System Dynamics PART 2

An Insight into InsightMaker

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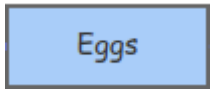
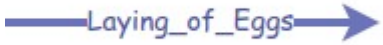
First a quick recap...

System Dynamics Building Blocks

Here are the key building blocks of a SD model :



Stock : A stock holds the “stuff” that is flowing around the system. Imagine a water tank.



Flow : Flows allow the “stuff” to move around the system. The rate at which the “stuff” flows can be controlled by the valve.
Imagine water flowing through pipes.

Variable : A variable represents something that is not otherwise captured by the model, but will influence a stock’s level or a rate of flow.

Link : A link indicates that a stock’s level or a flow rate is affected by a stock’s level or a variable.

Key “Quirks” of SD Models

SD models are a little different from the models that you’ve seen so far. In particular :

- the entities that are flowing through the model are not represented as individual entities, but as a continuous mass (think of water)
- SD models are not stochastic, but *deterministic*. That means that every time you run a SD model, you’ll get exactly the same results.
- with SD models, we’re typically interested in generally patterns / dynamics within the system, rather than accurate predictions such as “you need x doctors to meet this demand y% of the time”.

Let’s look at an example of some of these “quirks” for the Chicken and Egg model. We said that eggs take, on average, 21 days to hatch. Let’s imagine we have our time unit representing weeks (as we know chickens lay an average of 5 eggs per week).

How do you think we will describe the number of eggs hatching per week?

Key “Quirks” of SD Models

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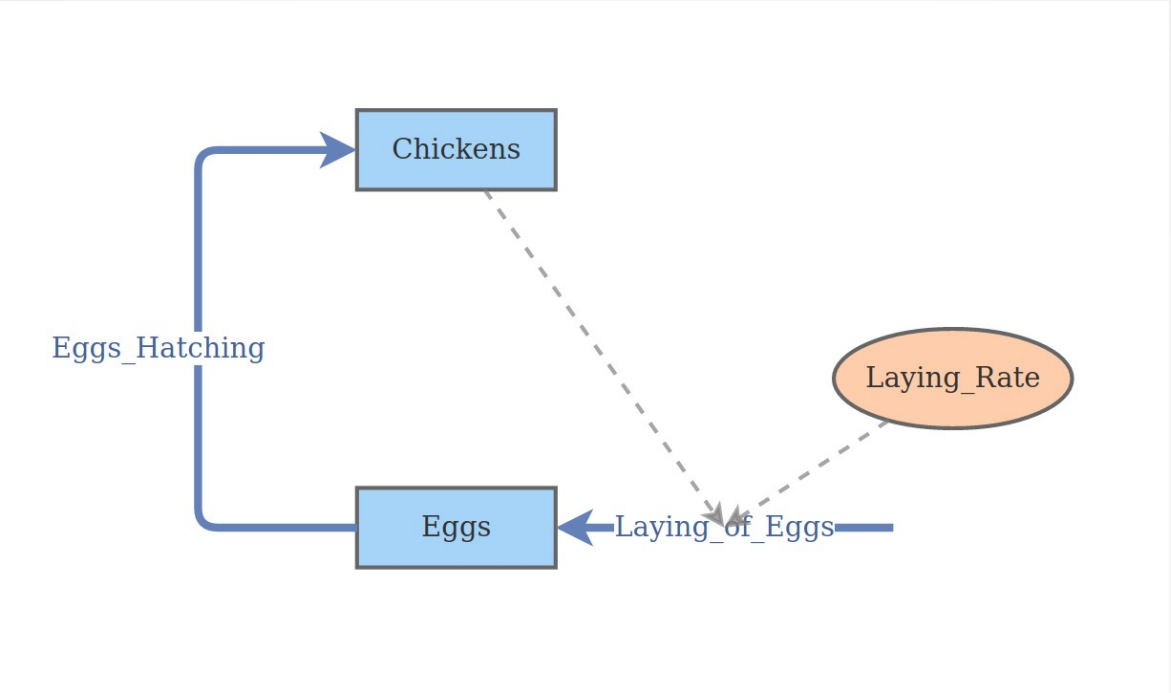
ANSWER : Number of Eggs / 3

WHY?
If we had 1 egg, it would take 3 weeks (21 days) to hatch. In SD world, this means that one third (or 1/3) of the egg would hatch per week.

