Soda Constructor Physics

Age group: 11 – adult

Abilities assumed: Basic digital literacy

Time: 30-45 minutes

Size of group: 1 upwards

Focus

Computational Thinking, Algorithmic Thinking, Computational Modelling, Physics, gravity, springs, mass, friction.

Syllabus Links

This activity can be used (for example)

- as a general introduction to applications of algorithmic thinking in the form of computational modelling from KS2 up.
- as a general introduction to physics from KS2 up.
- to show how computational models can be used to understand real-world phenomena from KS2 up.

Summary

You demonstrate the Soda constructor – a drawing program with the laws of Physics built in, where you can engineer creatures and create interactive art. You explain gravity, friction and springs. The class explore how they work by by playing with their effects on a series of creatures.

Technical Terms

Algorithms, computational modelling, algorithmic thinking, computational thinking, mass, gravity, friction, Newton's Laws, Hooke's Law.

Materials

Data projector to allow demonstration to class.
Computers for all students with Java installed

On all computers to be used creatures downloaded from Soda play (sodaplay.com/)
Eg

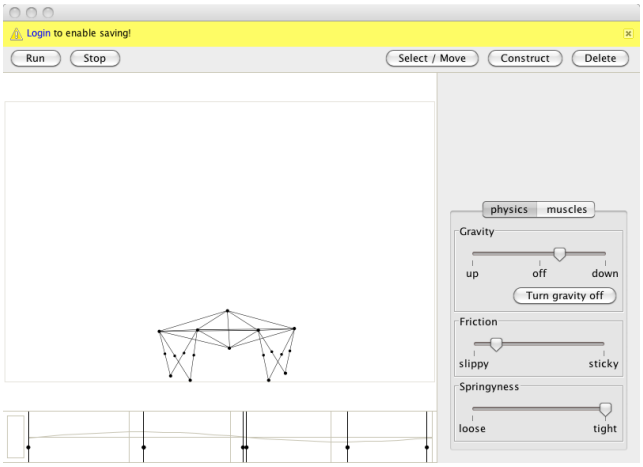
Carefulslug: http://sodaplay.com/creators/ed/items/carefulslug
Dainty Walker: http://sodaplay.com/creators/ed/items/daintywalker
Monster Truck: http://sodaplay.com/creators/karulo/items/monster_truck
mmaarrkkuuss: http://sodaplay.com/creators/mmaarrkkuuss/items/mmaarrkkuuss
inspyre: http://sodaplay.com/creators/kevino/items/inspyre
legs: http://sodaplay.com/creators/lewa/items/legs

What to do

In preparation

Download a series of Soda constructor creatures such as those suggested above on to all student machines as well as the one you will demonstrate on.

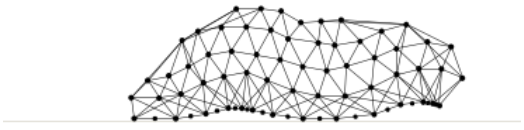
On your demonstration machine run the example creatures downloaded by opening the downloaded jnlp files so all are ready to be demonstrated. Each should be in a window like the following (here showing a Dainty Walker creature).

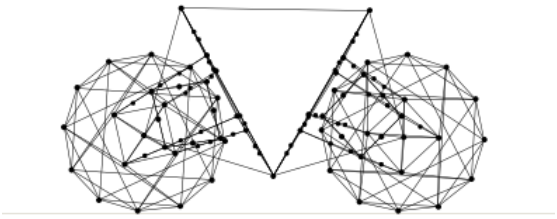


Demonstrating Creatures

Explain that Soda constructor is just a line and dot drawing programme but one with the twist that it has the laws of Physics built in. That means your creations can come to life. It is a computational model of the laws of physics. Computing + Drawing + Physics gives you a 2D virtual world.

