No-Code Programming for Biology
Today's Session

13:00 Welcome & Lesson 1: Introduction
An introduction to us, the grove board, microcontrollers and the XOD IDE

14:00 Break

14:20 Lessons 2 & 3: Getting Started & Explore XOD
Get started with using your board. We’ll start with some simple tasks like
flashing an LED, pressing a button and sounding a buzzer

Get to grips with some of the most useful nodes in XOD

15:50 Round-Up
No-Code Programming for Biology
Before we Start

1. Downloaded the XOD Software
   www.xod.io

2. Downloaded the No-Code Programming Beginner’s Guide
   www.biomaker.org/nocode-programming-for-biology-handbook

3. Installed USB Drivers (if required)
   www.silabs.com/developers/usb-to-uart-bridge-vcp-drivers
The Starter Kit
1. LED
2. Buzzer
3. OLED Screen
4. Button
5. Rotary Potentiometer
6. Light Sensor
7. Sound Sensor
The Microcontroller
<table>
<thead>
<tr>
<th>PIN</th>
<th>DEVICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>A0</td>
<td>Rotary Potentiometer</td>
</tr>
<tr>
<td>A2</td>
<td>Sound Sensor</td>
</tr>
<tr>
<td>A6</td>
<td>Light Sensor</td>
</tr>
<tr>
<td>D3</td>
<td>Temperature and Humidity Sensor</td>
</tr>
<tr>
<td>D4</td>
<td>LED</td>
</tr>
<tr>
<td>D5</td>
<td>Buzzer</td>
</tr>
<tr>
<td>D6</td>
<td>Button</td>
</tr>
<tr>
<td>I2C (19h)</td>
<td>Three-Axis Accelerator</td>
</tr>
<tr>
<td>I2C (77h)</td>
<td>Air Pressure Sensor</td>
</tr>
<tr>
<td>I2C (3Ch)</td>
<td>OLED Screen</td>
</tr>
</tbody>
</table>

**A0-A6**  Analog

**D0-D13** Digital

**I2C**  I2C (require address)
Diagram illustrating the connection between a Development Host (Laptop/PC) and an Arduino:

1. XOD
2. USB interface
3. Connection
4. USB interface
5. Microcontroller
6. Component (e.g., Buzzer)
Welcome to XOD, Maker!

In XOD, we do not use text to code; we use visual objects instead.

This large gray area with boxes is your program. It’s called a patch. Patches are like documents or source files in other systems.

Several related patches form a project. Currently, you are working on a project named welcome-to-xod.

Exercise

Let’s learn how to navigate a project.

1. On the left-hand side, you will find a list of patches grouped by a project or library name. The list is called a Project Browser. The first one in it is welcome-to-xod. Expand the project by clicking on it.

2. As you can see, the tutorial consists of many patches. Right now, you are in the patch 001-hello. The next chapter of the tutorial is in the patch 002-simulate. Double-click it and let’s meet there!

Web hints

If anything goes wrong or you have no idea what to do, we have hints for every patch on the web.
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1 Your Patch

2 Project Browser: Buttons

3 Project Browser: Project Patches
1. Your Patch

2. Project Browser: Buttons

3. Project Browser: Project Patches

4. Project Browser: Libraries
1. Your Patch

2. Project Browser: Buttons

3. Project Browser: Project Patches

4. Project Browser: Libraries

5. Inspector
1. Your Patch

2. Project Browser: Buttons

3. Project Browser: Project Patches

4. Project Browser: Libraries

5. Inspector

6. Quick Help

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1 Your Patch

2 Project Browser: Buttons

3 Project Browser: Project Patches

4 Project Browser: Libraries

5 Inspector

6 Quick Help

7 Upload Buttons
1. Your Patch

2. Project Browser: Buttons

3. Project Browser: Project Patches

4. Project Browser: Libraries

5. Inspector

6. Quick Help

7. Upload Buttons
Testing Your Board
Try it Yourself – 20min

1. Work in small groups (introduce yourselves if necessary)
2. Complete Task 1
4. Ask if you need help
Inputs and Outputs
Try it Yourself – 20min

1. Work through Task 2 in groups
2. Step-by-step instructions are in the Guide (p26-29)
3. Ask if you need help
Congratulations!
You can now programme an Arduino Board!
Tweak and Watch Nodes
Flip, Clock and Count Nodes
Concat, Join and Format-Number Nodes
Next Week’s Session

13:00  Welcome, Recap & Lesson 4: Building Devices

   Learn how to make more complex programmes in XOD using logic nodes, sequences and loops.

