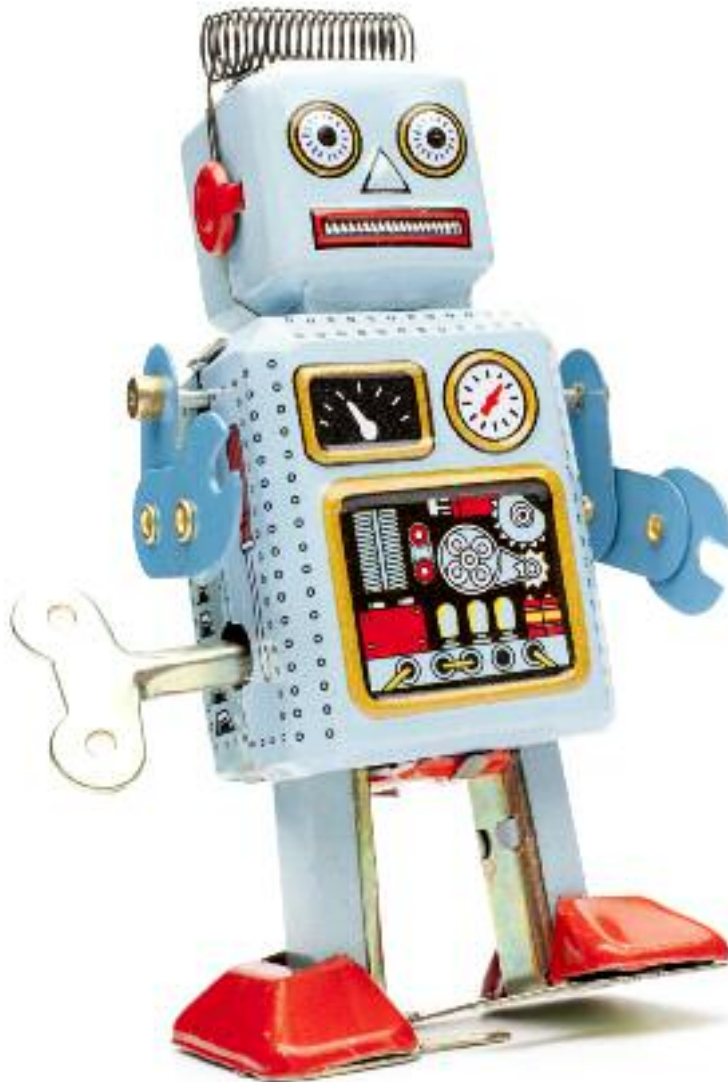


# **CS4FN**

***Computer science activities with a sense of fun***



## ***Create-a-face: programming an emotional robot***

# ***Create-a-face: programming an emotional robot***

Created by Paul Curzon, Queen Mary, University of London with Steve Mesure, Quintin Cutts and Steve Brindley of the University of Glasgow with support from EPSRC and Google

**Age group:** 9 – 10+ (for adults, you may want to drop the second programming part)

**Abilities assumed:** drawing, simple reasoning

**Time:** approx 50 minutes

**Size of group:** anything from 7 to hundreds

## ***Focus***

**How can you program a robot to react to and show emotions?**

**What is object-based programming?**

## ***Summary***

This is an exploration of affective computing, which relates to moods and emotions. The class make an affective (relating to moods and emotions) robot face out of card, tubes and themselves. It is programmed to react to different kinds of sounds (nasty, nice or sudden) and show different emotions (sad, happy, surprised). The class then think up some other facial expressions and program sets of rules to make the face respond to sounds with the new expressions.

## ***Aims***

The aim of this activity is to demonstrate how apparently complicated behaviour can be programmed using some simple rules. It also shows how programs are just rules followed by computers and specifically introduces object-based programming. The activity shows how breaking a program into objects can be much easier to write than trying to write it in one go. The class get to write some simple programs to control the face they created.

## ***Technical terms***

Affective computing, object-based programming, artificial intelligence, robots, human-computer interaction.