Show the group some of the creatures that you previously downloaded – machine-like contraptions like the Monster Truck and mmaarrkkuuss, Earth like creatures such as the slug and mini-beast like Dainty Walker, and more alien creatures like inspyre. There are lots more on the Soda Play website. They were all created by people like the class and uploaded to the Soda Zoo.





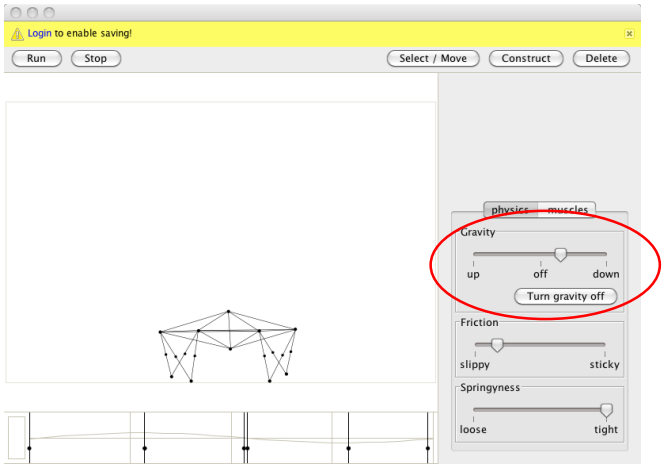
Let the class explore the different creatures. If they have an Internet connection and your firewall allows it, they can download more creatures from http://sodaplay.com/play

Play with Gravity

What do we mean by a computational model of the basic laws of physics? Soda Constructor has Newton's Laws, Gravity, Friction and Hooke's Law (which is the law governing how springs behave) built in. Let's look at gravity first.

Go back to the Dainty Walker window. Explain that every time you draw a dot in this program you are creating a mass – something that gravity will act on. When you draw a line you are creating a spring (and each spring can also be turned into a muscle by giving it energy pulses which is what allows creatures to move – but we won't go in to that in detail here - we will save it for another activity).

If it isn't highlighted already click on the "Select/Move" button at the top of the screen. Now explain what you mean when you say the Laws of Physics are built in. Click (and hold) on one of the lines at the top of the dainty walker creature and lift it up to the top of the window so it is apparently dangling in the air. Point out that it is made of lots of masses and the program has the law governing how gravity behaves built in. Ask what will happen if you let go? Let the group predict that it will fall and then let go to see if they are right. You can then do more experiments. What happens if you turn gravity off? Try it! (use the button middle right) There are no forces acting on the mass so it just floats around. What happens if you turn it back on again? You can do that with the slider.



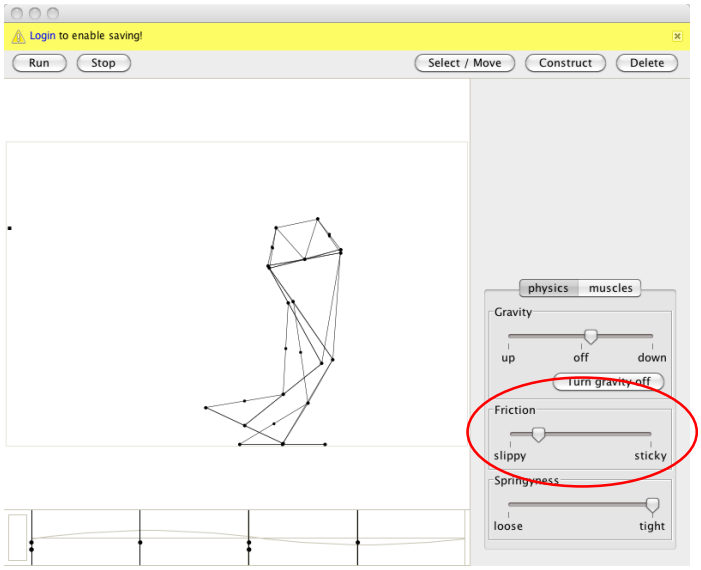
The strength of gravity varies on different planets. In Soda Constructor you can vary how strong the force it exerts is and change its direction. That is a bit like moving your creature away from the planet as if on a rocket heading out into space causing the effect of gravity to weaken. Changing the direction fo gravity is like the rocket then getting closer to another planet. You can even be a bit sadistic and turn gravity up and down quickly, over and over again (just slide the slider backwards and forwards). If you break the creature close the window and start again.

