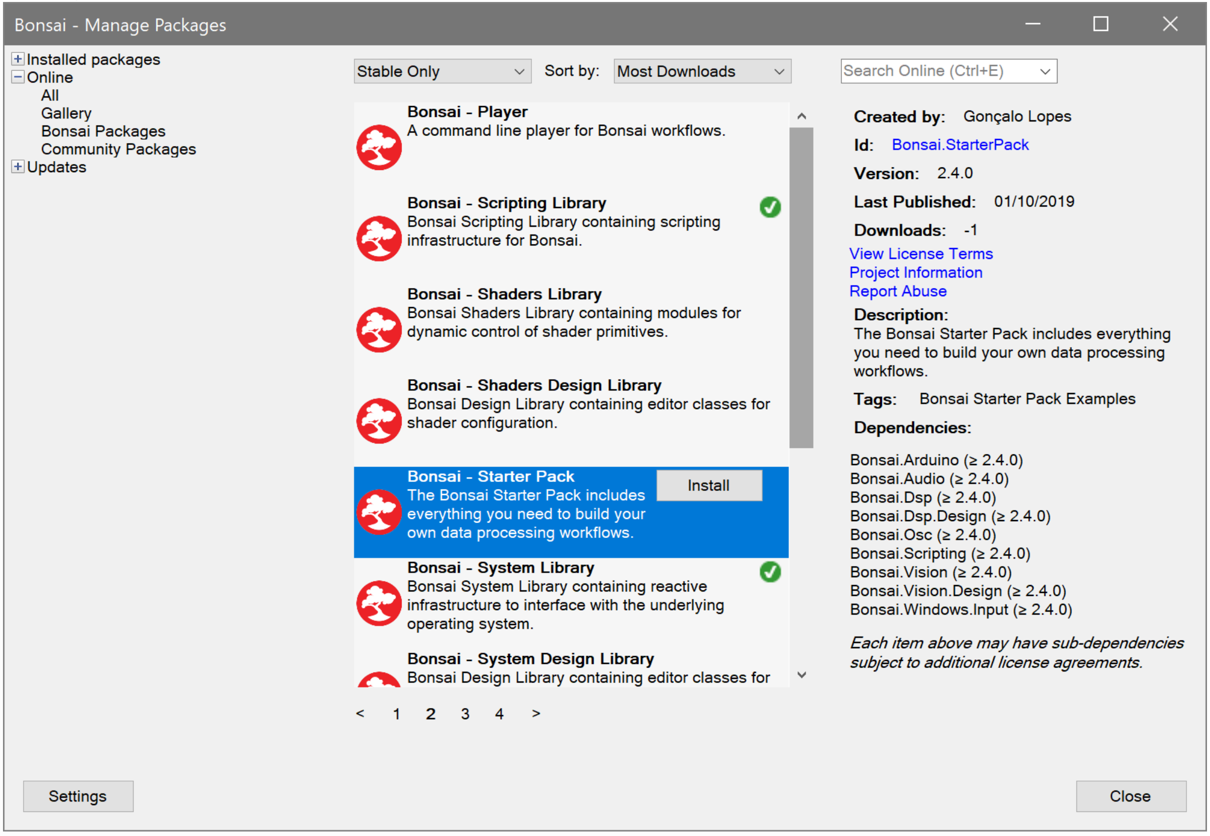
Day 4 – Exercises

Bonsai

Adapted from Neurogears @ Wustl19, https://neurogears.org/wustl-2019/worksheets/acquisition/

Getting Started

1. Download Bonsai from http://bonsai-rx.org.
2. Install **Bonsai - Starter Pack** from the package manager.



Bonsai - Player
A command line player for Bonsai workflows.

Bonsai - Scripting Library ✓
Bonsai Scripting Library containing scripting infrastructure for Bonsai.

Bonsai - Shaders Library
Bonsai Shaders Library containing modules for dynamic control of shader primitives.

Bonsai - Shaders Design Library
Bonsai Design Library containing editor classes for shader configuration.

Bonsai - Starter Pack
The Bonsai Starter Pack includes everything you need to build your own data processing workflows.

