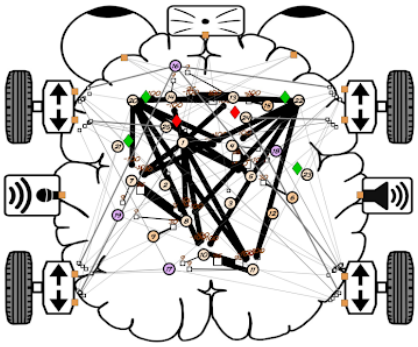
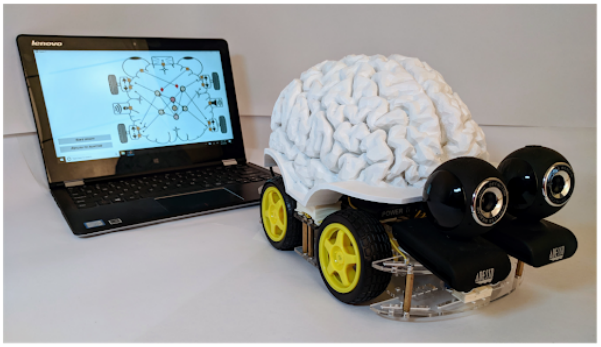
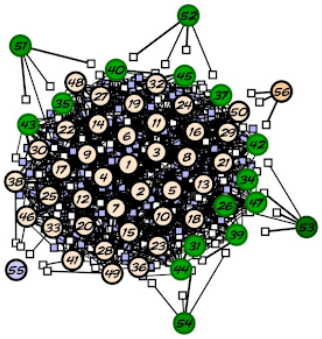
BACKYARD BRAINS

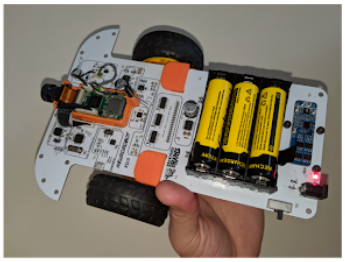
NEUROROBOT USER GUIDE

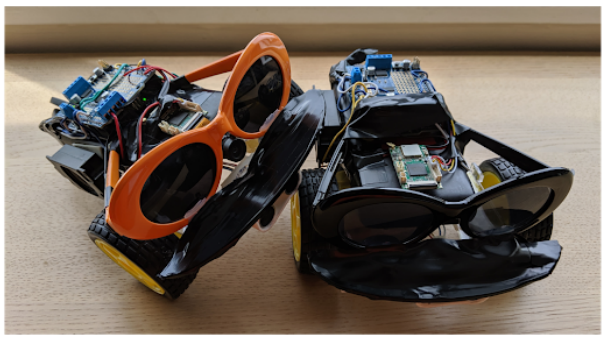
2019





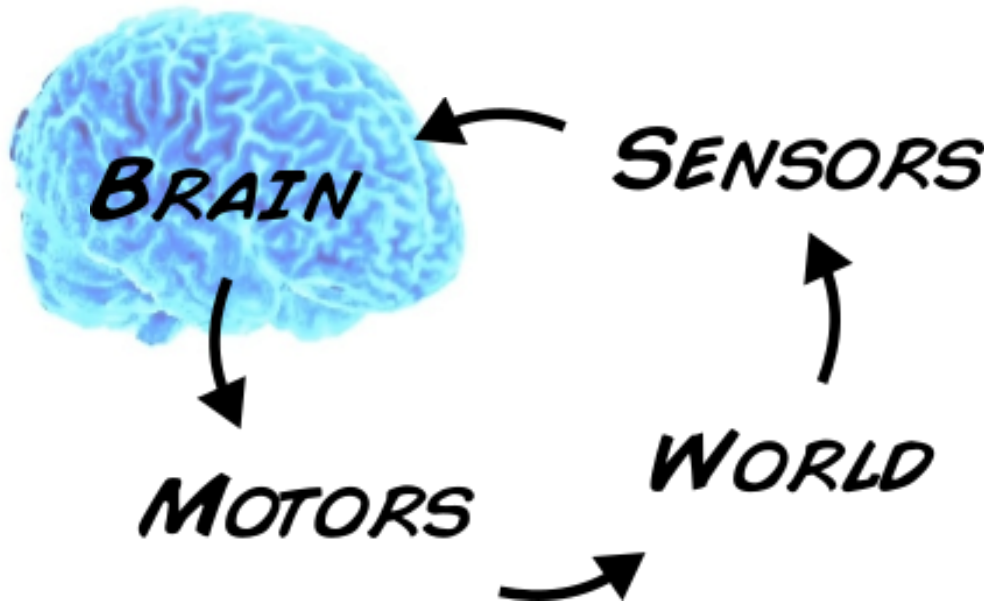






Welcome to neurorobotics!