## ***Materials***

- 2 large card eyes, wide (circles)
- 2 large card eyes, narrowed
- 2 large card eyebrows
- 1 mouth made from four tubes threaded together in a circle using string (see Figure 1)
- 6 program cards for each of left and right eye, left and right eyebrow and left and right of the mouth
- Set of program sheets to be modified (one per group of 6)
- Three flash cards to tell the audience what to do
- Pens, cards and paper for drawing faces and writing new instructions

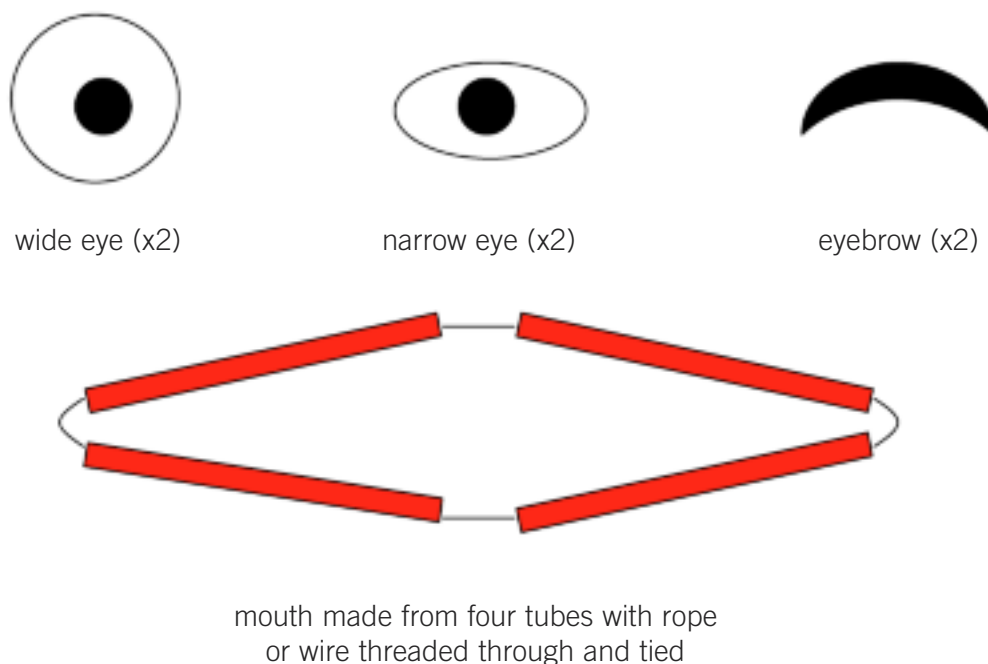
## **What to do**

### **Preparation:**

Before the session make the parts for the face. The eyes and eyebrows can be made of stiff card covered in sticky-backed plastic or glued on coloured paper.

Templates are provided at half full size – enlarge them with a photocopier if you use them.

The mouth is made from four long tubes (eg from rolls of wrapping paper), tied in a loop with string or wire down the centre. It should easily flex into curved shapes and into a circle. Colour it bright red either with coloured paper or sticky-backed plastic. See figure 1.



**Figure 1: Elements of the face**

**The grab:** Playing the emotional robot video makes a good grab for this exercise as essentially we are creating a tube and card version of it. Explain that you are going to explore how hard it is to program such a robot face.

### **Setting up the face:**

Get six volunteers to come out to the front. They will control different parts of the robot face by following the instructions in the program. The remainder of the class will be making the noises that the robot reacts to. You can swap over and let others control the robot's features if you are doing a longer version of the activity. You can even have two faces running at once if you want to get more involved.

Give the two tallest volunteers an eyebrow each and get them to stand a couple of metres apart. They should hold the eyebrows up quite high. Ideally have a blank wall behind them as the backdrop of the face. Next give two more volunteers one wide and one narrowed eye each. They kneel in front of the first two and hold the narrowed eyes below the eyebrows. The wide eyes are held behind the back until needed. Finally the last two people kneel and hold the ends of the mouth.

### Operating the face:

Now you have a robot face. Point out it isn't going to do anything useful without rules to follow – without a program. You could have written instructions for the face as a whole but it is easier to see it as made up of lots of separate objects (the two eyes, the two eyebrows and the two sides of the mouth) each with their own rules that work independently.

Give each person in the face the appropriate instruction sheet for operating their object. These sheets are provided at the end of this document. They are made of if-then rules. For example, the rules for an eye are:

If NICE SOUND then WIDE OPEN

If NASTY SOUND then NARROWED

If SUDDEN SOUND then WIDE OPEN

Explain that they have to listen to the sounds from the audience and do the action. The eyebrows can be raised as high as possible or lowered to just above the eyes. The eyes can either be wide or narrowed. The mouth can have the middle pointing down, up or the two tubes each person holds can be opened. The rules tell them what state to go into depending on the kind of sounds they hear.