Bonsai - System Library ✓
Bonsai System Library containing reactive infrastructure to interface with the underlying operating system.

Bonsai - System Design Library
Bonsai Design Library containing editor classes for

Created by: Gonçalo Lopes
Id: Bonsai.StarterPack
Version: 2.4.0
Last Published: 01/10/2019
Downloads: -1
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Project Information
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Description:
The Bonsai Starter Pack includes everything you need to build your own data processing workflows.
Tags: Bonsai Starter Pack Examples
Dependencies:

Bonsai.Arduino (≥ 2.4.0)
Bonsai.Audio (≥ 2.4.0)
Bonsai.Dsp (≥ 2.4.0)
Bonsai.Dsp.Design (≥ 2.4.0)
Bonsai.Osc (≥ 2.4.0)
Bonsai.Scripting (≥ 2.4.0)
Bonsai.Vision (≥ 2.4.0)
Bonsai.Vision.Design (≥ 2.4.0)
Bonsai.Windows.Input (≥ 2.4.0)

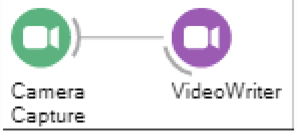
Each item above may have sub-dependencies subject to additional license agreements.

3. Click the `Updates` tab on the left side of the screen and install any available upgrades.
4. Refer to http://bonsai-rx.org/docs/editor for an introduction to the user interface.

Video Acquisition

Bonsai can be used to acquire and record data from many different devices. The exercises below will make you comfortable with the most common Bonsai data types. The first data type we will discuss is an image, which is represented as a 2D matrix of pixels. Each pixel represents either a brightness value in a grayscale image, or a BGR colour value in a colour image.

Exercise 1: Saving a video

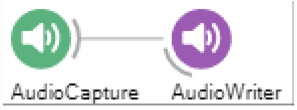


- Insert a `CameraCapture` source.
- Insert a `VideoWriter` sink.
- Configure the `FileName` property of the `VideoWriter` operator with a file name ending in `.avi`.
- Run the workflow and check that it generates a valid video file.

Audio Acquisition

Audio data is captured at much higher temporal sampling frequencies than video. However, the data is typically buffered into chunks of multiple samples before being sent to the computer. Also, multiple audio channels can be acquired simultaneously in the case of a stereo microphone, or high-density ephys probes. For this reason, such multi-sample, multi-channel data is also typically represented as a 2D matrix of amplitude values, where rows represent channels, and columns represent time.

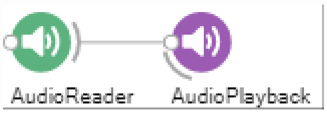
Exercise 2: Saving a WAV file



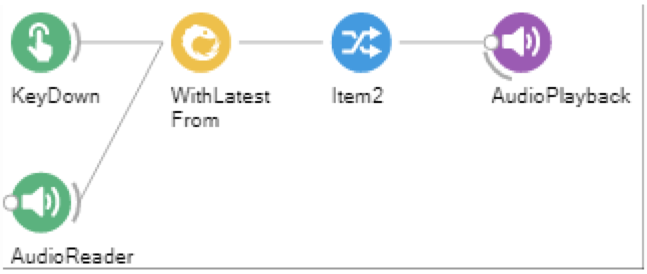
- Insert an `AudioCapture` source.
- Insert an `AudioWriter` sink.
- Configure the `FileName` property of the `AudioWriter` operator with a file name ending in `.wav`.
- Make sure that the `SamplingFrequency` property of the `AudioWriter` matches the frequency of audio capture.

- Run the workflow for some seconds. Playback the file in Windows Media Player to check that it is a valid audio file.

Exercise 3: Trigger an auditory stimulus

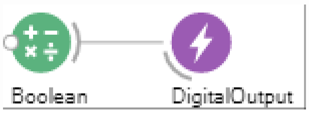


- Insert an AudioReader source.
- Configure the FileName property to point to the audio file you recorded in *Exercise 3*.
- Insert an AudioPlayback sink.
- Run the workflow and check that the sound is played correctly.



