GoFish: A low-cost, open-source platform for closed-loop behavioural experiments on fish

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- Annotated Bonsai workflow screenshots -

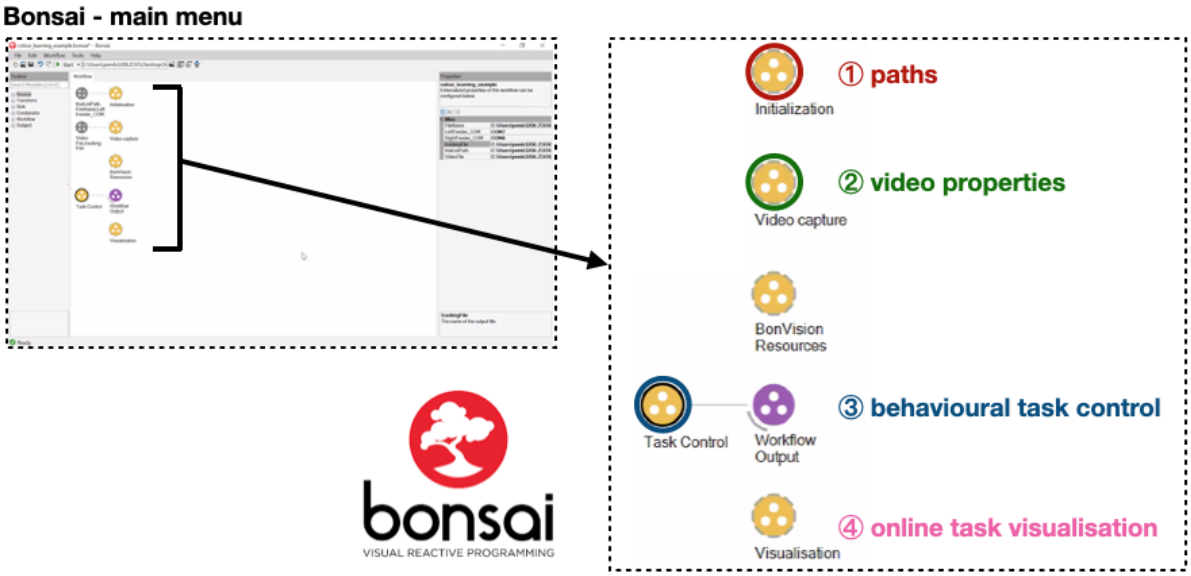

Figure 1. Bonsai start page. Bonsai is a visual programming language. The Bonsai code to run the task is organised into four key nodes, (1) task initialization, in which key task parameters such as trial number are set; (2) video properties, which controls subject tracking; (3) behaviour task control which links fish position to pre-programmed task contingencies such as stimulus presentation (4) online task visualisation, which allows users to view video data in real time along with the stimuli that are being displayed. Each of these nodes is a grouped node with further workflows (i.e., chain of nodes) inside them.