Next, explain to the audience what they have to do. When you tell them to, they need to make either a horrible sound (as horrible as they can manage!), a nice sound or all shout boo suddenly. You will tell the audience what to do using flash cards so the people in the face can only react to the sound not what you are asking to happen. See figures 2-4 for the kind of faces you should get.

Do some practice runs where you say what is on the card so the people operating the face get the hang of it, with you checking. Then do a real run, using the flash cards to indicate that the audience should do, switching between them randomly. You can do this with different people operating the face if you have time and want everyone to have a go.

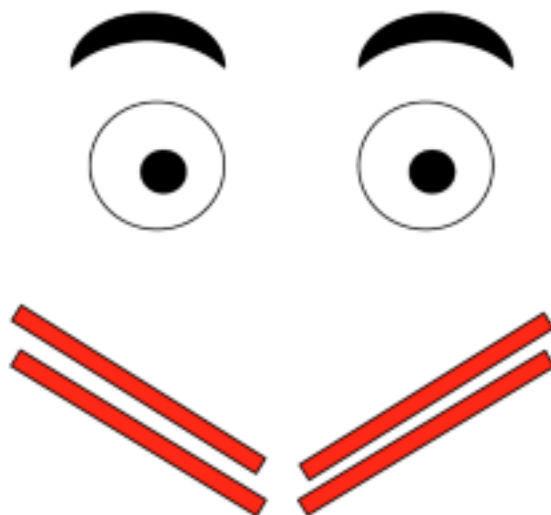
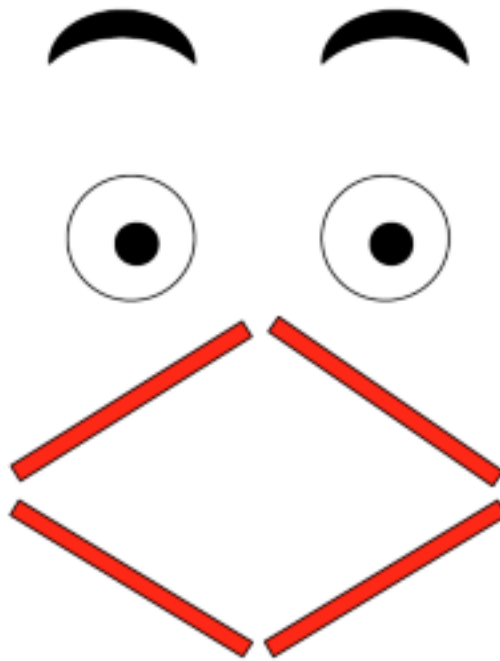
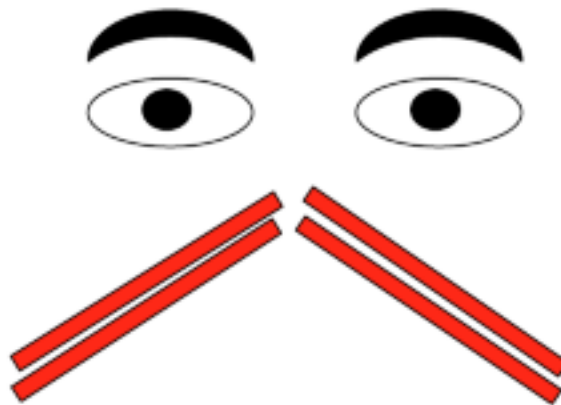


Figure 2: A happy face



**Figure 3: A surprised face**



**Figure 4: A sad face**

**Programming the face:**

Next, set the challenge of programming the face. Split the class into groups of six and get each to come up with up to three new facial expressions (e.g., winking) of their choice. They might want to take it in turns to act out an emotion and get the others to see what facial expression they do. Point out that the left and right side of the face can be given different rules so they can do different things. They can also create new positions like slanting the eyebrows or create new versions of the eye (e.g., closed eyes).

They must then draw a separate picture of the face showing each of those expressions. This is important so that they are precise about the positions and shapes of the eyebrows, eyes and mouth that give the expression. Next they must think of a sound (or something that might be seen in the audience) that might lead to a person showing that emotion or expression.