If we had 2 eggs, each week one third of each egg would hatch. Which means after week 1, we’d have two one-thirds of eggs hatched (or 2/3 of an egg hatched). Think about it after three weeks, we’d expect 2 chickens. 3 x (2/3) = 6/3 = 2

Essentially, we’re saying :
eggs hatching per week = number of eggs x 1 / 3 (a third of each egg we have).
Which we simplify to : Number of Eggs / 3

The Chicken and Egg Model



https://insightmaker.com/insight/112161/ChickensEggs

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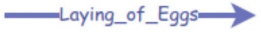

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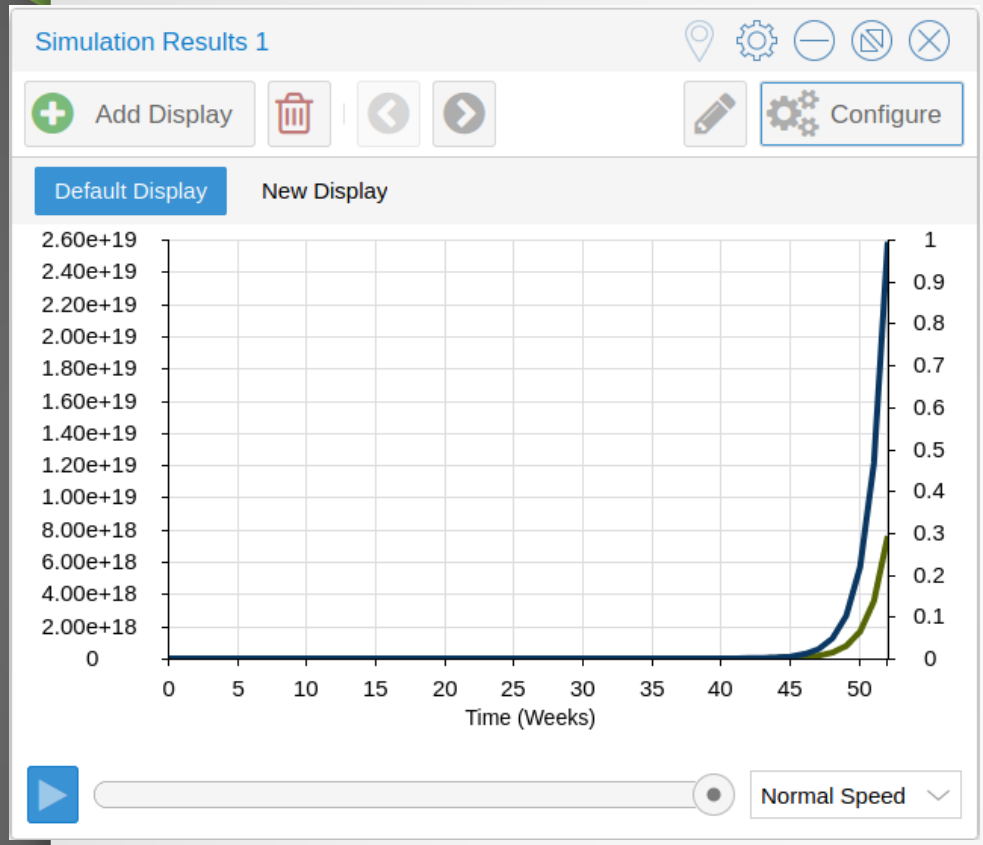
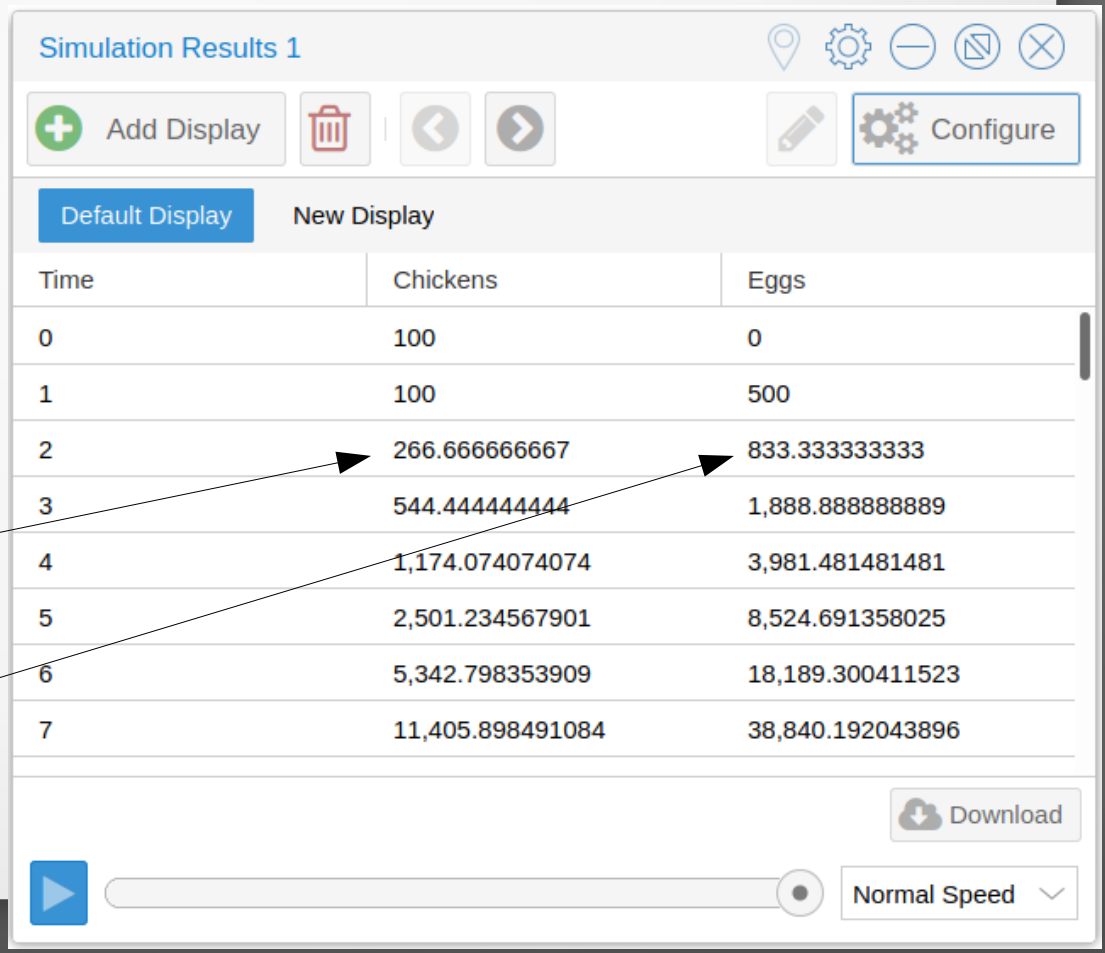




