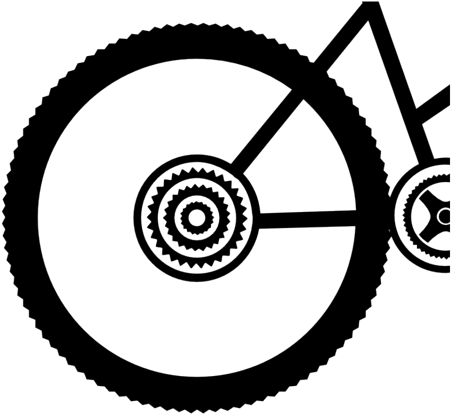
MODELiGEM

RubberBye

Jamboré Meetup 2015

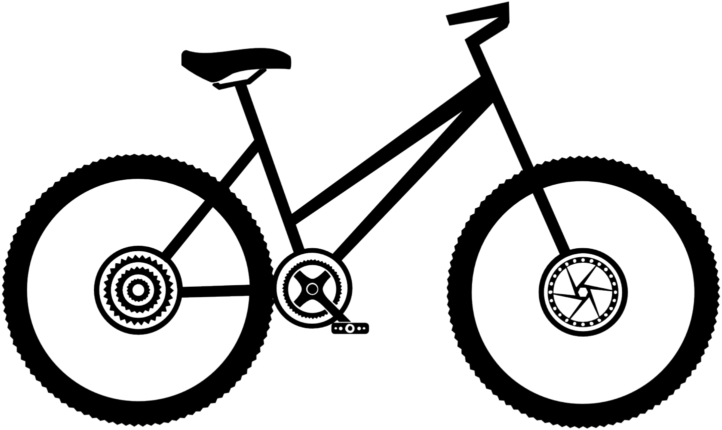
@ IFSC - USP - Brazil July 18th 2015

What is modeling...?



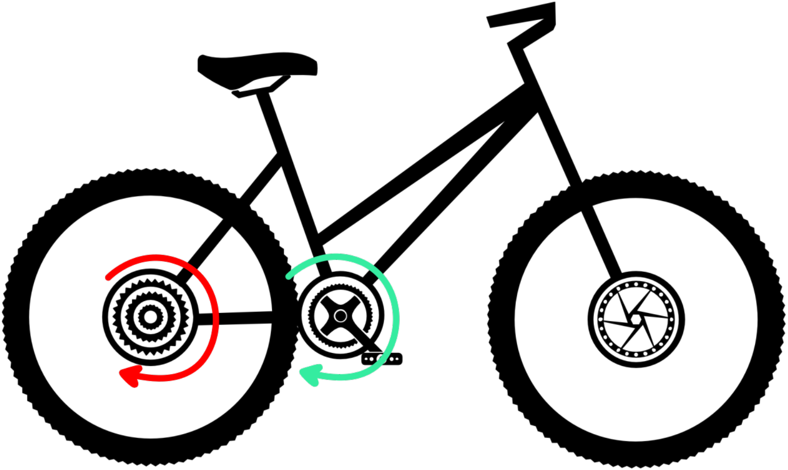
A problem

Can we explain why is it easier to climb up hill with a lower gear in our bike?

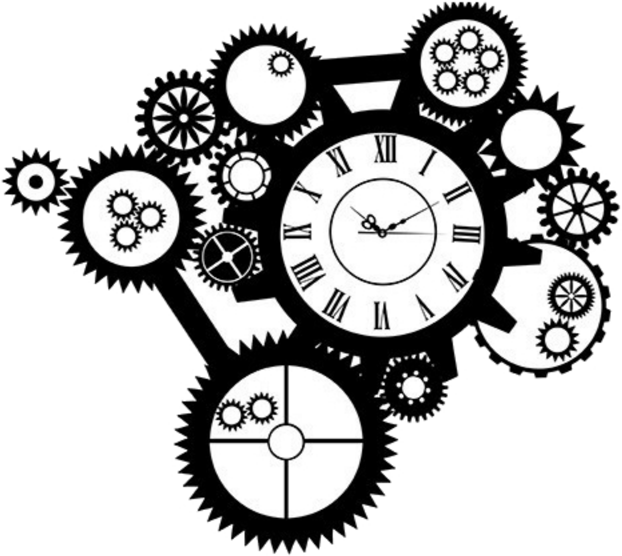


The solution is using COGS

And this is why...