14:00  Break

14:20  Lesson 4 cont. & Lesson 5: Next Steps

   Learn how to expand your programming and hardware building capabilities to start building your own devices, and take a look at some previous projects.

15:55  Round-Up
Thank You

More info:

www.biomaker.org
Session 2
No-Code Programming for Biology
Today’s Session

13:00 Welcome, Recap & Lesson 4: Building Devices
Learn how to make more complex programmes in XOD using logic nodes, sequences and loops.

14:00 Break

14:20 Lesson 4 cont. & Lesson 5: Next Steps
Learn how to expand your programming and hardware building capabilities to start building your own devices, and take a look at some previous projects.

15:55 Round-Up
Last Week’s Session

1. The Grove Board (p6-7)
2. The Microcontroller (p8-11)
3. The XOD IDE (p12-15)
4. Turned the LED on using the button (p20-25)
5. Controlled the buzzer using the button and potentiometer (p26-29)
6. Learned about some useful nodes in XOD (p31-45)

Tweak, watch, flip, clock, count, concat, join and format-number
Creating New Nodes
Try it Yourself – 15min

1. Work though Task 6 in groups
2. Step-by-step instructions are in the Guide (p50-54)
3. Ask if you need help
Using Buses
Try it Yourself – 15min

1. Work though Task 7 in groups
2. Step-by-step instructions are in the Guide (p56-59)
3. Ask if you need help
Break
20min
Logic Programmes
Try it Yourself – 15min

1. Work though Task 8 in groups
2. Step-by-step instructions are in the Guide (p60-63)
3. Ask if you need help
Sequences and Loops
Try it Yourself – 15min

1. Work though Task 9 in groups
2. Step-by-step instructions are in the Guide (p64-70)
3. Ask if you need help
Case Studies
eCO-SENSE: Soil Sensors Powered by Plant Photosynthesis

Behavioural Chamber to Evaluate Rodent Forelimb Grasping

Camera for Monitoring Plant Pollination Events

Open Source Microbial Bioreactor

www.hackster.io/biomaker
Discussion – 15min

1. Read through the case studies (p80-83)
2. Discuss in groups
3. Which of this devices is most relevant to your research?
4. What extra hardware or programming skills would you need to create one of these devices?
Expanding Your Capacity
Expanding Your Capacity

Wires  Shields  Breakout Boards
Plug-and-Play Components

- **seeedstudio.com**
  - Shop > Grove

- **www.m5stack.com**
  - Store > Unit

- **open-smart.aliexpress.com**

- **www.adafruit.com**
  - Products > STEMMA/STEMMA QT

Plug directly into white sockets on the board

Plug into Open Smart Expansion Shield (or use JST PH to JST XH cables)

Plug directly (STEMMA 4 pin) Plug with JST PH to JST SH cable (STEMMA QT 4 pin)
Wired Breakout Boards

**Open-Smart**

Connect using expansion shield or Grove-to-female wires (make sure pin labels match up)

**Sparkfun Electronics**

**Adafruit**

Solder pins to board. Connect using Grove-to-female wires (make sure pin labels match up)

[Links to www.adafruit.com and open-smart.aliexpress.com]
Finding XOD Nodes

Search using ‘reference designator’
e.g. BMP280 (barometer) or SSD1306 (OLED screen)

www.xod.io/libs

forum.xod.io
Arduino IDE

Arduino provides its own free IDE software, which uses C++ coding language to programme the board.

www.arduino.cc/en/software

Converting Arduino libraries for use in XOD
bit.ly/arduino-to-xod

Combining XOD and Arduino IDE
XOD menu > Deploy > ‘Show Code for Arduino’

More complex programming
www.arduino.cc/en/Tutorial/HomePage
What would you build?
Discussion – 10min

1. What instruments would be useful in your own research?
2. How would you go about building such a device?
3. What additional hardware/programming would you need?
4. Do some research – has something like this already been done? Can you find the things you need?

Questions? Contact the Biomaker team: coordinator@synbio.cam.ac.uk
Thank You

More info:
www.biomaker.org