

SASB 2018

Proving the absence of unbounded polymers in rule-based models

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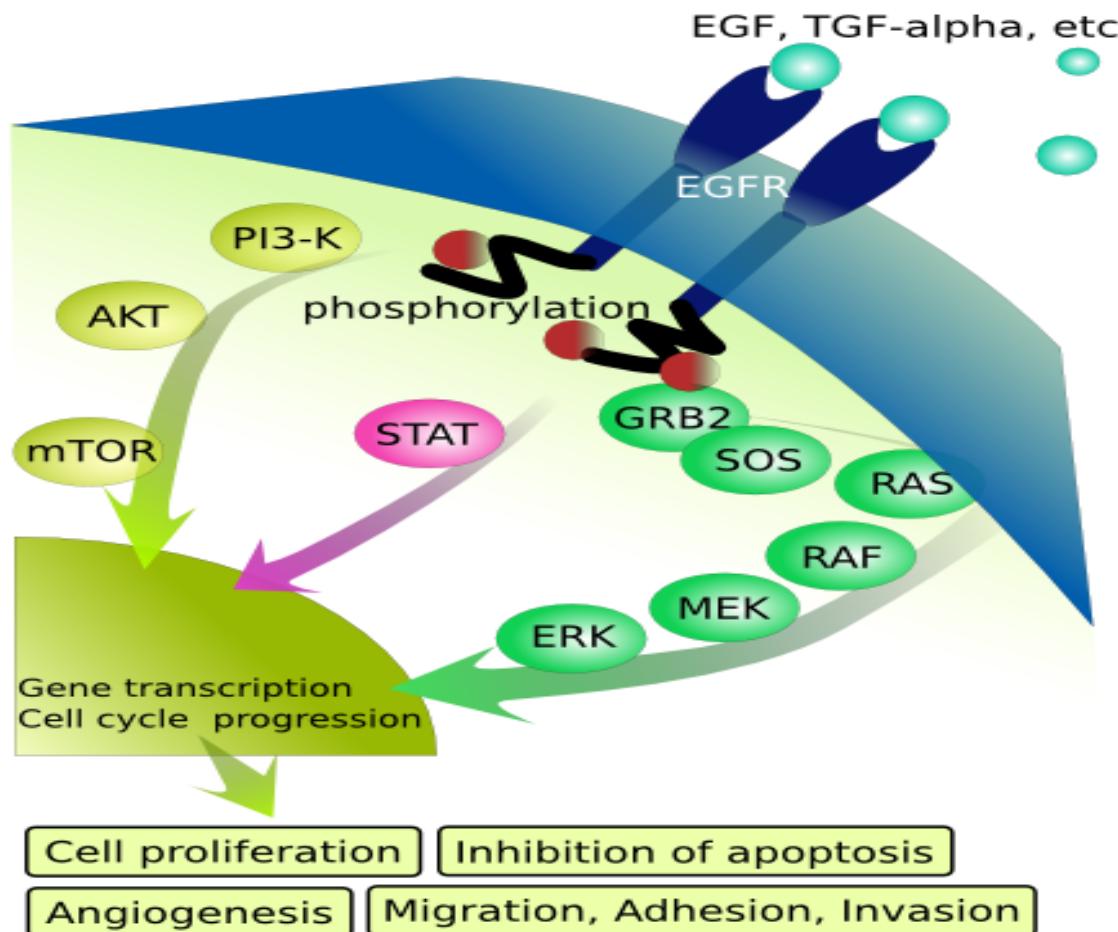
Joint work with Pierre Boutillier and Aurelie Faure de Pebeyre

Freiburg im Breisgau, August 28 2018

On the menu today

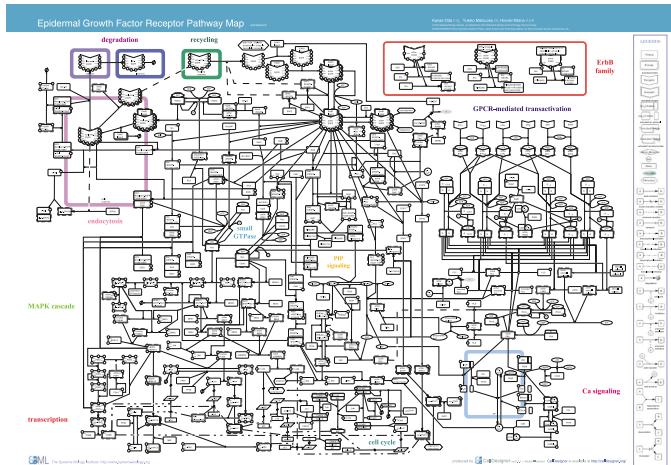
1. Rule-based modelling
2. Kappa
3. Unbounded bio-molecular compounds
4. The graph of the sites
5. The graph of the edges
6. Refinement
7. Conclusion

Signalling Pathways



Eikuch, 2007

Bridging the gap between...