This is precisely how clocks work!



This is a perfectly fine explanation!

But there is a problem: we can't measure it!

This also means:

- We can't test it!
- We can't make predictions!

What do scientists sell?

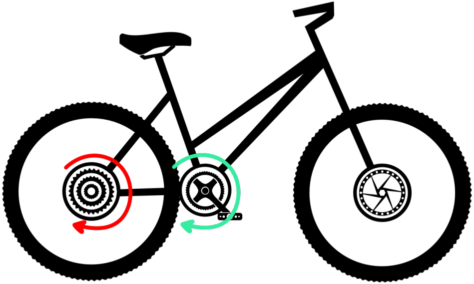
Ideas!

If you understand something, you should always try to disprove yourself.

That is the whole idea behind constructing models

- Let's construct a simple model
- We should be able to test out model!
- We should be able to make predictions!

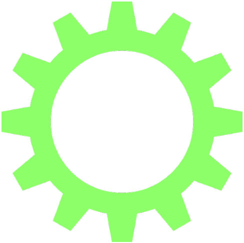
How do bike gears work?



- Suppose we fix the front gear, with radius L_f
- Let L_b be the radius of the back gear
- Let Δ be the length of a gear tooth
- The number of teeth in a gear with radius L is

$$\frac{\text{Circunference Length}}{\text{Length of each Tooth}} = \frac{2\pi L}{\Delta}$$

How do bike gears work?



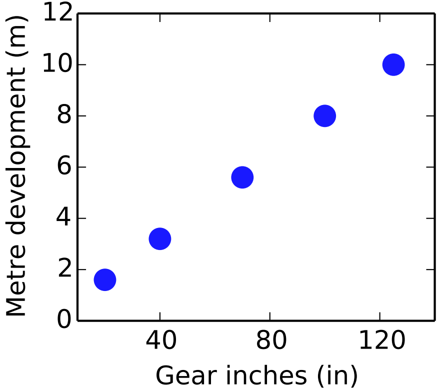
- A full rotation makes ALL TEETH pass through a point.
- Therefore, if the front gear rotates 360^o degrees, then the back gear will rotate

$$n_b = \frac{2\pi L_f L_b}{\Delta^2}$$

- Linear in L_b?!?!

Calculating in meters, one rotation means $(2\pi)^2 \frac{L_f L_b}{\Delta}$

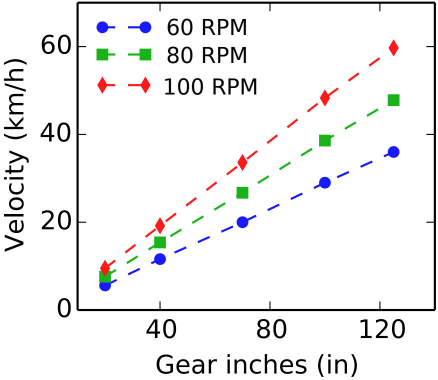
Actual measurements:



How about now rotating the front gear
with constant frequency F??

Model prediction: $v = F(2\pi)^2 \frac{L_f L_b}{\Delta}$

Thus: the higher the rotation, the steeper the curve!



- Modeling gives you predictive power!

- It also makes you more confident that you actually know what is going on!

Model is not suppose to be representing the true!

It should, however, represent a
simplistic, clear, testable, mechanistic view
of how your system behaves!

Then it comes Systems Biology!

