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About the repository

- ### About the pathway illustration

The diagram illustrates a metabolic pathway for the conversion of formaldehyde (HCHO) to carbon dioxide (CO₂), integrated with genetic circuits for three organisms: *E. coli* B121Cb, *E. coli* B121s, and *Synechococcus elongatus* PCC 7942.

Metabolic Pathway:

- HCHO** is converted to **CH₃OH**.
- CH₃OH** is converted to **CH₃CHO** by the enzyme **CH₃OH dehydrogenase** (represented by a square).
- CH₃CHO** is converted to **CH₃COOH** by the enzyme **CH₃CHO dehydrogenase** (represented by a square).
- CH₃COOH** is converted to **CO₂** by the enzyme **CH₃COOH dehydrogenase** (represented by a square).
- CO₂** is converted to **CO₂** (output).

Genetic Circuits:

- E. coli* B121Cb:** A genetic circuit (represented by a square) that takes an input (represented by a circle) and produces **mRNA** for **FrmR**. **FrmR** is then translated into **FrmR** protein, which inhibits the input. The circuit also produces **mRNA** for **4GFP**, **fghA**, and **fgh**.
- E. coli* B121s:** A genetic circuit (represented by a square) that takes an input (represented by a circle) and produces **mRNA** for **inv**. **inv** is then translated into **inv** protein, which inhibits the input. The circuit also produces **mRNA** for **inv**.
- Synechococcus elongatus* PCC 7942:** A genetic circuit (represented by a square) that takes an input (represented by a circle) and produces **mRNA** for **inv**. **inv** is then translated into **inv** protein, which inhibits the input. The circuit also produces **mRNA** for **inv**.

Integration:

- The **CO₂** output from the metabolic pathway is used as an input for the *E. coli* B121Cb and *E. coli* B121s genetic circuits.
- The **glucose** output from the metabolic pathway is used as an input for the *E. coli* B121s genetic circuit.
- The **glucose** output from the metabolic pathway is used as an input for the *Synechococcus elongatus* PCC 7942 genetic circuit.
- The **glucose** output from the metabolic pathway is used as an input for the *Synechococcus elongatus* PCC 7942 genetic circuit.
- The **glucose** output from the metabolic pathway is used as an input for the *Synechococcus elongatus* PCC 7942 genetic circuit.

Yes, all data are open-sourced. Check the `./RawData` directory.