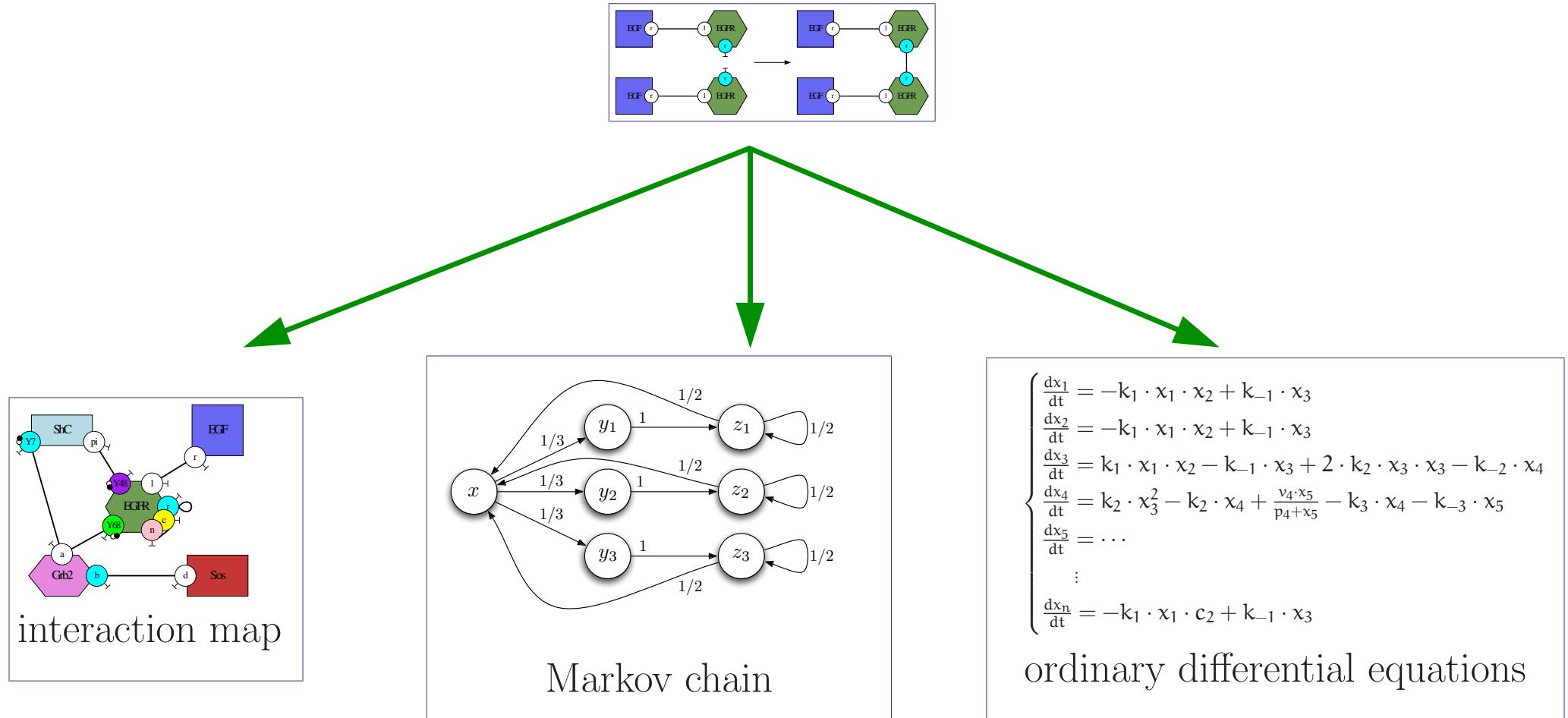


knowledge
representation
and

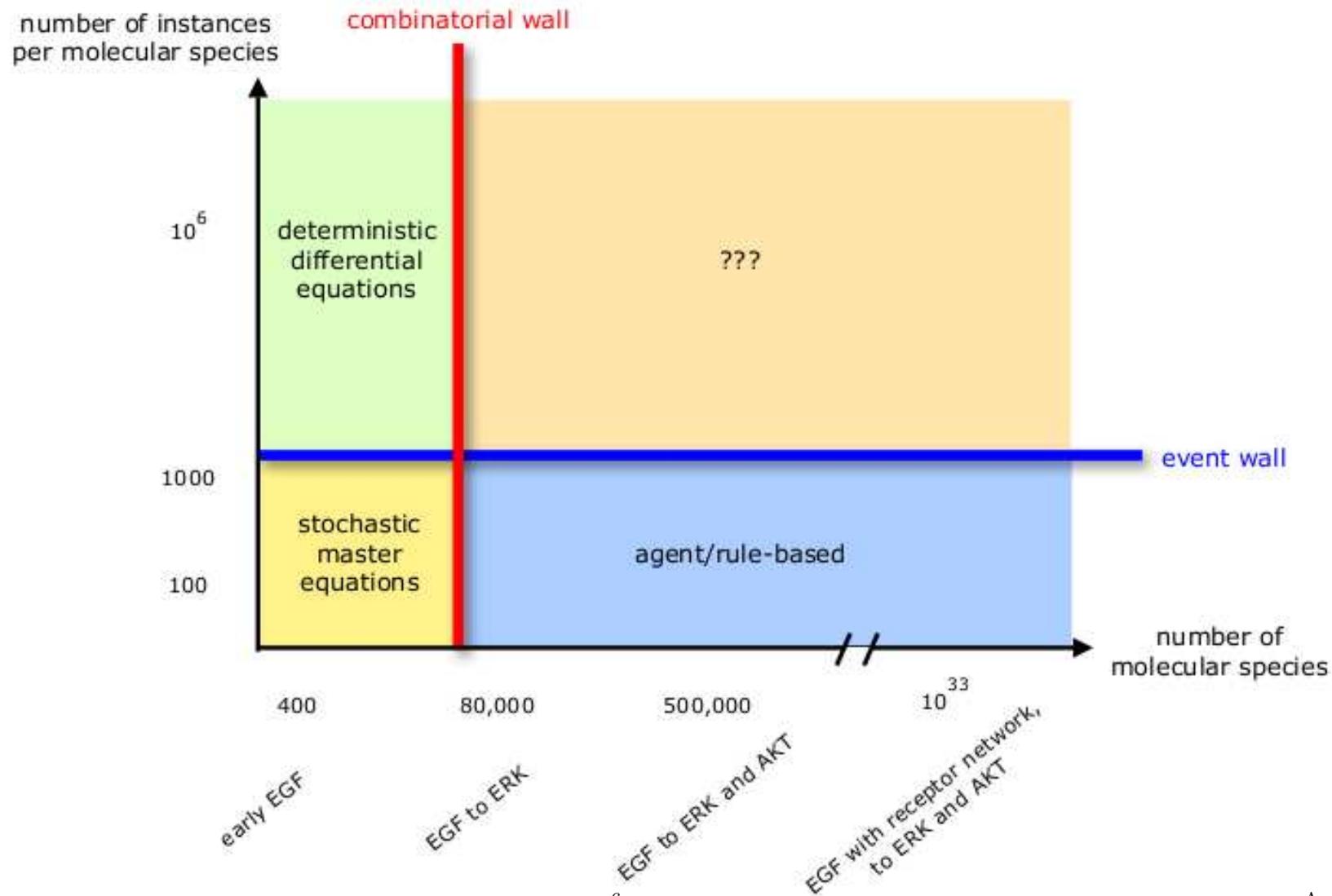
$$\left\{ \begin{array}{l} \frac{dx_1}{dt} = -k_1 \cdot x_1 \cdot x_2 + k_{-1} \cdot x_3 \\ \frac{dx_2}{dt} = -k_1 \cdot x_1 \cdot x_2 + k_{-1} \cdot x_3 \\ \frac{dx_3}{dt} = k_1 \cdot x_1 \cdot x_2 - k_{-1} \cdot x_3 + 2 \cdot k_2 \cdot x_3 \cdot x_3 - k_{-2} \cdot x_4 \\ \frac{dx_4}{dt} = k_2 \cdot x_3^2 - k_2 \cdot x_4 + \frac{v_4 \cdot x_5}{p_4 + x_5} - k_3 \cdot x_4 - k_{-3} \cdot x_5 \\ \frac{dx_5}{dt} = \dots \\ \vdots \\ \frac{dx_n}{dt} = -k_1 \cdot x_1 \cdot c_2 + k_{-1} \cdot x_3 \end{array} \right.$$

models of the
behaviour of
systems

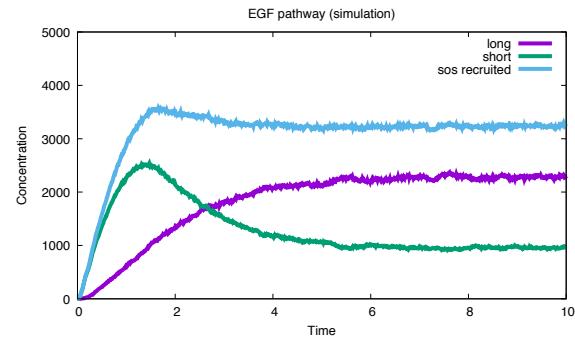
Choices of semantics



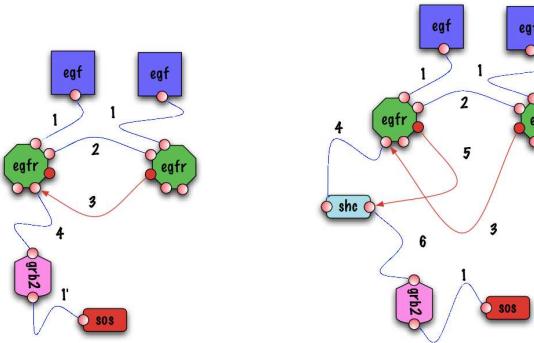
Complexity walls



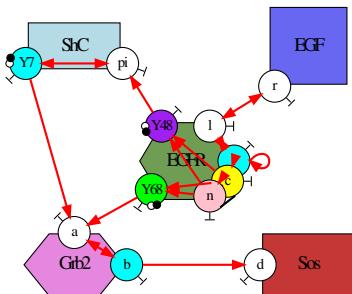
Abstractions offer different perspectives on models