100 old + (500 / 3) new

500 previous + 500 new – (500 / 3 ready to hatch)

Exercise 1

Your first task is to expand the chicken and egg model we previously demonstrated. You'll take a copy of the model (by "cloning" the insight) and then make the following changes to the new copy :

- Not all eggs are fertilised. Make the proportion of eggs fertilised a user-definable variable (with slider), defaulting to 1. You should only model fertilised eggs in your model.
- Chickens can either die through natural causes or predation by foxes.
- Chickens have an average lifespan of around 7 years.
- Foxes give birth to around 5 kits per year. Start with 100 foxes in the model, and no kits.
- Kits move into adulthood (when they start finding their own food) at around 12 weeks of age.
- Foxes have an average lifespan of 4 years.
- We'll make an initial assumption that each fox kills 1 chicken every 5 weeks. Make this a user definable variable (with slider).

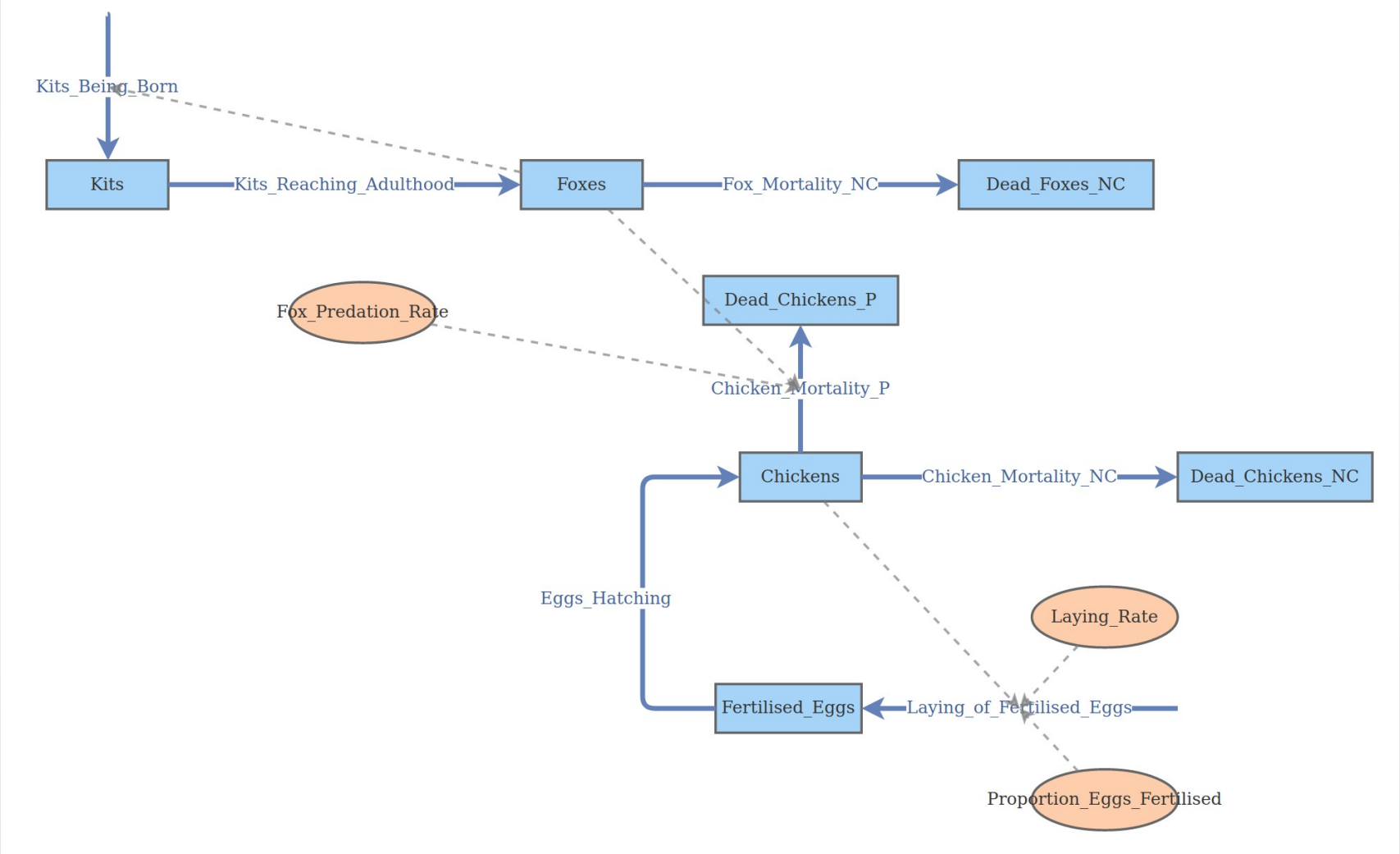
Once you've built this new expanded model, use it to answer the following questions :

a) Assuming all else is as above, what is the minimum proportion of eggs that need to be fertilised to ensure our chicken population doesn't die out within 1 year?

b) If 80% of eggs were fertilised, how much more regularly would a fox need to kill a chicken to make the species extinct within a year?

You should work in groups. You have 1 hour.

Exercise 1 Solution



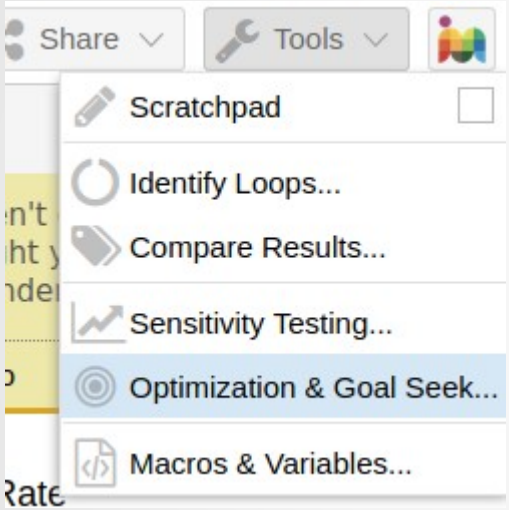
a) At least around 8% of eggs would need to be fertilised to ensure the chicken population doesn't die out

