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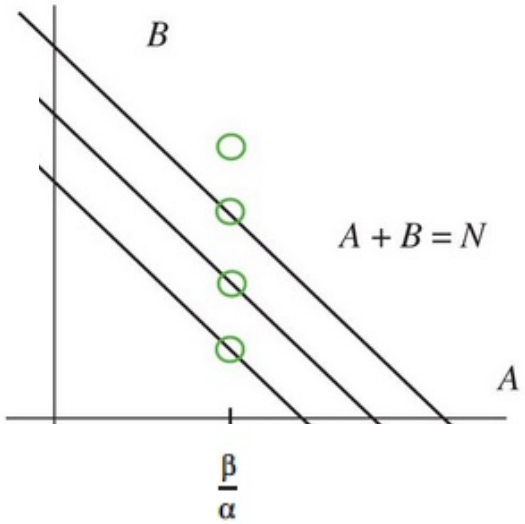
Chemical Reaction Networks, Absolute Concentration Robustness, and bifunctional enzymes.

$$A + B \xrightarrow{\alpha} 2B$$
$$B \xrightarrow{\beta} A$$

$$\dot{c}_A = -\alpha c_A c_B + \beta c_B$$
$$\dot{c}_B = \alpha c_A c_B - \beta c_B$$

$$c_A = \frac{\beta}{\alpha}$$



Fructose 1, 6-bisphosphate aldolase/phosphatase may be an **ancestral gluconeogenic enzyme**

RF Say, G Fuchs - Nature, 2010 - nature.com

Most archaeal groups and deeply branching bacterial lineages harbour thermophilic organisms with a chemolithoautotrophic metabolism. They live at high temperatures in volcanic habitats at the expense of inorganic substances, often under anoxic conditions 1. These autotrophic organisms use diverse carbon dioxide fixation mechanisms generating acetyl-coenzyme A, from which gluconeogenesis must start 2, 3, 4. Here we show that virtually all archaeal groups as well as the deeply branching bacterial lineages contain a …

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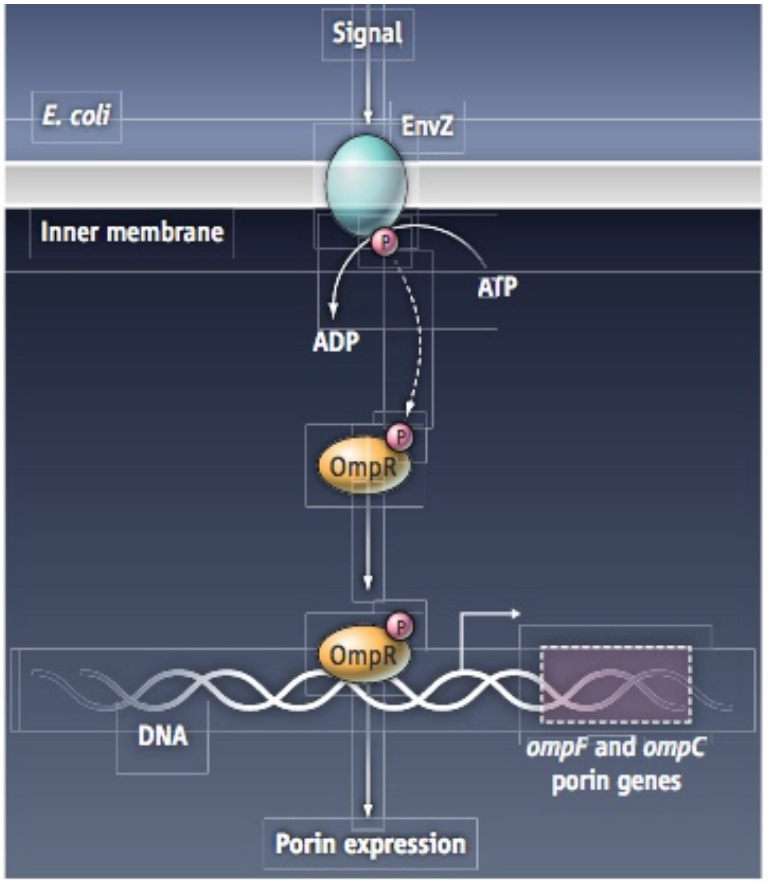

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Challenges:

- For most networks of interest, analytical solutions to their mass-action equations are intractable or non-existent.
- Conditions for the existence of absolute concentration robustness (ACR) remain mostly unknown.
- However, we have some heuristics of where to look for networks exhibiting ACR.
- Parallelizing the generation and stability analysis of chemical reaction networks would alleviate the combinatorial explosion.
- Clustering these networks based on their respective topologies could provide us with intuition for discovering necessary and sufficient conditions for ACR.

n	The number of Sudoku grids of order n (boxes are size $\sqrt{n} \times \sqrt{n}$)
1	1
4	288 [4][5]
9	6,670,903,752,021,072,936,960 [4][6]
16	5.96×10^{98} **(estimated)** [7]
25	4.36×10^{308} **(estimated)** [8]

References:
1. German A. Enciso, J. R. Soc. Interface 2016 13 20160475; DOI: 10.1098/rsif.2016.0475. Published 31 August 2016
2. Jeremy Gunawardena, *Science* 30 Apr 2010: Vol. 328, Issue 5978, pp. 581-582
3. R. F. Say, G. Fuchs,Nature, *464, 1077 (2010)*.
4. Guy Shinar, Martin Feinberg, Science. 2010 Mar 12;327(5971):1389-91.
5. https://en.wikipedia.org/wiki/Combinatorial_explosion