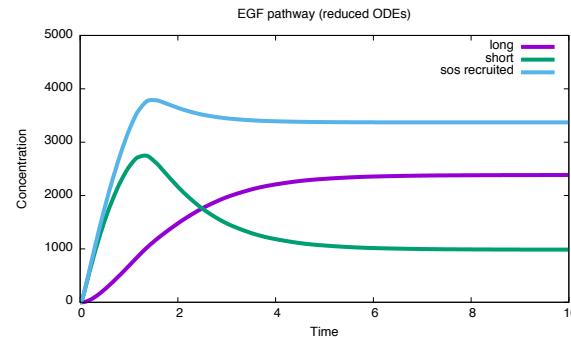
concrete semantics



causal traces



information flow

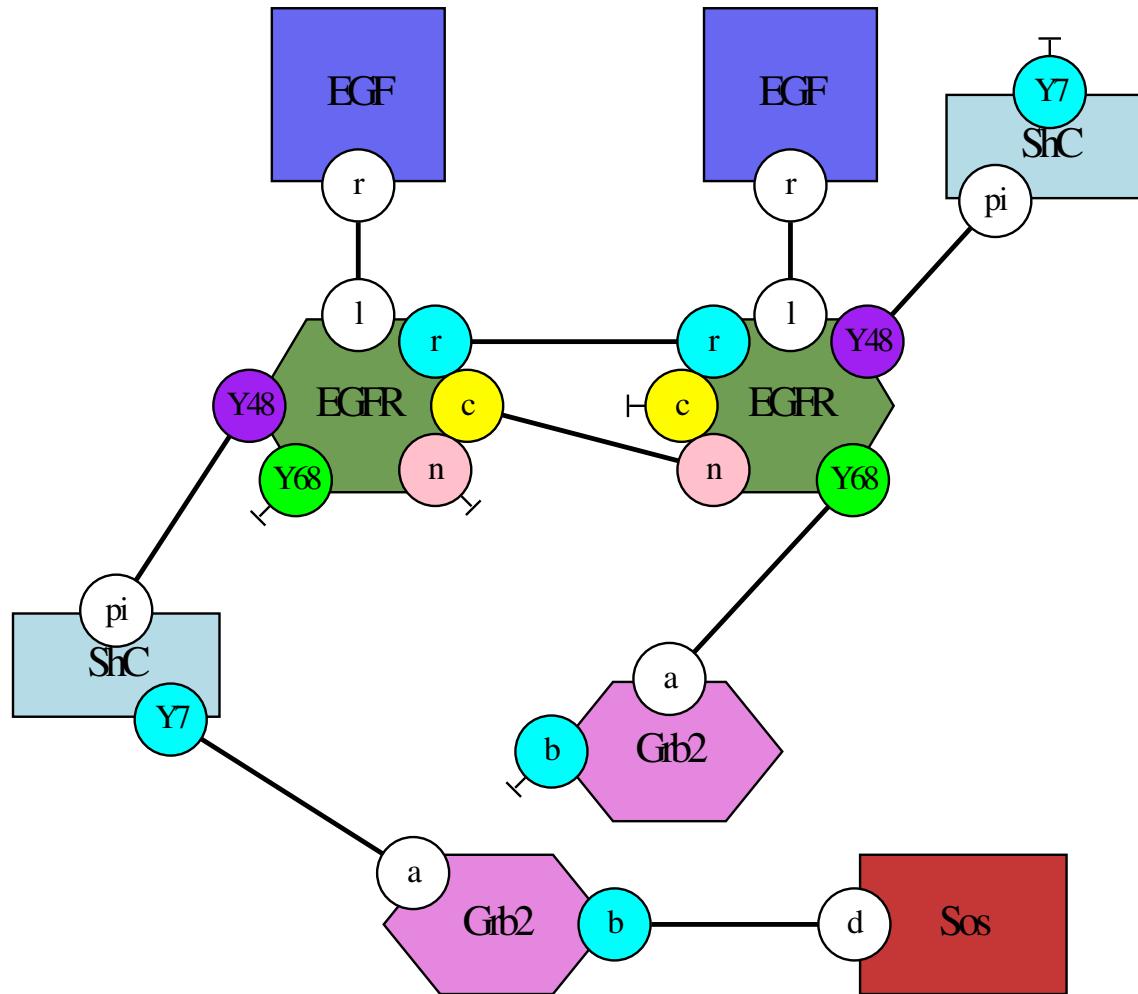


exact projection
