No-Code Programming for Biology

BIOMAKING FOR DUMMIES

No coding or electronics skills required

Learn visual programming and build new devices from simple computing hardware, sensors, actuators and programmable touchscreens

Cambridge Workshop
March 23-24

No-Code Programming Workshop
Details at: https://www.biomaker.org
No-code programming workshop? What’s that?

Modern software provides tools that allow novice programmers to build instrumentation with sophisticated user interfaces - for sensing and controlling biological systems. Learn how to use these tools. No prior knowledge of programming or electronics is required.

1. Learn how to build simple computing devices.

You will be provided with an Arduino-compatible microcontroller and a kit of sensors, displays and output devices. The Arduino community has established open standards and rich ecosystem of resources for simple microcontrollers, first established to simplify programming and physical computing for designers and artists. An Arduino circuit board can be plugged into the USB port of any laptop, and a simple programming environment used to program it. A program is simply loaded to permanent memory on the Arduino board, which will execute a program loop whenever the board is powered on - behaving as a dedicated appliance or instrument. Arduino boards include many input/output ports, and are intended to interface with sensors, displays, motors and other output devices. The Arduino system provides a simple environment for learning programming and hardware skills, and developing real-world laboratory tools for biologists.

2. Code-free Programming

XOD provides a visual way of programming using a flowchart-like system of interconnected nodes (https://xod.io). Each node corresponds to hardware device or computational process, and data flow is controlled by connections between the nodes that are drawn on-screen. XOD eliminates the need to write code manually, and avoids the complexities of text-based code and syntax. XOD can be used to directly program Arduino boards, and allows real-time debugging of code. Experienced programmers can encapsulate and share existing Arduino IDE code in graphical nodes. The graphical dataflow layout of a XOD program allows biologists to better communicate and collaborate in joint projects - facilitating communication between wetware, software and hardware experts.

3. Graphical user interfaces

Biomaker has adopted the use of touch-responsive programmable displays, along with code-free systems for programming the screens and communication with any Arduino microcontroller. XOD libraries for direct communication between the microcontroller and display are available - along with sophisticated development tools that allow graphical programming of a wide range of display elements like gauges, switches, sliders, readouts, etc., for creating customised touchscreen user interfaces. This allows great flexibility in the design of the interface - and can simplify an instrument’s control or display.

Training in the use of these new tools allows biologists to build a wide range of instruments and devices that are potentially useful for experiments in the lab and field. These new skills can be enabling in many ways. The components for this type of instrumentation are often very cheap, especially when compared with off-the-shelf commercial solutions. The use of simple hardware and software resources allow easy modification, extension and repair of custom instruments. The use of open-source components and systems promotes sharing of information and set up of collaborative projects, which creates a growing set of resources for the community to draw from.
Workshop schedule

Location: Practical Laboratory, Ground Floor
Department of Plant Sciences, Downing Street, Cambridge.

Monday 23rd March 9:30 to 17:00

1. Introduction and distribution of Biomaker starter kits.

2. Setup and testing of the starter kits with XOD.
   Objectives: (i) Install the software and drivers. (ii) Explore basic microcontroller and XOD concepts. (iii) Test the connections and software installation. (iv) Set parameter values for XOD nodes. (v) Program and debug connected LEDs, switches and other simple hardware.

3. Handling input and output devices with XOD.
   Objectives: (i) Learn how to connect and use input and output devices, using XOD programming. (ii) Connect onboard touch buttons and buzzer. (iii) Program the sound of the buzzer. (iv) Plug in an extension shield, and send data to a 16x2 text display.

4. Use open source software libraries to program new devices.
   Objectives: (i) Load external libraries in XOD. (ii) Program advanced devices on the Arduino board, including real-time clock, temperature sensor, 4-digit display, etc.

Tuesday 24th March 9:30 to 17:00

5. Code-free programming of touchscreen user interfaces.
   Objectives: (i) We will provide you with a 3.2” touchscreen display (4D Systems µLCD-32DT-AR Arduino display pack). Hook up the LCD display to the Arduino via a serial port. (ii) Build user interfaces for Arduino-based instrumentation using graphical tools. The screens are pre-programmed with starter “widgets”. (iii) Send information about data and user interactions to and from the screen. (iv) Create custom user interfaces on the on the touchscreen.

6. System building with additional hardware.
   The kit includes extra components: input-output shield, voltage sensor, ultrasonic sensor, touch sensor, water sensor, PIR motion sensor, rocker switch, temperature sensor, light sensor, slide potentiometer, vibration motor, buzzer, speaker, bright LED, 8 LED array, 2x16 character text display, 4-digit display, microSD card, infrared remote controller, micro SD card adapter, infrared emitter, multicolour LED ring, LED traffic light, 64x128 graphic display, Arduino shield with text display and input buttons, gas sensors and prototyping board. Use some of these components to design and build a new instrument.

Friday 27th March 9:30 to 11:30

7. Follow-up and display of final assemblies.

Useful information

Websites:

**Biomaker**: [https://www.biomaker.org](https://www.biomaker.org)
Collection of technical information, pointers to tutorials and software resources.

**Tutorials**: [https://www.biomaker.org/tutorials](https://www.biomaker.org/tutorials)
List of tutorial sessions for Biomaker

**Hackster**: [https://www.hackster.io/biomaker](https://www.hackster.io/biomaker)
Biomaker community hub used for open documentation of tutorials and projects.

**XOD**: [https://xod.io](https://xod.io)
Download XOD software, libraries, documentation and forum advice.

**Arduino**: [https://www.arduino.cc](https://www.arduino.cc)
Official repository of Arduino information.

**Arduino Create**: [https://create.arduino.cc](https://create.arduino.cc)
Integrated resource for code and project-sharing.

GUI software and information about touchscreens.

**Open-Smart**: [https://open-smart.aliexpress.com/](https://open-smart.aliexpress.com/)
Source of hardware for Biomaker starter kit.

**Sparkfun**: [https://www.sparkfun.com](https://www.sparkfun.com)
Good source of practical information about microcontrollers and devices.

**Seeedstudio**: [https://www.seeedstudio.com](https://www.seeedstudio.com)
Hardware supplier for Arduino and beyond.

**Adafruit**: [https://www.adafruit.com](https://www.adafruit.com)
Good source of practical information about microcontrollers and devices.

**Instructables classes**: [https://www.instructables.com/classes/](https://www.instructables.com/classes/)
Classes in many maker skills, including electronics and 3D printing.

**Fritzing**: [https://fritzing.org](https://fritzing.org)
Open source circuit layout and illustration.

**Processing**: [https://processing.org](https://processing.org)
Software sketchbook for dynamic graphics and visual arts.

For more information about the workshop, contact:

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**Prof. Jim Haseloff**, jh295@cam.ac.uk

**Synthetic Biology IRC**: [https://www.synbio.cam.ac.uk](https://www.synbio.cam.ac.uk)
University of Cambridge Interdisciplinary Research Centre

**OpenPlant**: [https://www.openplant.org](https://www.openplant.org)
BBSRC-EPSRC Synthetic Biology Research Centre

**Application details at**: [https://www.eventbrite.co.uk/e/no-code-programming-for-biology-registration-97302352957](https://www.eventbrite.co.uk/e/no-code-programming-for-biology-registration-97302352957)