- Insert a KeyDown source (Windows.input).
- Set the BufferLength property of the AudioReader to zero, so that all audio data is read into a single buffer.
- Combine the key press with the audio data using the WithLatestFrom combinator.
- Right-click the WithLatestFrom operator. Select Output > Item2 from the context menu.
- Move the AudioPlayback sink so that it follows the selected Item2 member.
- Run the workflow and press a key. What happens if you press several keys?

Exercise 4: Control an LED



- Upload StandardFirmata to your teensy in the Arduino software (File/ Examples/Firmata/StandardFirmata)
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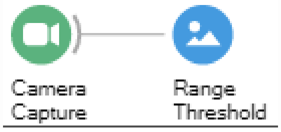
- In Bonsai: Insert a Boolean source.
- Insert a DigitalOutput sink.
- Set the Pin property of the DigitalOutput operator to 13. This is the LED pin of the teensy- it turns on the LED that is already attached to the board.
- Configure the PortName property.
- Run the workflow and change the Value property of the Boolean operator.
- **Optional:** Change the output pin to a different digital output pin. Connect an LED and a resistor to this pin through the breadboard and turn the LED on with Bonsai. The LEDs in your kit have three pins, you can treat them as a normal LED by leaving one of the short pins unconnected.

Video Tracking

Bonsai allows processing the captured raw data to extract real-time measures of behaviour or other derived quantities. The exercises below will introduce you to some of its online video processing capabilities.

Exercise 5: Segmentation of a coloured object

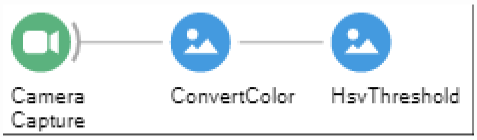
Find a coloured object to track.



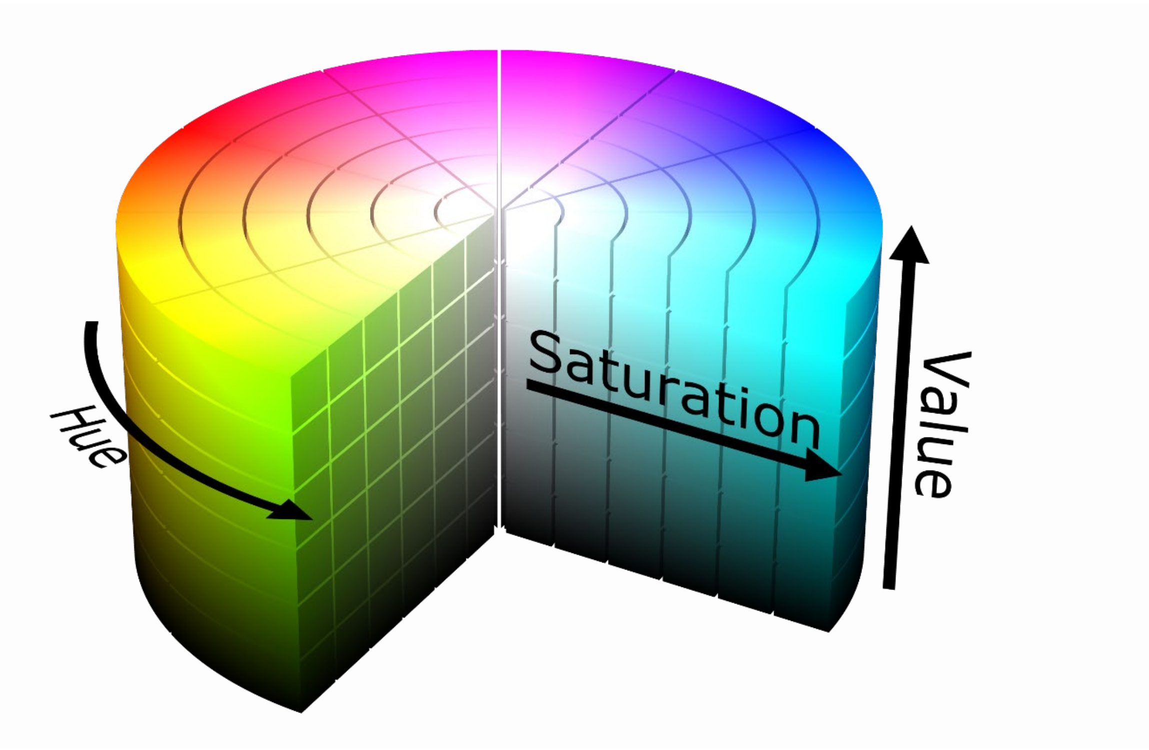
- Insert a CameraCapture source.
- Insert a RangeThreshold transform.
- Open the visualizer for the RangeThreshold operator.