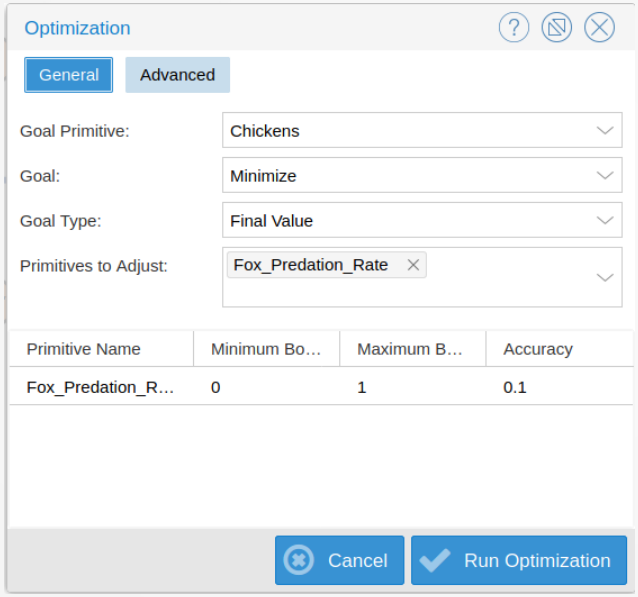
b) Foxes would need to kill chickens around 5 times more regularly (1 chicken per fox per week) to make chickens extinct within a year

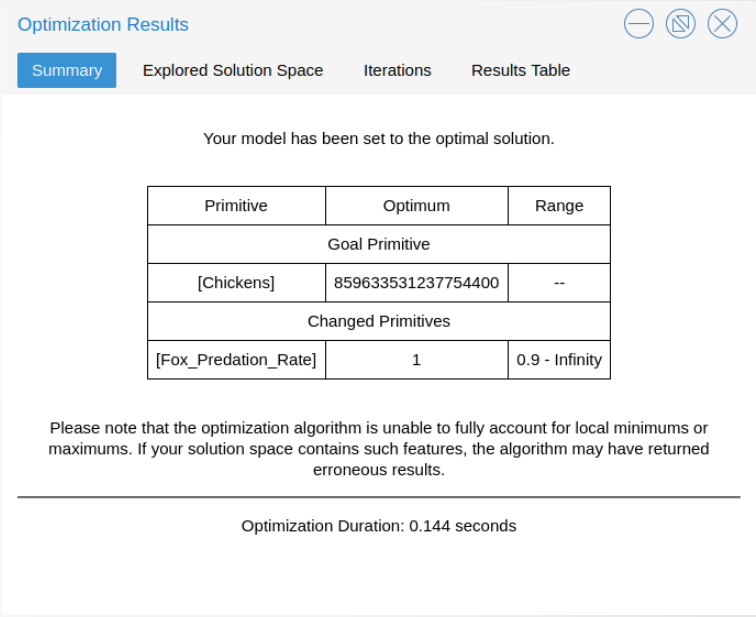
Optimisation and Goal Seek

In the exercise, we manually tested different values in our model to answer the questions.

However, InsightMaker has a more efficient way of doing things – Goal Seek and Optimisation.