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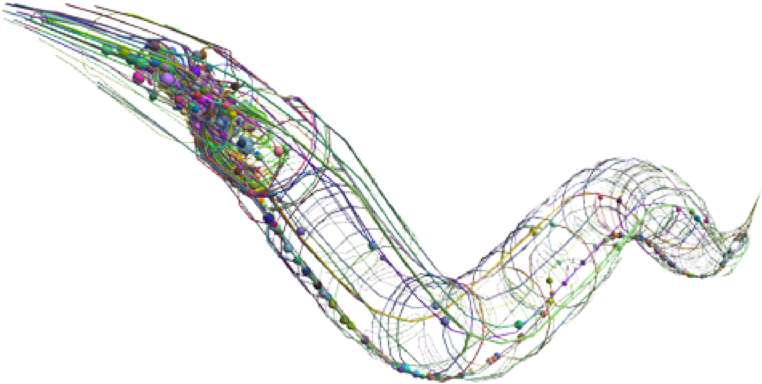
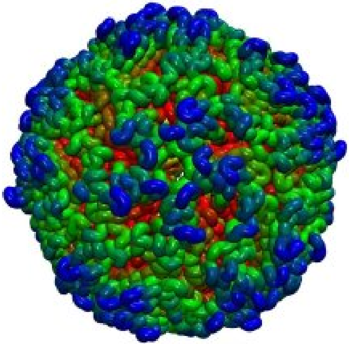


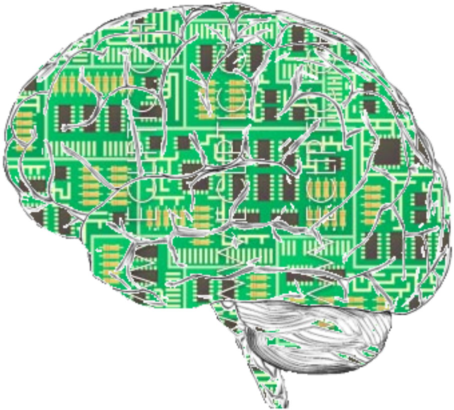
Then it comes Systems Biology!



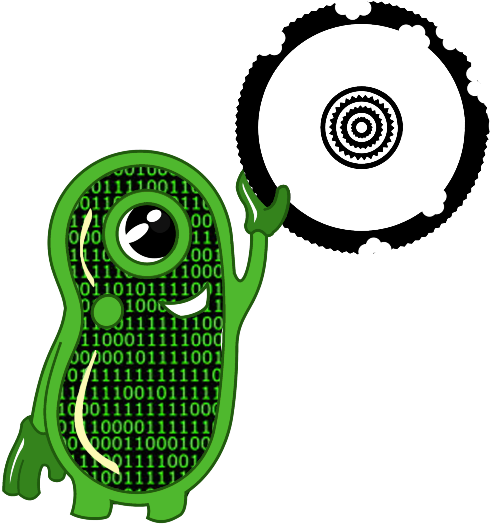
Theoretical and Computational Biophysics Group
Beckman Institute
University of Illinois at Urbana-Champaign

Then it comes Systems Biology!

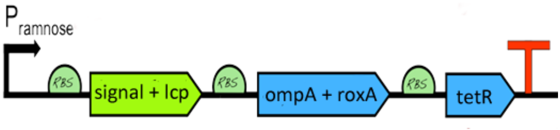
Blue Brain Project

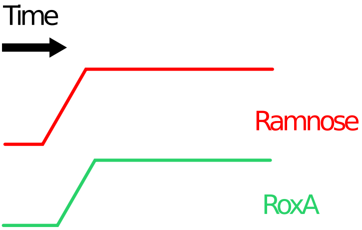


Let's go back to the tire...



Our RubberBye degradation circuit





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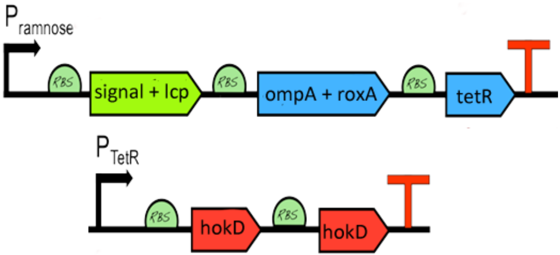