- Configure the Lower and Upper properties of the RangeThreshold to isolate your coloured object (hint: click the small arrow to the left of each property to expand their individual values).

This method segments coloured objects by setting boundaries directly on the BGR colour space. This colour space is considered a poor choice for colour segmentation. Can you see why?

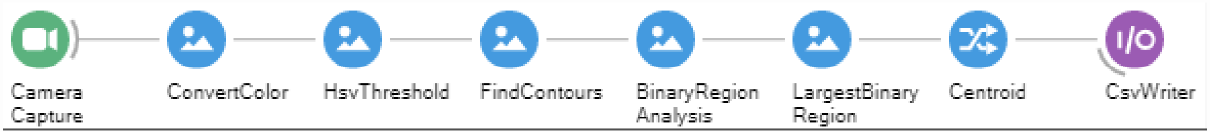


- Replace the RangeThreshold operator by a ConvertColor transform. This node converts the image from the BGR colour space to the Hue-Saturation-Value (HSV) colour space.



- Insert an HsvThreshold transform.
- Configure the Lower and Upper properties of the HsvThreshold to isolate the object.

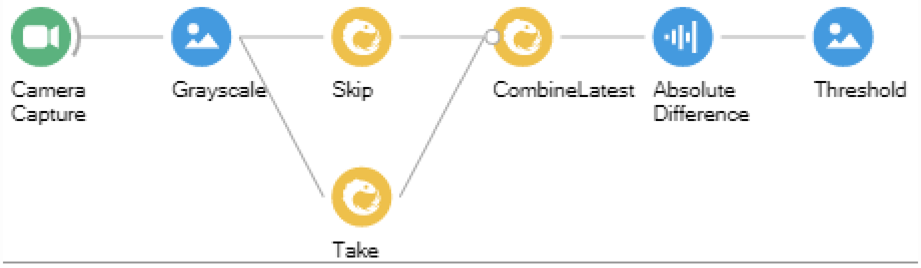
Exercise 6: Real-time position tracking



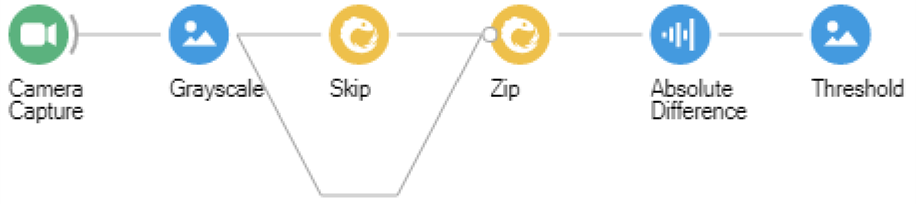
- Starting with the workflow from the previous exercise, insert a FindContours transform. This operator traces the contours of all the objects in a black-and-white image. An *object* is defined as a region of connected white pixels.

- Insert a BinaryRegionAnalysis transform. This node calculates the area, center of mass, and orientation for all the detected contours.
- Insert a LargestBinaryRegion transform to extract the largest detected object in the image.
- Select the ConnectedComponent > Centroid field of the largest binary region using the context menu.
- Record the position of the centroid using a CsvWriter sink.

Exercise 7: Background subtraction and motion segmentation



- Create a grayscale video stream similar to *Exercise 2*.
- Insert a Skip operator. Set its Count property to 1.
- In a new branch, insert a Take operator. Set its Count property to 1.
- Combine the images from both branches using the CombineLatest combinator.
- Insert the AbsoluteDifference transform after CombineLatest.
- Insert a Threshold transform. Visualize the node output and adjust the ThresholdValue property.



- Replace the CombineLatest operator with the Zip combinator.
- Delete the Take operator.

Describe in your own words what the above modified workflow is doing.