Getting Started with Framsticks

Part 1: Evolving virtual creatures

Start the Framsticks program. This tutorial will be using the GUI, although a more complicated command line interface is available.

So, you are bombarded with a group of windows and options. Seems complicated. We will worry about these later. For now, just follow along and evolve some creatures.

First, click the *Simulation* tab up top and go to *Parameters*.

Here you will find more options, but don't worry. The parameters window is the heart (or maybe brain) of the Framsticks simulator. You will learn to utilize it in many different ways.

The *Experiment* screen is where you will load and initialize different experiments that you set up. For now, just set the experiment definition to standard and click *Apply* followed by *Initialize experiment*. This sets all of your parameters to the default, standard settings.

The next thing we should do is explore some parameters. Click the *Parameters* dialog on the left. There a few settings you can change here. We will alter these later.

Click on the + icon on the parameters dialog to reveal a few more sub-folders. Click the *Fitness* tab. The Fitness setting is crucial to your experiments. This is where you set your fitness function. Your creatures will be evaluated by these settings.

For example, if you want to evolve creatures that move very fast, you can set one point in velocity. This is a multiplier that increases the total fitness of a creature if it has a higher velocity score. Just put 1 in velocity and 0 in everything else. Let's get some creatures evolving.

Click Apply and then go back to the experiment dialog. Before you start any experiment, always make sure to click *Apply* and *Initialize experiment* on this page. This makes sure your settings and parameters are loaded and ready to go.

Close the Parameters window.

Click the red play arrow icon at the top. You will notice a few things start to happen. First, in the top right, you will see cogs moving and the word RUNNING. This lets you know your experiment is running. You will also notice a number of steps. This lets you know how many steps your experiment has gone and the speed at which it is progressing.

By now, you should have noticed that there is something going on in your *Artificial World* window. You will see what looks like a stick. After so many steps, the stick disappears and a new stick arrives.

So what's happening here? Well, your population starts as 1 little stick. From here, the stick is tested in the environment (the artificial world) and its fitness is calculated. The stick then mutates or crosses over (based on settings and parameters you choose) and a new stick enters the gene pool. This stick is then evaluated, and so on.

You can see your gene pool window starting to populate. You may notice some unusual names and notation. This is Framsticks' way of naming different creatures and combinations of parts. Each genotype has stats for number of joints, brain size, velocity, etc. These stats should look familiar! They correlate with the multipliers you set up in the Parameters window. So take a look at two of these stats right now. Make sure your window displays a genotype's *Velocity* and its *Final fitness*. You can do this by right clicking on one of the stats and going to *show columns*. Then make sure that velocity and final fitness have a check mark. You can uncheck some other stats that you aren't concerned with right now.

Now that these stats are displayed, you can start to analyze your data. Click the velocity tab to sort all your data in order, greatest to least. Notice that the genotypes with the highest velocity, also have the highest fitness. This is no coincedence. Remember that you set the velocity multiplier to 1 and everything else to 0. This means that creatures that happen to display some movement (velocity), will have a higher fitness.

Depending on how you set your parameters, these high-fitness individuals will survive in the gene pool longer. (There are several selection options you can change.)

So your gene pool is filling up as you can see by the greater amount of genotypes filling the window. You can change your gene pool limit, the default should be 200. The lower window is your population window. This shows how many creatures are in your actual population (the artificial world). At this point, there should only be 1 creature in this population at any given time. You can change this setting as well to allow multiple creatures to coexist in a world.

Right now, your creatures are likely still very boring. They are probably just different types of sticks. So let's make things more exciting. Let's speed up the evolution, we don't have time to wait a million years.

To speed things up, there are two settings you must toggle. The first is in the top right corner of the Artificial World window. It should say something like Every 50fps. Don't worry about the exact specifications of this option, just increase it to 1:1000. You will notice the speed of evolution increase dramatically. You can see many different creatures very quickly in your window. You will notice that some of them have become more complex with branches and so forth. Let's speed things up even more. On the left side of your population window, you will see a similar looking toggle. (Down at the bottom left). Set that to 1:10,000. Things should be even faster.

Now that things are moving at max speed, you can sit back and watch the evolution. This is a good time to sort your data and start analyzing different stats. Notice how over time the creatures' velocity is increasing as well as the fitness. Once your velocity has improved a sufficient amount, go back to the speed toggle in the artificial world window and choose "Every". This will slow things down enough for you to see what each individual creature is doing. Some of your creatures may wiggle around a bit and then stop cold. Others may not move at all. The longer you let your creatures evolve, the more fit they will get. Remember that you set your velocity multiplier to 1 and everything else to zero. So over time your creatures will have higher and higher velocities. You may find they start doing some really interesting things. Some may even look like actual creatures running around. It just takes time, and nothing is for certain.