of the ODE semantics

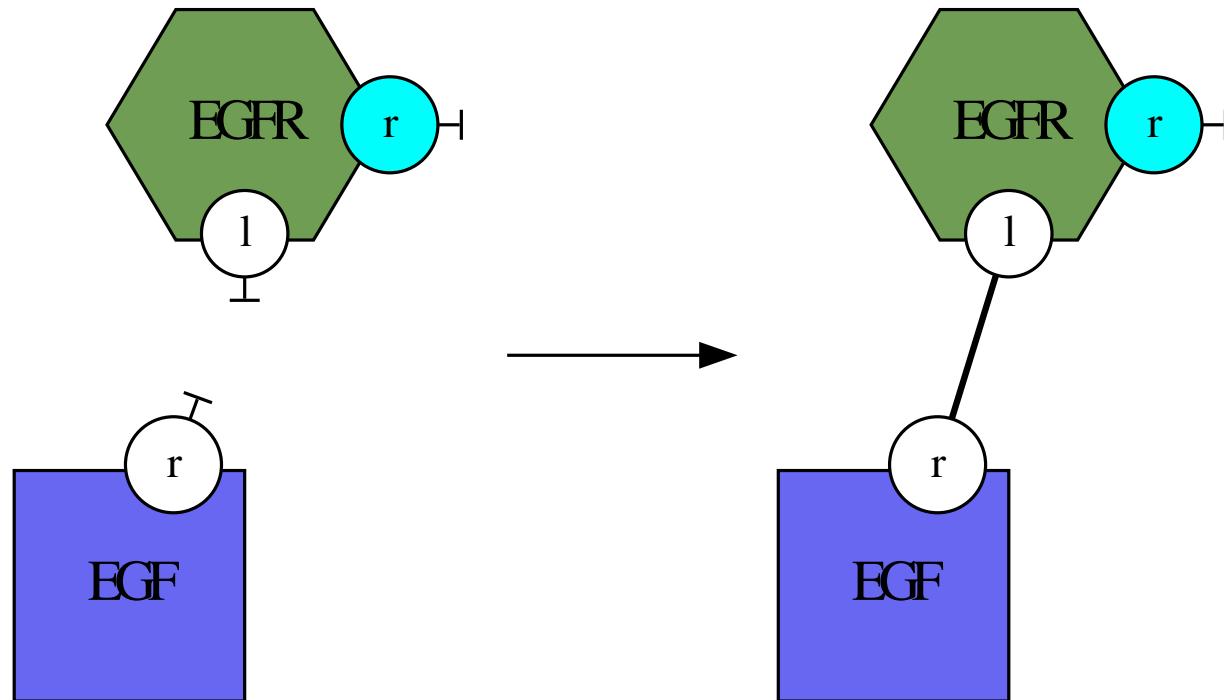
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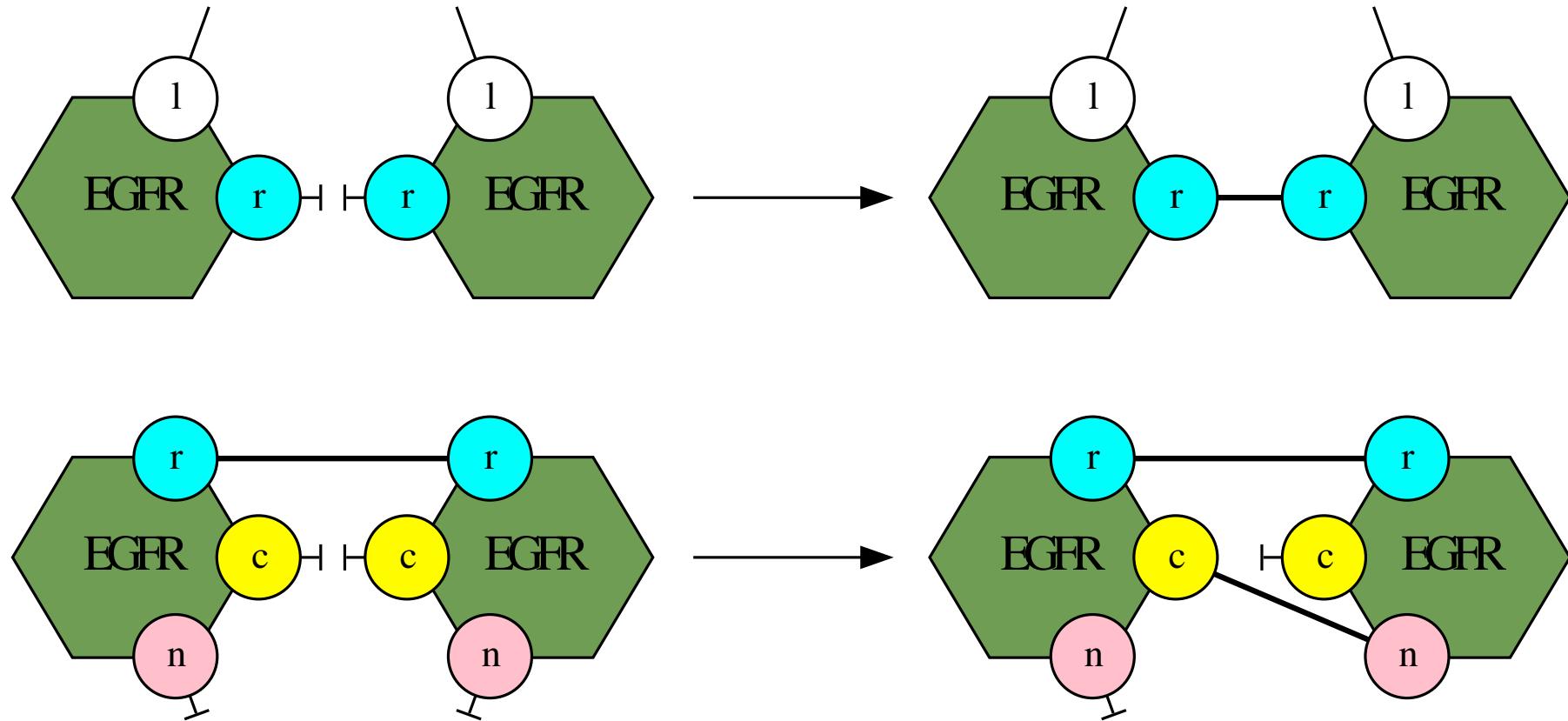
A chemical species