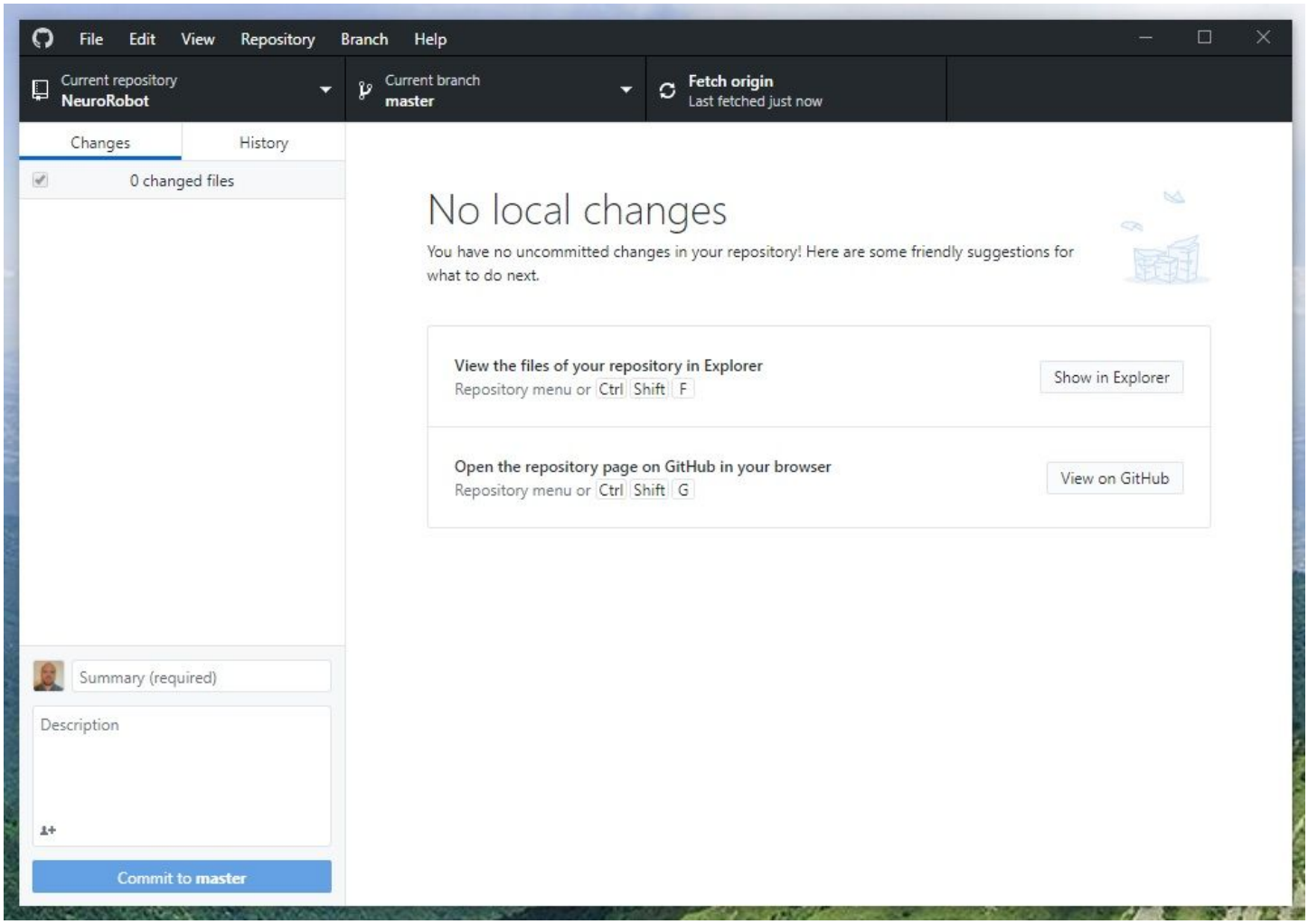
Understanding the brain is a fascinating challenge, captivating the scientific community and the public alike. At Backyard Brains, we are developing neurorobots - robots controlled by computer models of biological brains - to investigate key concepts in neuroscience, including spiking neural networks, synaptic plasticity, and adaptive action selection. The neurorobots use wheels, cameras, speakers, microphones and distance sensors. Our Neurorobot App visualizes the neurorobots' visual input and brain activity, and allows you to design new brains and deliver dopamine-like reward signals to reinforce chosen behaviors. Welcome to neurorobotics!



