PP2Ai + cdk1 PP1PP2Ai + cdc20 ->{k0} PP1PP2Ab + cdc20 PP1PP2Ab + cdc20 ->{k0} PP1PP2A + cdc20 </p> <p>cdk1i + cdc25 ->{k0} cdk1b + cdc25 cdk1b + cdc25 ->{k0} cdk1 + cdc25 cdk1i + cs ->{k0} cdk1b + cs cdk1b + cs ->{k0} cdk1 + cs cdk1 + wee1 ->{k0} cdk1b + wee1 cdk1b + wee1 ->{k0} cdk1i + wee1 cdk1 + cdc20 ->{re} cdk1b + cdc20 cdk1b + cdc20 ->{re} cdk1i + cdc20 </p> <p>cdc20i + cdk1 ->{re} cdc20b + cdk1 cdc20b + cdk1 ->{re} cdc20 + cdk1 cdc20 + ch ->{re} cdc20b + ch cdc20b + ch ->{re} cdc20i + ch cdc20i + cdc20 ->{k0} cdc20b + cdc20 cdc20b + cdc20 ->{k0} cdc20 + cdc20 cdc20 + cdc20i ->{re} cdc20b + cdc20i cdc20b + cdc20i ->{re} cdc20i + cdc20i </p>
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