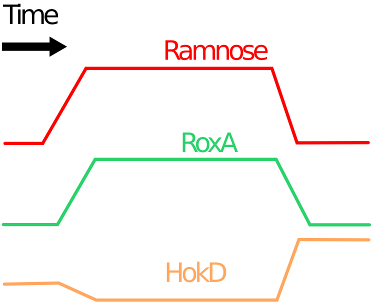

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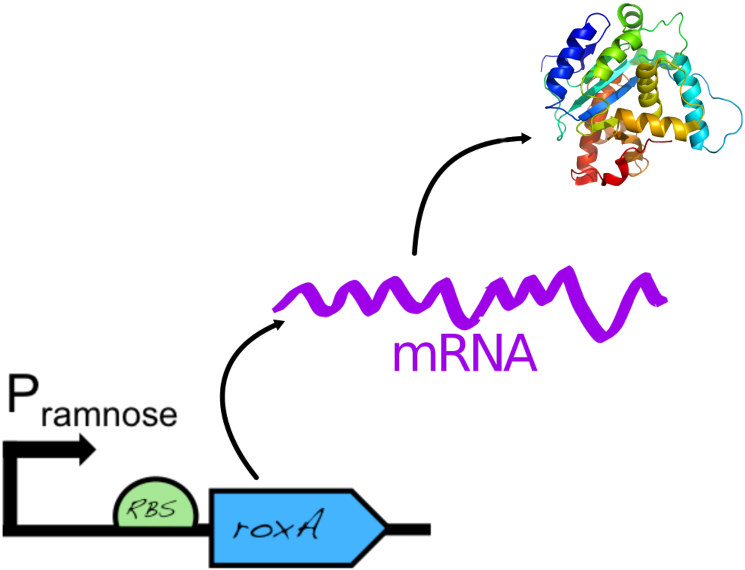

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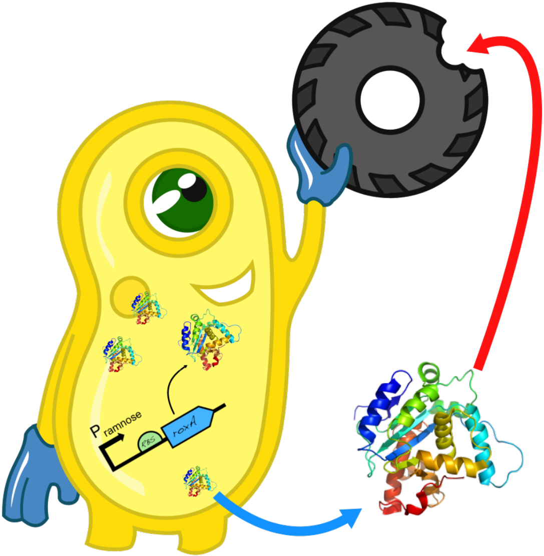


Our RubberBye degradation circuit

For roxA:

$$\frac{dM_r}{dt}(t) = -\alpha_r M_r(t) + \beta_r \frac{P^n(t)}{K^n + P^n(t)}$$

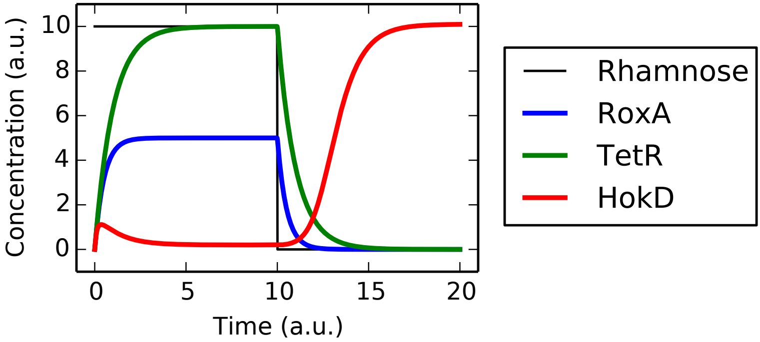
$$\frac{dP_r}{dt}(t) = -\delta_r P_r(t) + k_r M_r(t)$$

For hokD:

$$\frac{dM_h}{dt}(t) = -\alpha_h M_h(t) + \beta_h \frac{1}{1 + \frac{P_t^n(t)}{K^n}} + \beta_{lh}$$

$$\frac{dP_h}{dt}(t) = -\delta_h P_h(t) + k_h M_h(t)$$

Let's check how the system behaves if we
drop Rhamnose concentrations at some point...



- In conclusion: modeling is easy!!

- There are another challenge in our project: our enzyme's product is most of the time exactly the same as our substrate.

- To fix it and make enzymatic assays, we've re-derived a Michaelis-Menten like kinetics.

- We are now fitting our model with fluorescence experiments!

- We will use our simulations to guide us through scaling up to the industrial level!

A big thanks to our sponsors!

And thank you for your attention :)