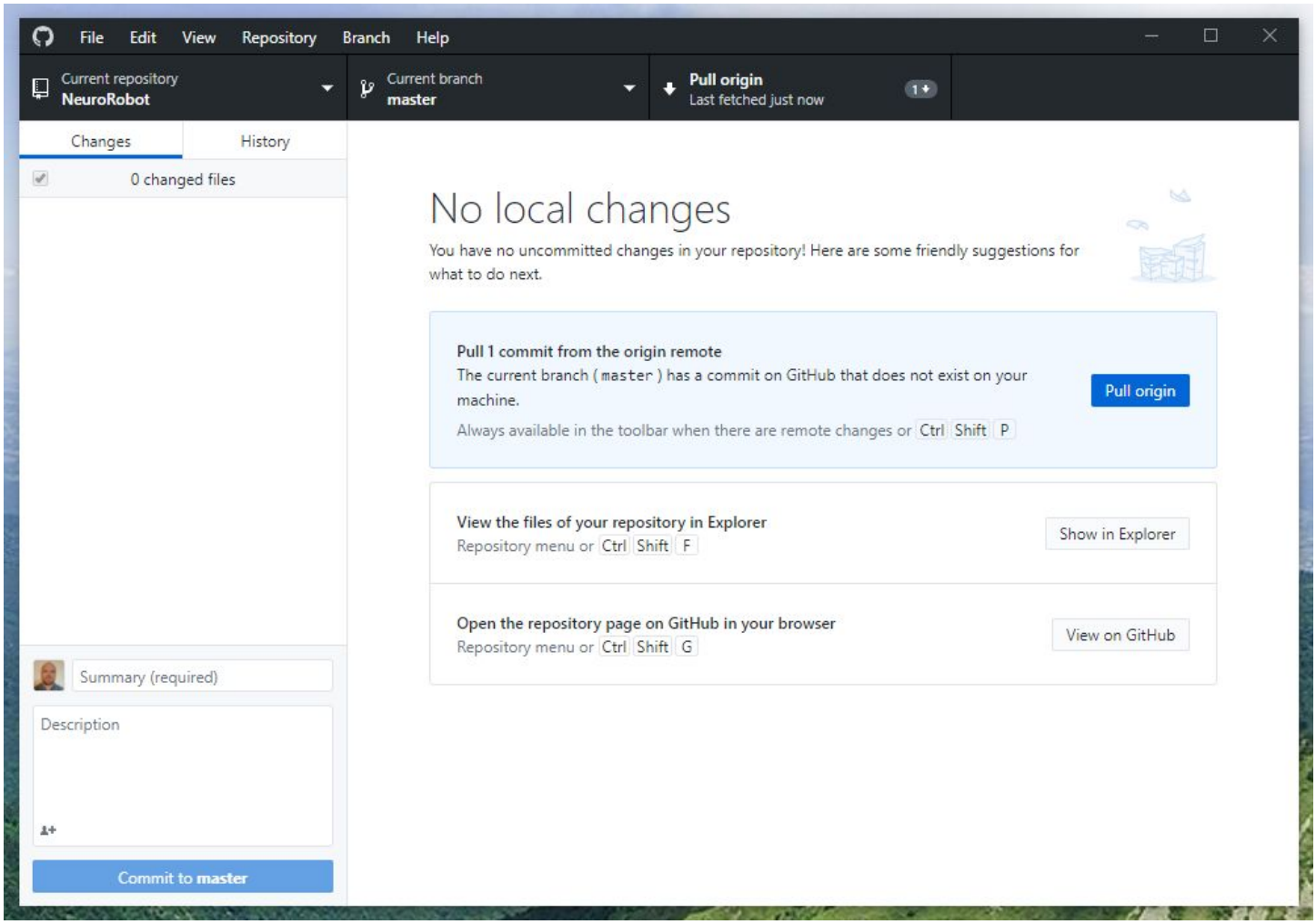
Keeping your Neurorobot App up to date

The Neurorobot App is an open source app hosted on GitHub, which is a platform for sharing and organizing code. To check for updates to the app and download updated code, use GitHub Desktop:

GitHub Desktop is a user friendly interface to GitHub. After you start GitHub Desktop, click “Fetch origin” to check for updates. If the GitHub Desktop interface looks like this, you have the most recent version of the Neurorobot App:



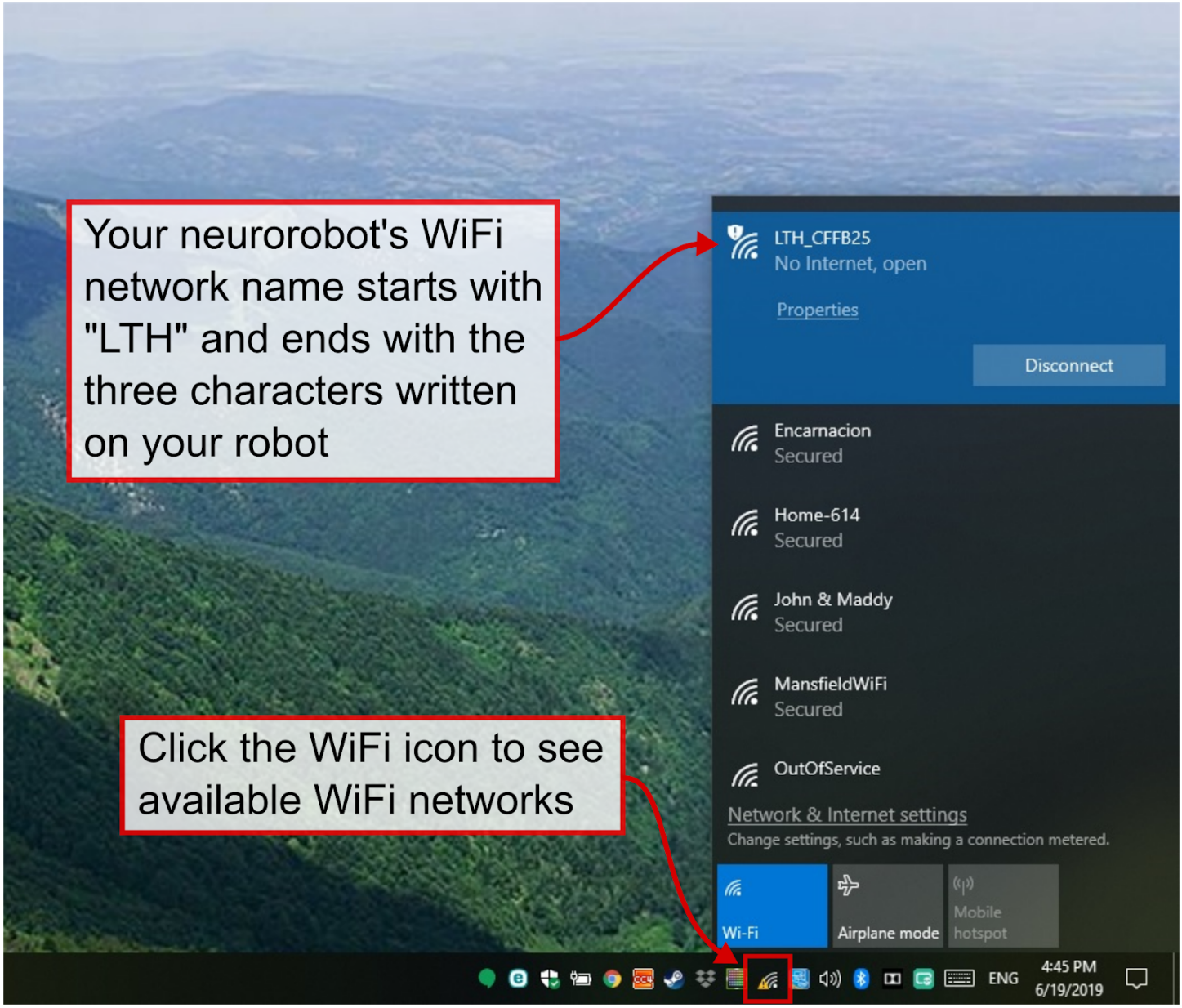
However, if the GitHub Desktop interface looks like this, you need to update your Neurorobot App:



To update the Neurorobot App, click “Pull origin”.

Connecting to your neurorobot's WiFi

Start your laptop and robot. Wait 20-40 seconds for your neurorobot's WiFi network to appear. You may need to disconnect your laptop from any other WiFi network to see your neurorobot's WiFi network. Your neurorobot's network name will start with the characters "LTH_" and will end with the three characters written on your robot.

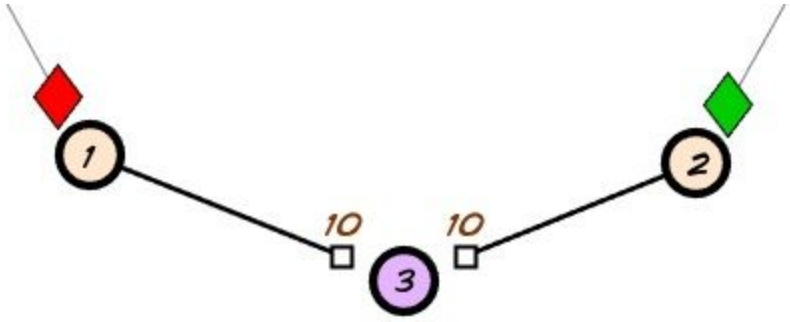


When you've connected to your neurorobot's WiFi network you will probably see an exclamation mark in a yellow triangle next to the WiFi icon in the Windows taskbar. This is because you're no longer connected to the internet. Don't worry about it.

Building neural circuits

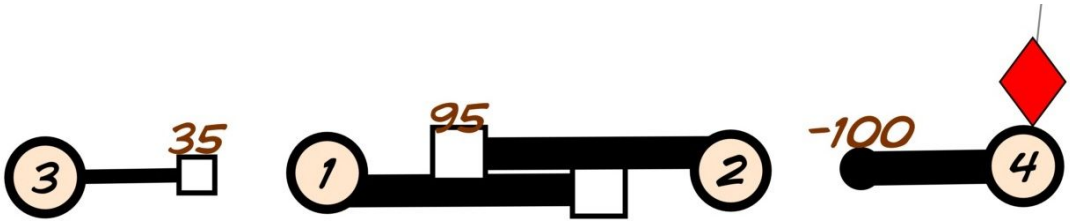
“AND”

Sometimes you want a neuron that is active only if two neurons are exciting it at the same time. One way to do this is to extend two medium-strength synapses from two neurons (1,2) to a third neuron that generates bursts when activated (3). The synapses will (mostly) not be able to activate the neuron on their own but together they will.



“UNLESS”

Sometimes you want neural activity that can be turned on and off. Connect two quiet neurons with strong excitatory synapses (1,2). If either neuron is activated, the activation will bounce back and forth for several seconds. This is called recurrent excitation and is an absolutely fundamental capacity of biological neural networks (and virtually nonexistent in contemporary AIs). Switch text and figure here to use a green visual activation of neuron 1 (instead of neuron 3, move the following text to a footnote or something). By connecting an occasionally active neuron (3) to the pair you can trigger sporadic bursts, just like a bursting neuron. But now you can also connect an inhibitory neuron (4) which will block activity in the circuit. This way, you can create sporadic behaviors that can be quickly turned off by a stimulus.



Motor pooling

Synaptic inputs to the motors are summed. For example, let’s say you have three neurons connected to the same motor, each with a strength of 80, and each responding to a different color. This would mean that the motor would move slowly if one color was observed, and very fast if all three colors were observed. Similarly, if two neurons are connected to the same motor, one with a strength of 100 and the other with a strength of -100, then if both neurons are active they will cancel each other out and the motor will not move at all.