Allow the group to explore gravity on the different creatures themselves on their machines.

For older groups this could lead to a deeper discussion of gravity and the laws behind it as on the appropriate syllabus. The slider is effectively changing the gravitational field strength.

Play with Friction

You can similarly play with friction. Legs (http://sodaplay.com/creators/lewa/items/legs) is a good model to start with here.



Show it walking then ask the group to predict what will happen if friction is turned down – what will it be like walking on? Let them suggest ice and the legs should fall over.Then try it. Let them experiment themselves on different creatures and then describe to the class what happened. They should also try and explain what they saw. How good a model is the world of our world? DO the same things happen? Do the laws embedded in it correspond to the actual laws that govern our world?

In general, too much friction and the creatures' joints seize up. That is why machines need oil on moving parts: to reduce the friction. Too little and they start to slide a bit though most don't fall over – more legs are better on an icy world perhaps. Too little friction and the creatures start to slide along and can even collapse.

Play with Springs

The group can similarly experiment with the springiness of the springs (the bottom-most slider). The law built in here is Hooke's Law, and the slider is varying the tightness of the spring – the spring constant. Most creatures have very tight springs so that they are rigid. Two springy and the springs become like slinkys and the creatures collapse. This could lead in to a discussion of Hooke's Law and the actual equation for older groups.

Summary: the computer science

We have explored some of the laws of Physics: gravity, friction and springs. The thing that has allowed us to do this is a **computational model**. We have created algorithms from the laws of physics. The computational model is a program that makes virtual objects we create in it act according to the equations. If the model we have created is an accurate model then our experiments in the virtual world should match what we see in reality exactly. If they do it suggests the laws are probably correct. If the bevaviour is different then either the scientists have to go back to the drawing board as their equations aren't right, or there is something wrong with our model.

Any model is an **abstraction** – we have hidden some of the details of reality. We don't model everything just the things of interest. With Soda constructor one abstraction is that it is just a one-dimensional world. Another is that the masses are all points, and the springs just lines – not solid objects. This simplification doesn't prevent the laws from working as they do in the real world – it is a good abstraction.

Computational models give us a powerful new way to do science. They gives us a new way to explore the consequences of theories. Rather than just doing experiments in the world, we can do experiments with the models in virtual worlds too. It is much easier to control things in a virtual world – such as removing friction or removing gravity to see what the equations then predict. Computer Science and in particular computational thinking – thinking of science in terms of algorithms – has completely transformed the way Physics and the other sciences are now done.

Variations and Extensions

Modify the creatures
By switching to the construct mode, the group can start to add to the creatures or create their own. This will be the focus of a different activity.

Other Sodarace and Soda constructor activities
There are a variety of other activities for schools and cs4fn articles on Sodarace. See http://www.cs4fn.org/alife/sodaindex.html

Links to other activities

Get the following activities with links to biology from teachinglondoncomputing.org

Sodarace: Evolution

Race a creature you create in a 2D world, then let your creature evolve and see if it is faster. Learn about computational modeling as way to understand and test scientific theories and in particular how evolution by natural selection works. Will anyone evolve an amoeba that flies off the cliff and across the line without touching the ground?

Brain-in-a-bag

Create a brain out of rope, tubes and kids that plays Snap. Demonstrate how neurones work, as well as how computational modeling can help us understand the world, and how biological processes can lead to new forms of algorithmic thinking.

Live demonstration of this activity

Teaching London Computing give live sessions for teachers demonstrating this and our other activities. See http://teachinglondoncomputing.org/ for details. Videos of some activities are also available or in preparation.

Acknowledgements

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