Finally they should pick one of their facial expressions to add to the program of the face. They should create a flash card for the expression telling the audience what to do. They will need to write an if-then rule for their expression, following the form of the ones already on the cards. One rule is needed for each of the six objects. An example of one might be: “If boring sound then closed” for the left eye. The extra rules should be added to the existing ones on a copy of the instruction sheet given to each group.

Each group can then take it in turn to operate the face with their amended rules.

Round up by summarising what they have been doing – writing a program similar to one that would operate a real face, doing object-based programming, and exploring the human-computer interaction of the future.

### ***Variations and extensions***

For a longer session get the class to make the parts of the face from pre-prepared shapes.

You can also allow the class to add extra things like closed eyes, a tongue, etc if they will better portray the desired emotions.

The class could write rules to allow the face to react to things other than sounds. That could even lead to two faces staring at each other where one reacts to sounds and the other mirrors the emotion of the first. If it sees a smile then its elements put on a smile too.

### ***Further reading***

#### **Blade the affective robot**

The robot that learnt to react to sounds with human-like expressions.  
[www.cs4fn.org/alife/robot/blade.php](http://www.cs4fn.org/alife/robot/blade.php)

#### **In the mood to face the computer?**

Teaching computers to recognise facial expressions.  
[www.cs4fn.org/emotions/inthemood.php](http://www.cs4fn.org/emotions/inthemood.php)

#### **Hostile intent?**

Can you tell whether someone is about to commit a crime from their ‘microemotions’?  
[www.cs4fn.org/society/hostileintent.php](http://www.cs4fn.org/society/hostileintent.php)

#### **Face off: the computer science of changing faces**

How do you map the movements of one person’s face onto another?  
[www.cs4fn.org/illusions/faceoff.php](http://www.cs4fn.org/illusions/faceoff.php)

### ***Links to other activities***

#### **The emotional robot video**

Watch a video of a robot with a neural network brain. This is a good way to introduce both affective programming, and show what can be done with a small neural network.  
[www.cs4fn.org/teachers/activities](http://www.cs4fn.org/teachers/activities)

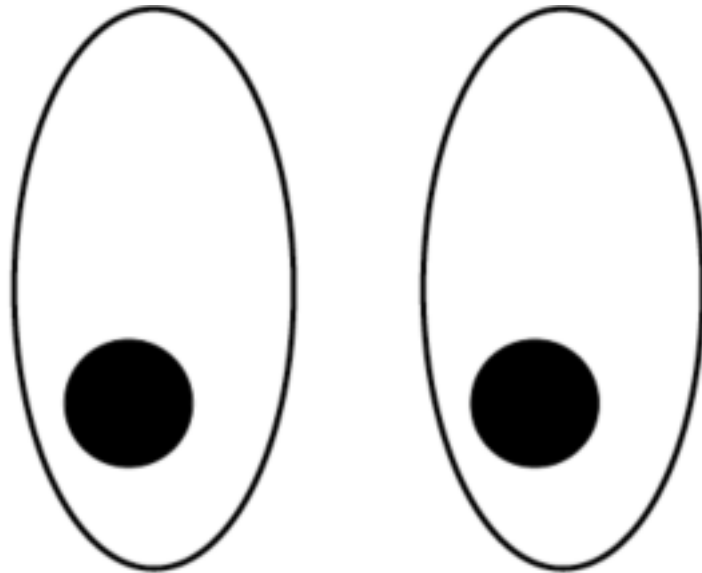
#### **Create-a-face: programming an emotional robot**

Make and program a giant “robot” face. This can be used to introduce the idea of breaking a program into “objects”.  
[www.cs4fn.org/teachers/activities](http://www.cs4fn.org/teachers/activities)

#### **Brain in a bag**

Make a neural network out of rope and toilet roll. Once the group agrees that intelligent things don’t blindly follow rules, this activity can be used to show how the brain works – and that it follows rules.  
[www.cs4fn.org/teachers/activities](http://www.cs4fn.org/teachers/activities)