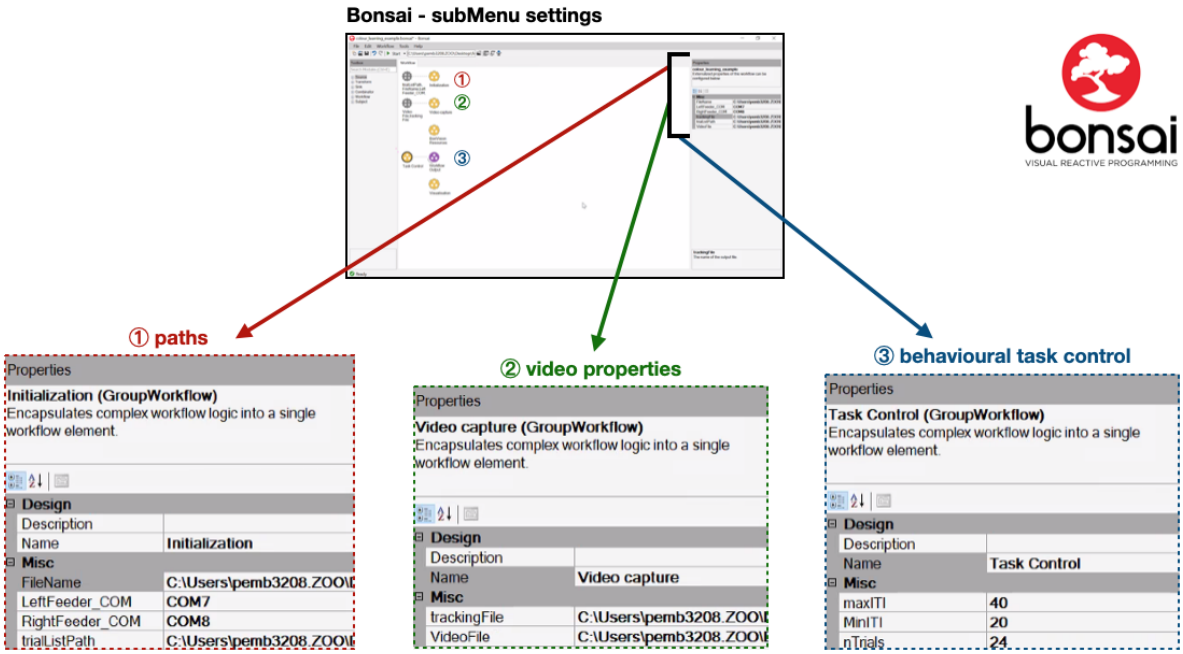

Figure 2. Bonsai submenu settings. Single-clicking each of the main nodes shown in Figure 1, allows the user to change/adjust its corresponding properties, including the main parameters to run the task and save data. Properties that can be readily adjusted in the start page include the directory where files specifying trial events are read from, (1) the directory where data are saved to, (2) general task parameters such as the inter-trial interval (ITI) minimum and maximum duration as well as the number of trials (3).