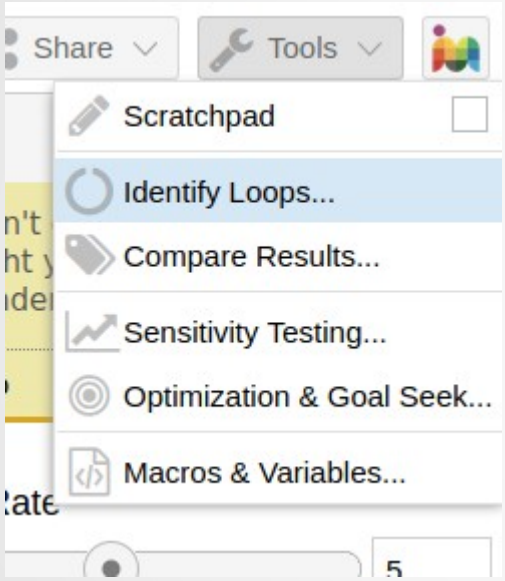


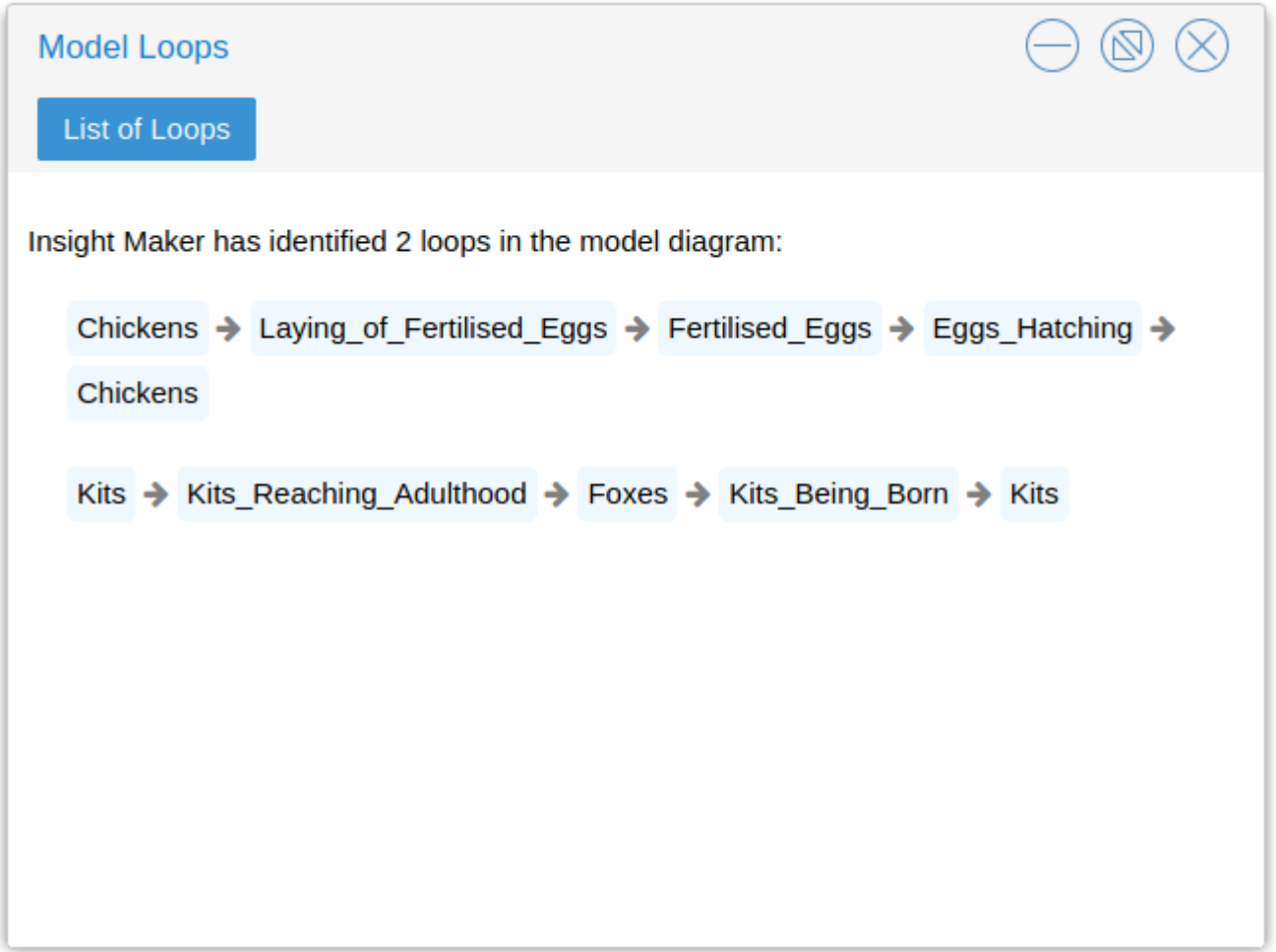




Automatic Loop Identification

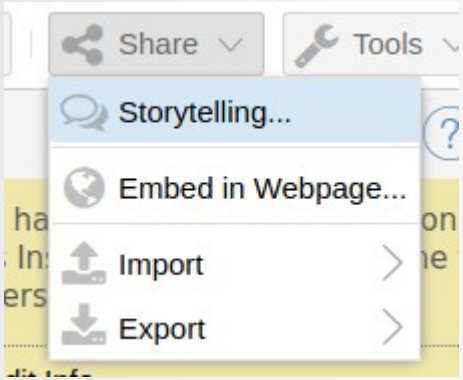
We can also use InsightMaker to automatically identify loops in our model :