Part 2: Playing with Parameters

Start by clicking the "*x*=" button, which opens the simulation parameters window. Alternatively you can use the drop-down menus and navigate to Simulation > Parameters...

The *Experiment* menu

Here you choose a preconfigured experiment, click "Apply", and then "Initialize experiment". After doing this you may run the experiment as is, or tweak various settings to your liking. The "standard" experiment gives the most freedom regarding settings changes, and using it is probably the best way to get acquainted with Framsticks. (Note: Many settings described on this page may be specific to the "standard" experiment.)

Other experiments of note:

- boids
- evolution_demo (small population arranged in a circle; individuals replaced based on middle creature's fitness)
- generational (simple genetic algorithm experiment; fitness function defined in generation's settings)

Experiment > Parameters

- **Gene pool capacity** changes the amount of genotypes in your pool.
- **Simulated creatures** allows you to add multiple creatures into the same environment. If you want to test the fitness of multiple creatures at the same time, that perhaps even interact with each other, you can do that here. Otherwise, just keep it at 1.
- **Initial placement** lets you specify where a creature spawns in the environment. They can spawn randomly on the grid, or always in the center.
- **Initial orientation** lets you specify which direction a creature faces when it spawns.
- **Initial elevation** allows you to start your creatures at various distances above the ground. Negative values can be used in water environments.

Experiment > Parameters > Selection

- Here you can alter your selection settings.
- **Unchanged** is the percentage of genotypes in your pool that do not change for the next generation.
- **Multiple evaluation** allows for creatures to be evaluated several times for an average fitness.
- **Mutated** sets the percentage of creatures that undergo mutation for the next generation.
- **Crossed over** sets the percentage of creatures that are crossed over for the next generation.

Note: Unchanged + Mutated + Crossover should total 100.

- **Minimal similarity** allows you to avoid crossing over genotypes that are too similar.
- **Selection rule** specifies the method of selection. You can choose random, fitness proportionate or tournament-style.
- **Delete genotypes** has three options. Randomly, inverse proportional, and only the worst. If you want to add some element of elitism into your simulation, make sure to choose inverse proportional or only the worst. This means that the higher fit individuals will have a smaller chance of being deleted when the gene pool is at capacity. If you choose only the worst, then only the least fit individuals will be deleted at this stage.

Experiment > Parameters > Fitness

This screen is very important. This is where you can alter all of your fitness multipliers. Most of the stats are self-explanatory. A higher multiplier in "body parts" will give creatures with more body parts a higher fitness. You can set multipliers for multiple different attributes as well as use negative values to discourage certain traits. Evolving creatures for specific tasks involves a lot of tinkering with ratios and

so forth to find the best balance. Remember the law of "uphill analysis and downhill invention". Trying to analyze which traits will produce certain outcomes is much more difficult than simply setting various configurations and watching what grows. In addition, you may be surprised at the results you find. Setting a higher distance multiplier may not always lead to creatures that run far, they may run in circles or even grow very tall and simply fall a great distance.

Remember what Jeff Goldbum says in Jurassic Park: "Life always finds a way".

Experiment > Parameters > Energy

- **Starting energy** is how much 'health' your creatures have.
- **Idle metabolism** is how much their health degrades at each step.
- **Automatic feeding** allows food to spawn in the world that the creatures can eat.
- **Food's energy** is how much health a piece of food will restore to the creature.
- **Ingestion multiplier** increases or decreases the effect of food.
- **Aging time** allows increased idle metabolism after a certain point.

World

- **Type** determines whether the world is flat or not. The blocks and height field options require you to manually map the world. Blocks will create blocky height differences, while height fields will have smooth slopes.
- **Size** is the size of the world.
- **Map** allows you to manually map out heights in your world. More details here.
- **Water Level** sets the water level. Main surface is at 0.0.
- **Boundaries** sets whether the world is unlimited (None), the creature is restricted to the world (Fence), or the world's boundaries simply wrap around to the opposite sides (Teleport).

And some miscellaneous settings...

Experiment > Parameters > Extras

- **Boost Phase After Stagnation**: After stagnation has been detected, toggling this setting will tweak experiment settings temporarily in order to boost evolution at the cost of quicker convergence and a higher selection pressure.

Experiment > Populations > Creatures

- **Group Name** lets you rename your population.
- **Energy Calculation**: If this setting is off, your creature's energy will be constant.
- **Death**: If this setting is on, your creature will die when its energy reaches 0.