# ***The Left Eye***

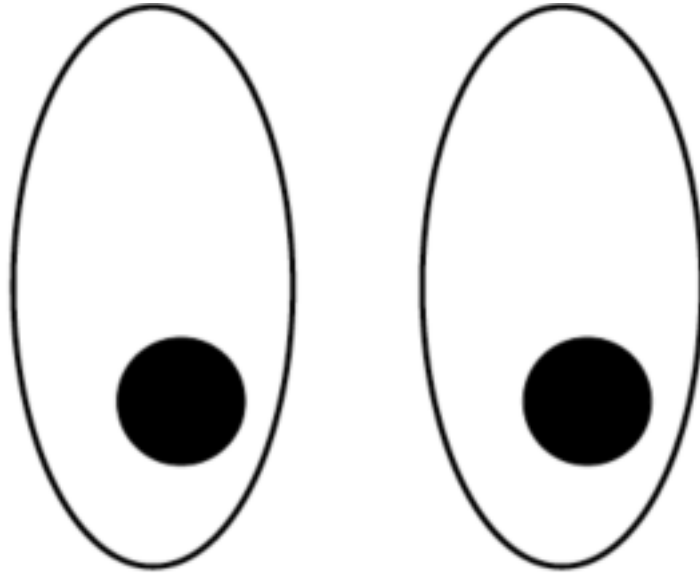


If NICE SOUND then WIDE OPEN

If NASTY SOUND then NARROWED

If SUDDEN SOUND then WIDE OPEN

# ***The Right Eye***



If NICE SOUND then WIDE OPEN

If NASTY SOUND then NARROWED

If SUDDEN SOUND then WIDE OPEN



# ***The Left Eyebrow***



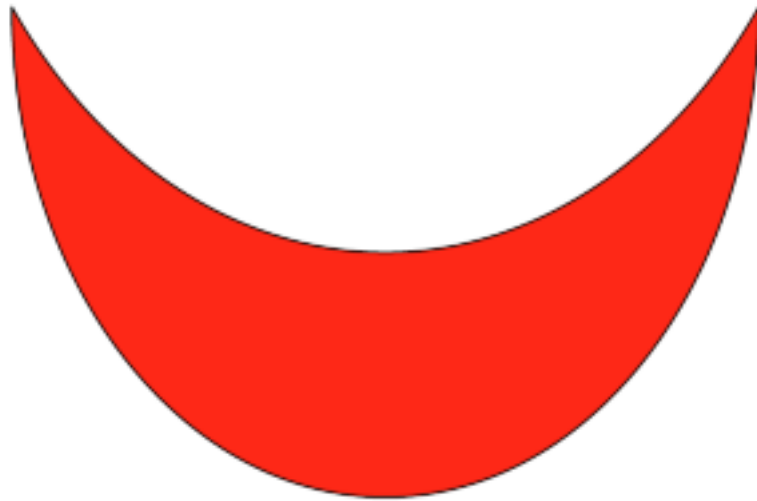
If NICE SOUND then DOWN  
If NASTY SOUND then DOWN  
If SUDDEN SOUND then UP