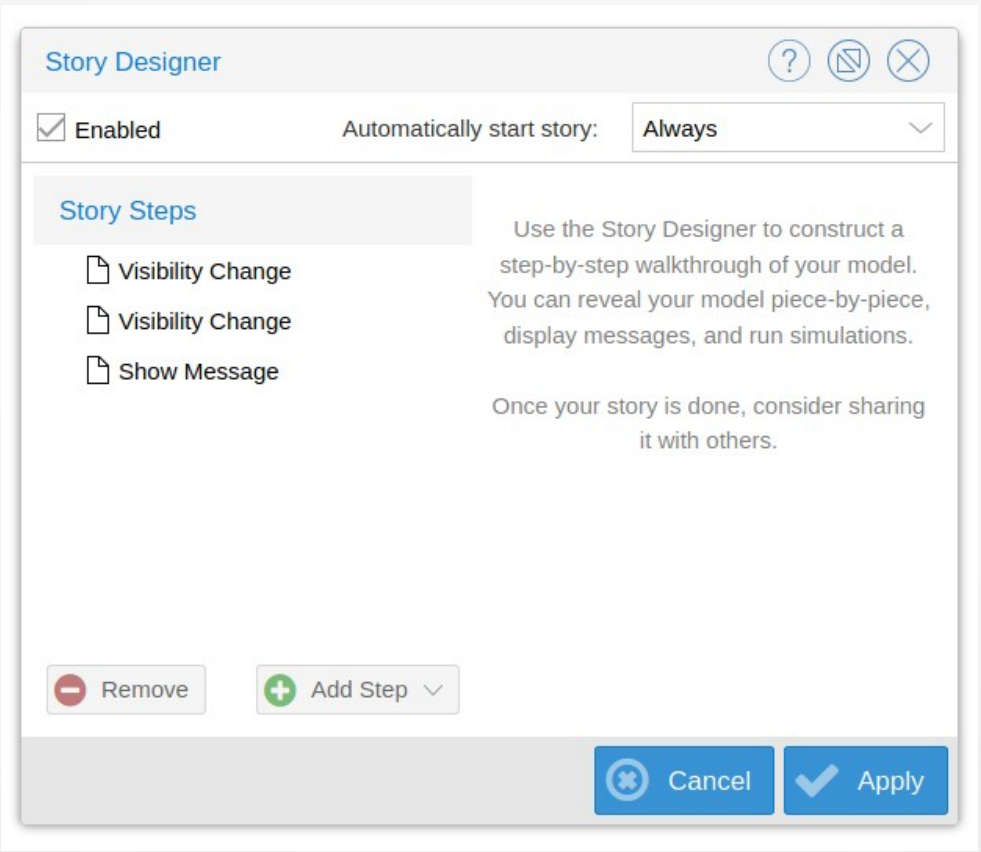


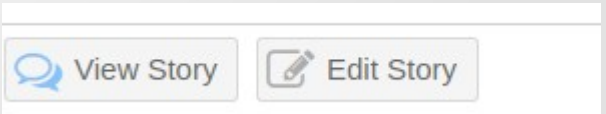


Storytelling

Storytelling is a feature that allows us to tell a story with the model, by guiding the user through a tour of the model. We can choose which bits of the model to show and when, display narrative messages, run the model at given points and more...