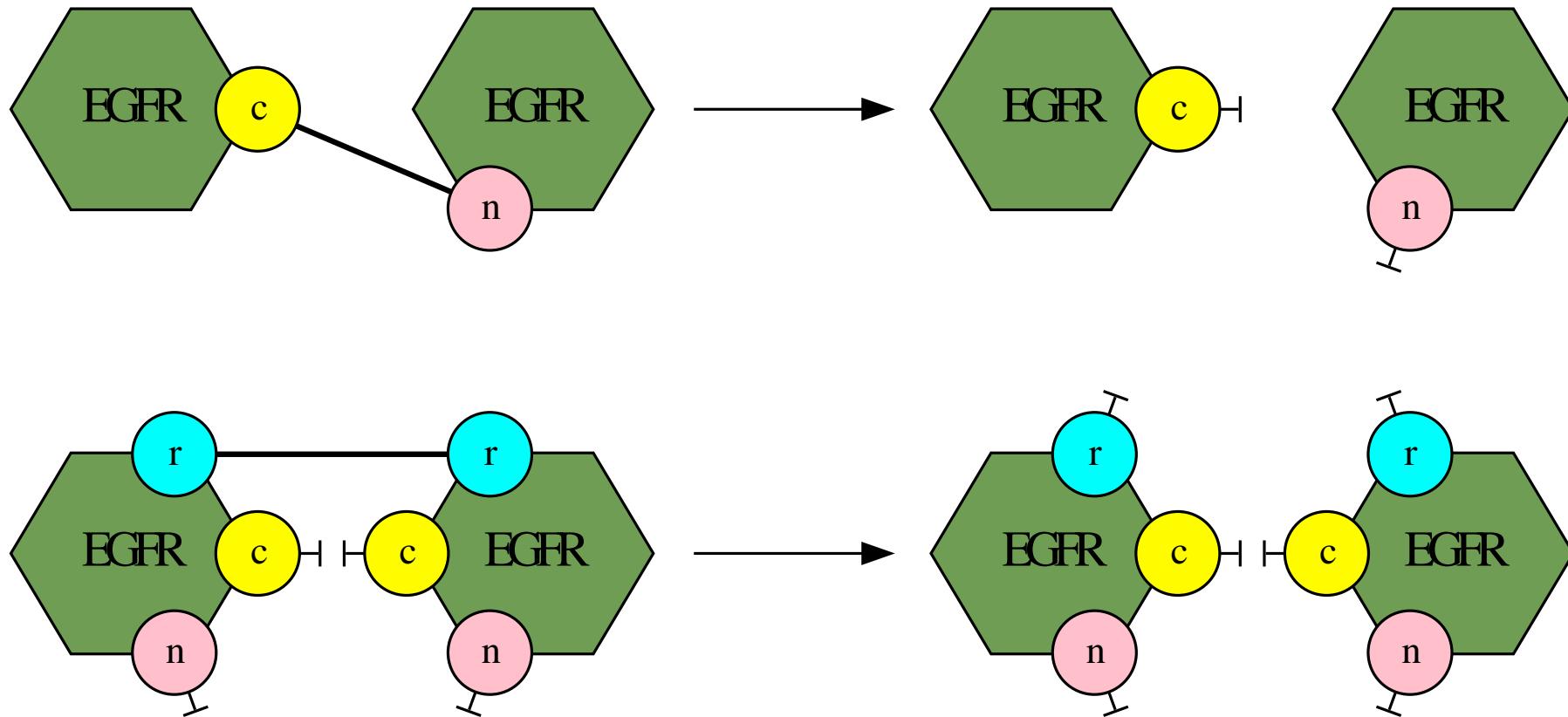
Receptor activation



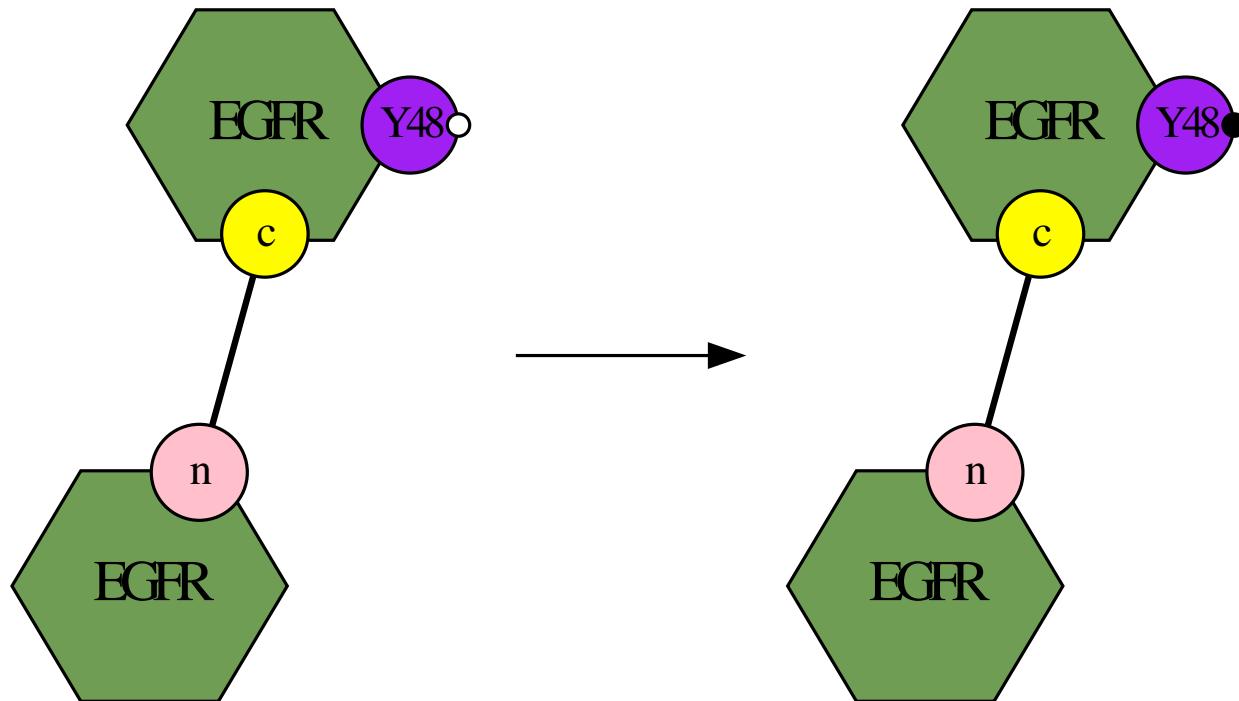
Asymmetric dimerisation



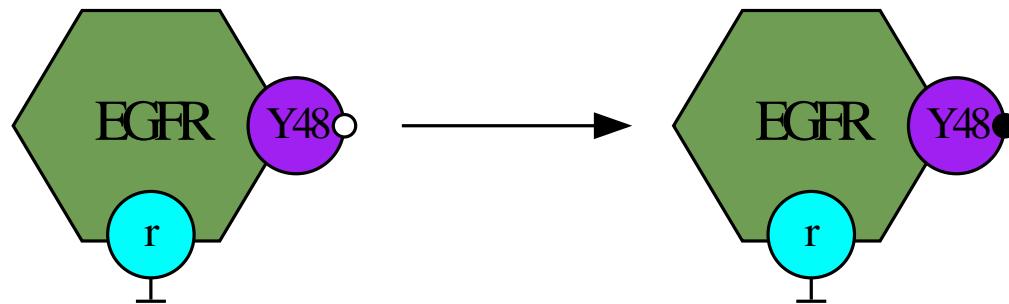
Sequential unbinding



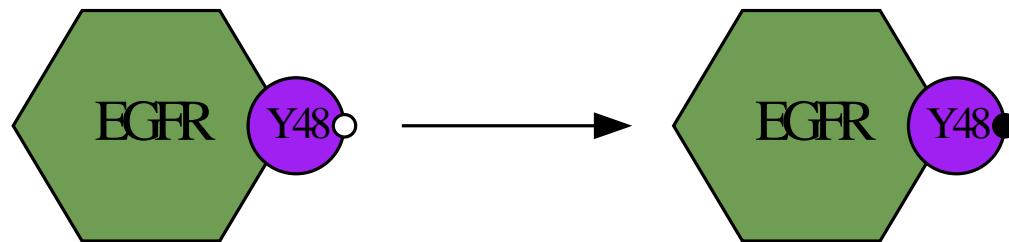
Internal state



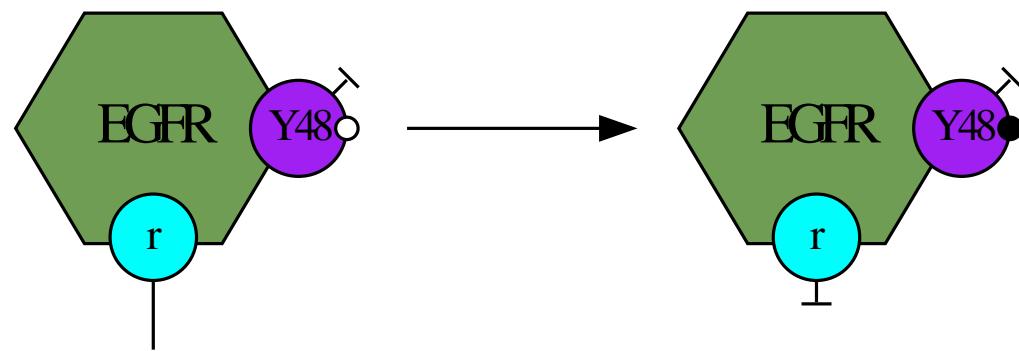
Don't care, Don't write



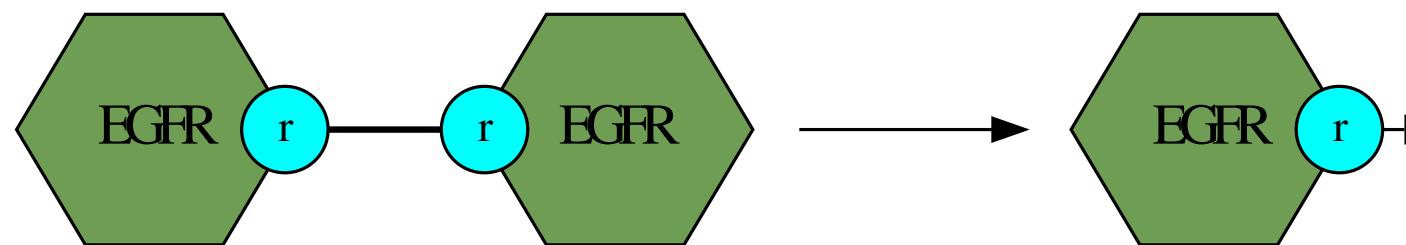
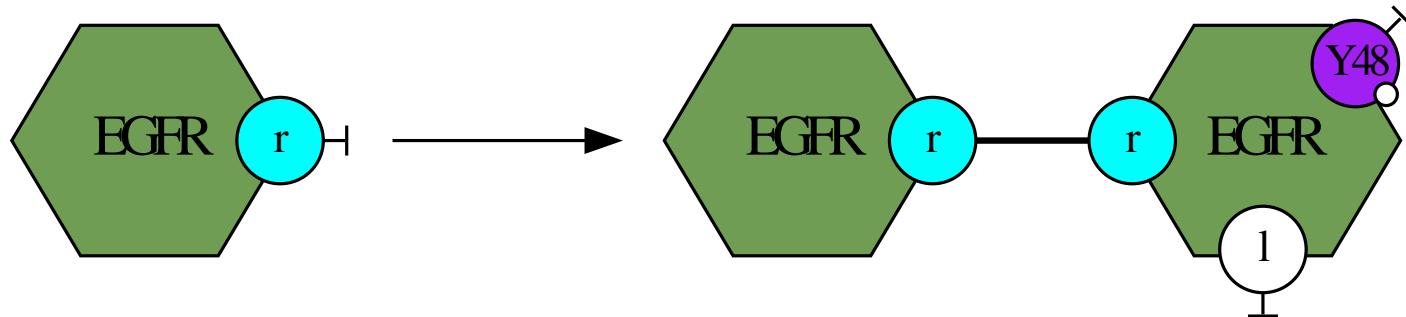
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Side effects



Creation/Suppression



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Contact map

Conflicts

Self-loops

Several self-loops

Invariants

Combinatorial complexity

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4. **The graph of the sites**
5. The graph of the edges
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Repeatable pattern

Transitions between sites

The graph of the sites

Detection of unbounded polymers

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Repeatable pattern

Transitions between the edges

The graph of the links

Detection of unbounded polymers

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Issues

The graph of the links

Labelled transitions

Refinement

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