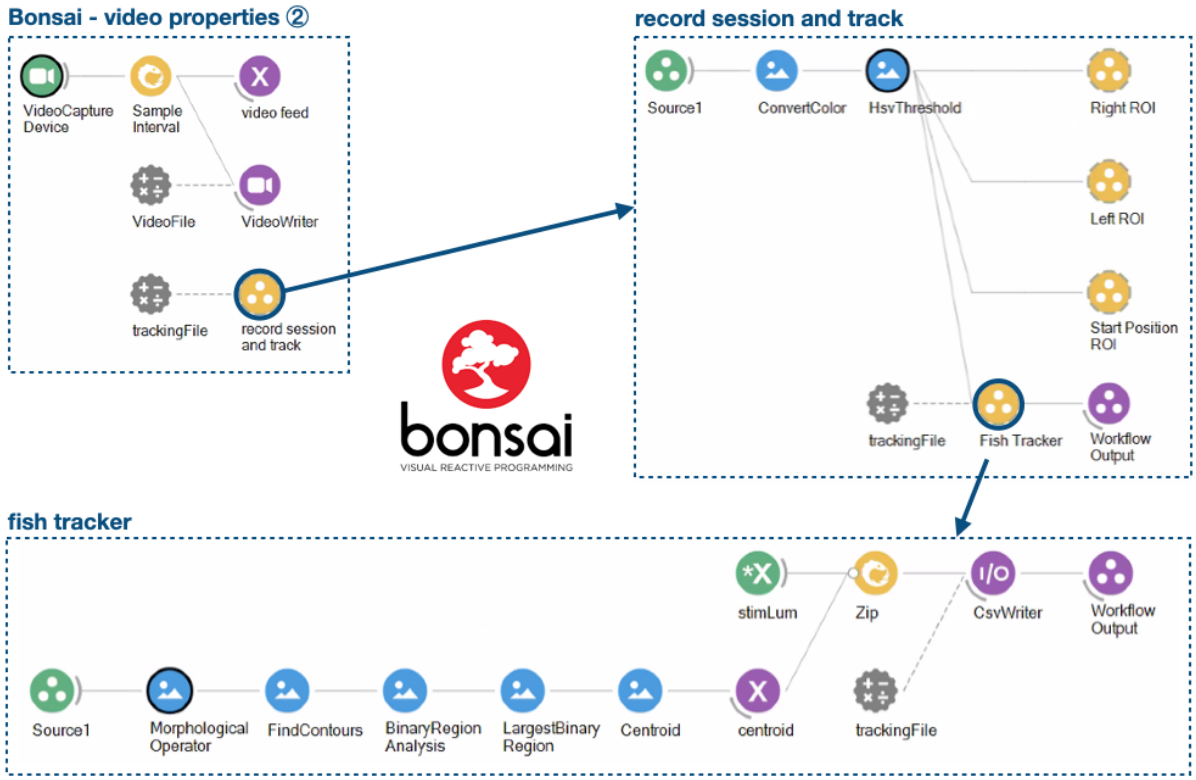

Figure 3. Bonsai video tracking. Left: Double clicking a grouped node such as 'video properties' shows the workflows (i.e., chains of nodes) nested within it. Right: the 'record session and track' node contains a workflow that allows users to first adjust the HSV threshold applied to the video feed by the means of a dropdown menu and slides (see "Colour Tracking" video below for an example of how to do this), and also allows users to define the position of the different ROIs (i.e., a start position and left and right choice areas by drawing the cropped region with a cursor (see "Read, crop and save a video file" video example below). Bottom: 'Fish tracker' grouped node. In this node, the user can adjust tracking parameters for individual subjects, such as what morphological operator to use that better adjusts to the subject's specific colour pattern (e.g., erode, dilate). When a node is clicked on a drop down menu appears in which parameters can be defined. For tutorials on video tracking using Bonsai, with a very similar workflow see: "Color Tracking" – https://www.youtube.com/watch?v=_uJVtsGtI1M, and "Read, crop and save a video file" - https://www.youtube.com/watch?v=736G93Qaak0.

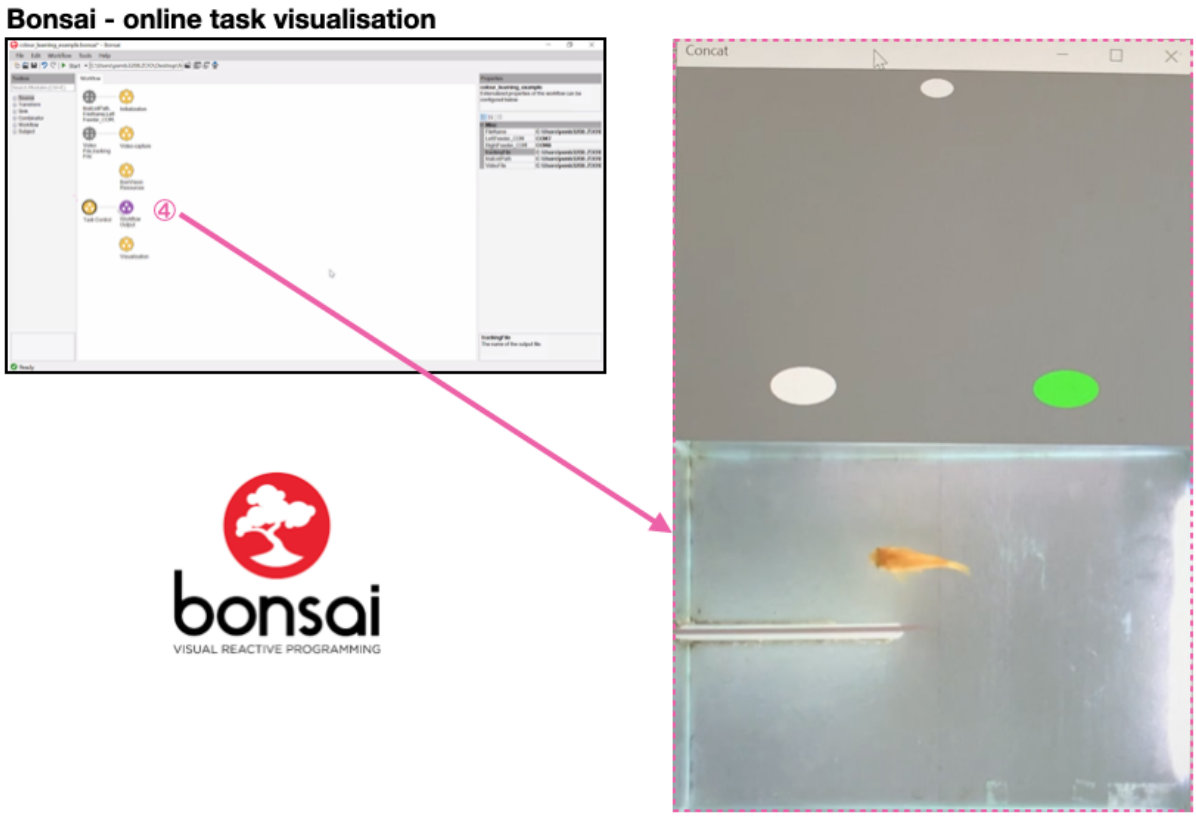

Figure 4. Bonsai online task visualisation. Left: This node does not have any role in task contingencies, but when clicked allows the user to simultaneously see the video from the experimental tank as well as what is being presented to the animals in the computer screen.