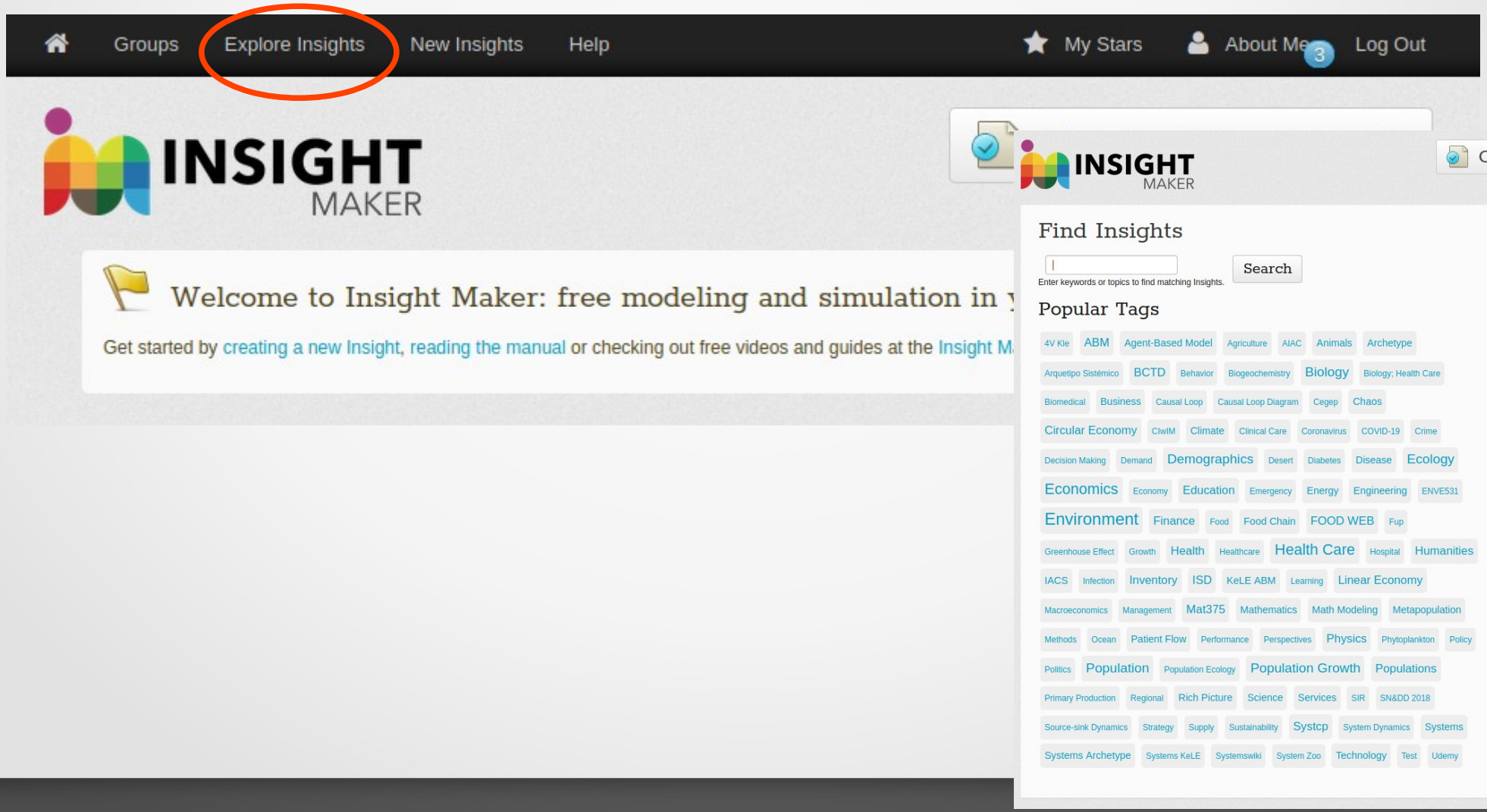






Searching for Insights

Many insights that people create are shared publicly, and you can search on key words in the “Explore Insights” facility of InsightMaker.



Exercise 2

Split into 4-5 groups. In your groups, I want you to use the Explore Insights facility to explore System Dynamics models that have been designed by other users to address COVID-related issues.

Then, pick a model that you come across and explore the model further – get a sense for how it works, what it's trying to do and the results generated by the model.

In 40 minutes, I'm going to ask you to come back, and for each group to give a short (max 5 minute) talk on the model you've selected, which should outline :

- the problem the model was trying to solve
- a brief description of how the model works
- key results / insights generated by the model
- any notable features in the model (e.g. use of storytelling to aid visualisation, other visual aspects)
- a short critical appraisal of the model (what do you think about the model? What works well? What would you have done differently?)