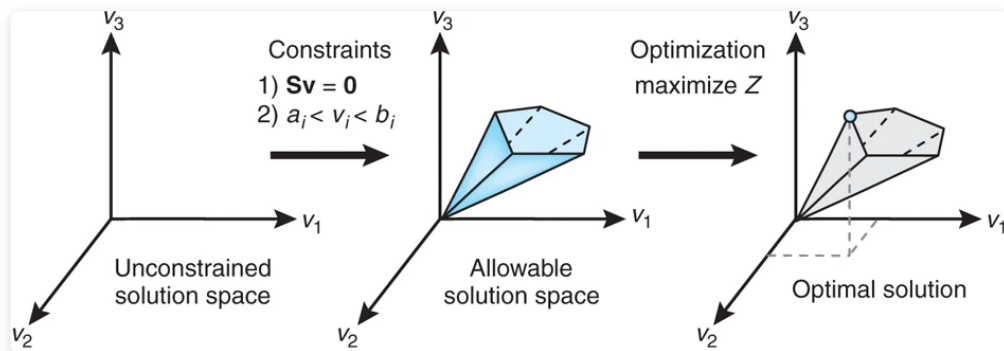
About questions

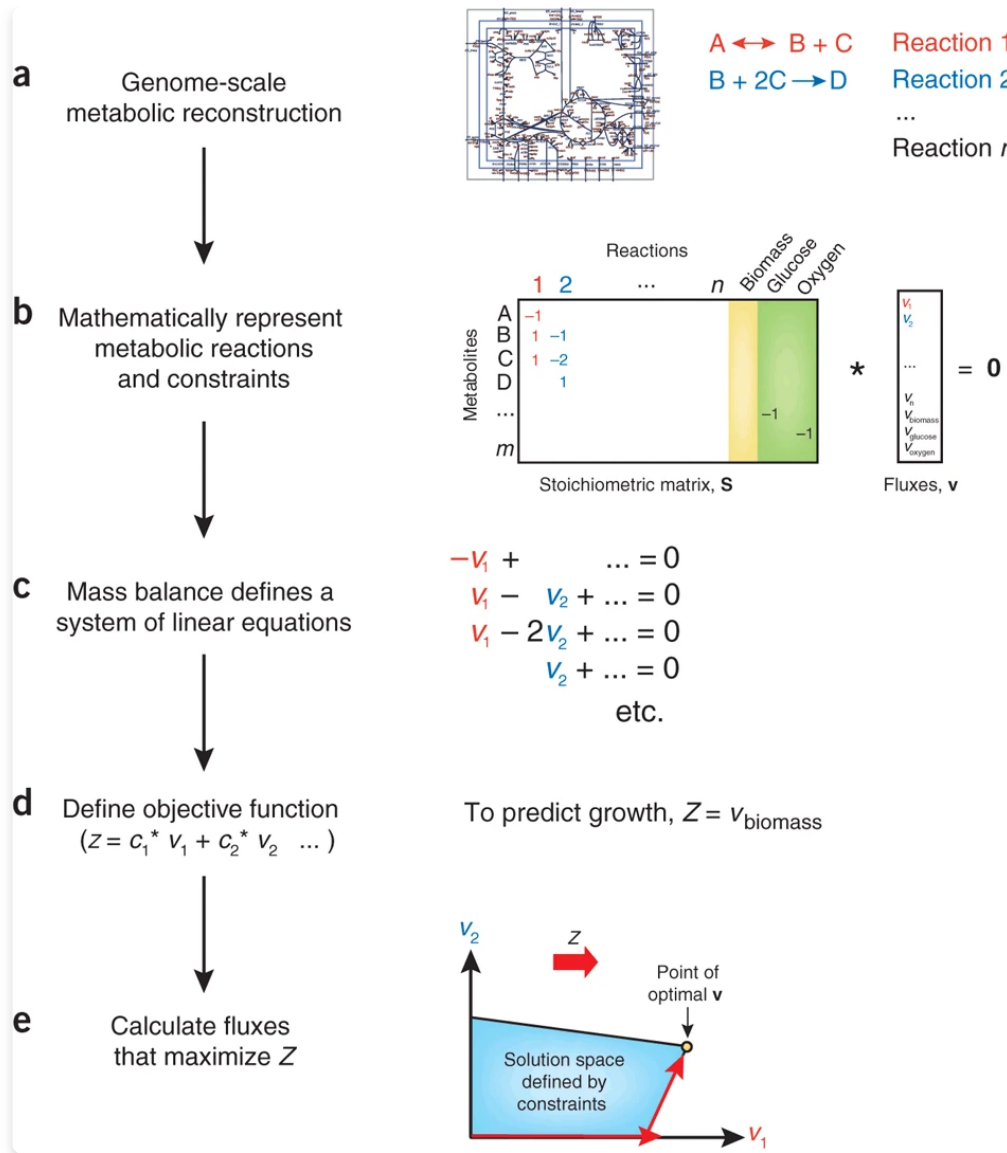
If you have any questions about our project, you may **open an issue** and illustrate your question in detail. I am not really familiar with all the math behind the method, so do not expect too much on this. I can find some sources referred to maybe.

1. FBA (Flux Balance Analysis)

When considering the analysis of metabolites flows on a metabolic network, FBA is a common and useful mathematics tool. Basically, FBA is trying to solve a **constraint-based optimization problem**.

You can refer to [this paper](#), which introduces the definition of FBA and the mathematics behind it, especially the Figure 1 and Figure 2 which are posted here.





COBRA Toolbox

The toolbox [COBRA](#) mentioned in the paper is useful in implementation. We choose MATLAB version, though Python version is available as well.

BiGG database

[BiGG database](#) played an important role in providing well constructed model in a friendly format for COBRA.

FEM (Finite Element Method)

This is a numeric method widely used in simulation. The key idea of it is to divide **continuous bodies** into **discret small mesh of simple parts**, or elements. Refer to [wiki in Brilliant](#) for a better, rough understanding. Notice that the implementation of FEM is highly related to the problem's definition, so further research in the implementation in specific fields may be necessary.

We use MATLAB to finish the modeling and solving.

Things We learned

Clarify the problem

A clear definition of problem is one of the parts in the first step of modeling. Make sure what is the problem to solve, then there is a direction for research.

Talk to others in group

Make sure everyone is actively engaged in the project and know what are others doing, which will prevent work on the same thing or something is missing due to lack of communication.

Talk to other groups

This is very important and easy to forget. One of the requirements of [best model in iGEM](#) is about the special contributions of model to the whole project.

What's more, communicate with other groups may help them strengthen the relation of their work with yours.

Cite everything

This will not only prevent a plagiarism issue, but also support the results with solid sources.

If you use any tool, conclusion, data that are not originated from you, cite it in correct format, APA 7th for example.

Great example

[Toulouse_INSA-UPS, Best model nomination](#): inspired us of the usage of FBA

Reference

Orth, J., Thiele, I. & Palsson, B. What is flux balance analysis?. Nat Biotechnol 28, 245–248 (2010).
<https://doi.org/10.1038/nbt.1614>