# ***The Right Eyebrow***



If NICE SOUND then DOWN  
If NASTY SOUND then DOWN  
If SUDDEN SOUND then UP

# ***The Mouth (Left Side)***

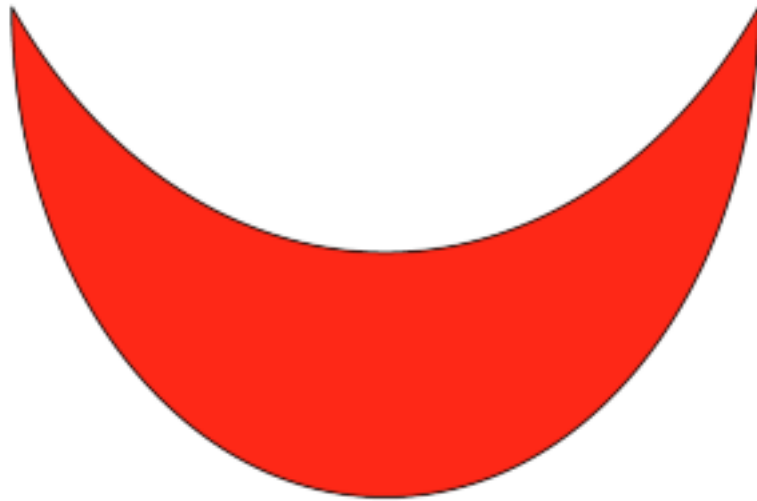


If NICE SOUND then UP

If NASTY SOUND then DOWN

If SUDDEN SOUND then OPEN

# ***The Mouth (Right Side)***



If NICE SOUND then UP

If NASTY SOUND then DOWN

If SUDDEN SOUND then OPEN

***Make a  
HORRIBLE  
sound***

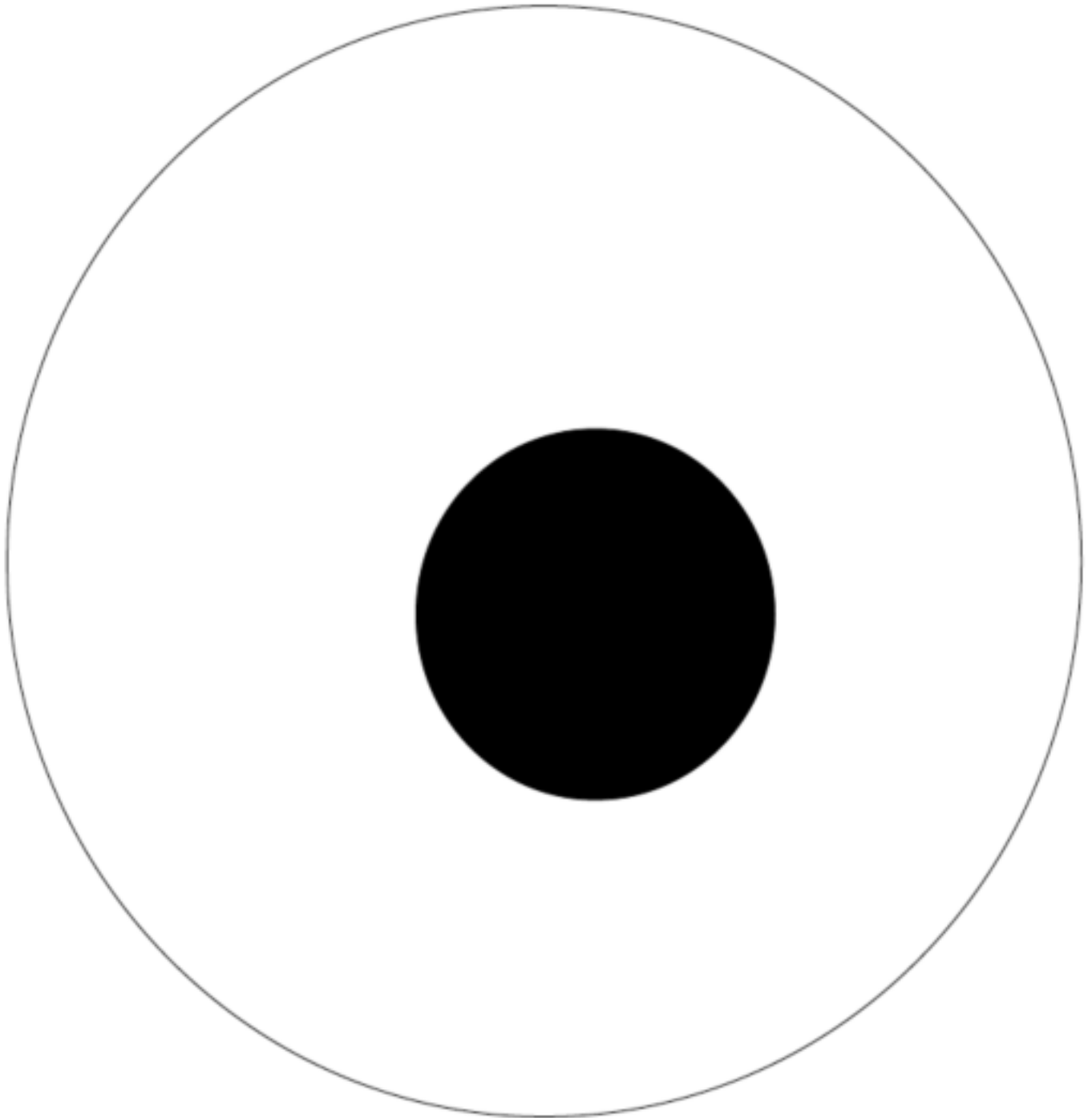
***Make a  
NICE  
sound***

***Shout***  
***BOO***  
***suddenly***

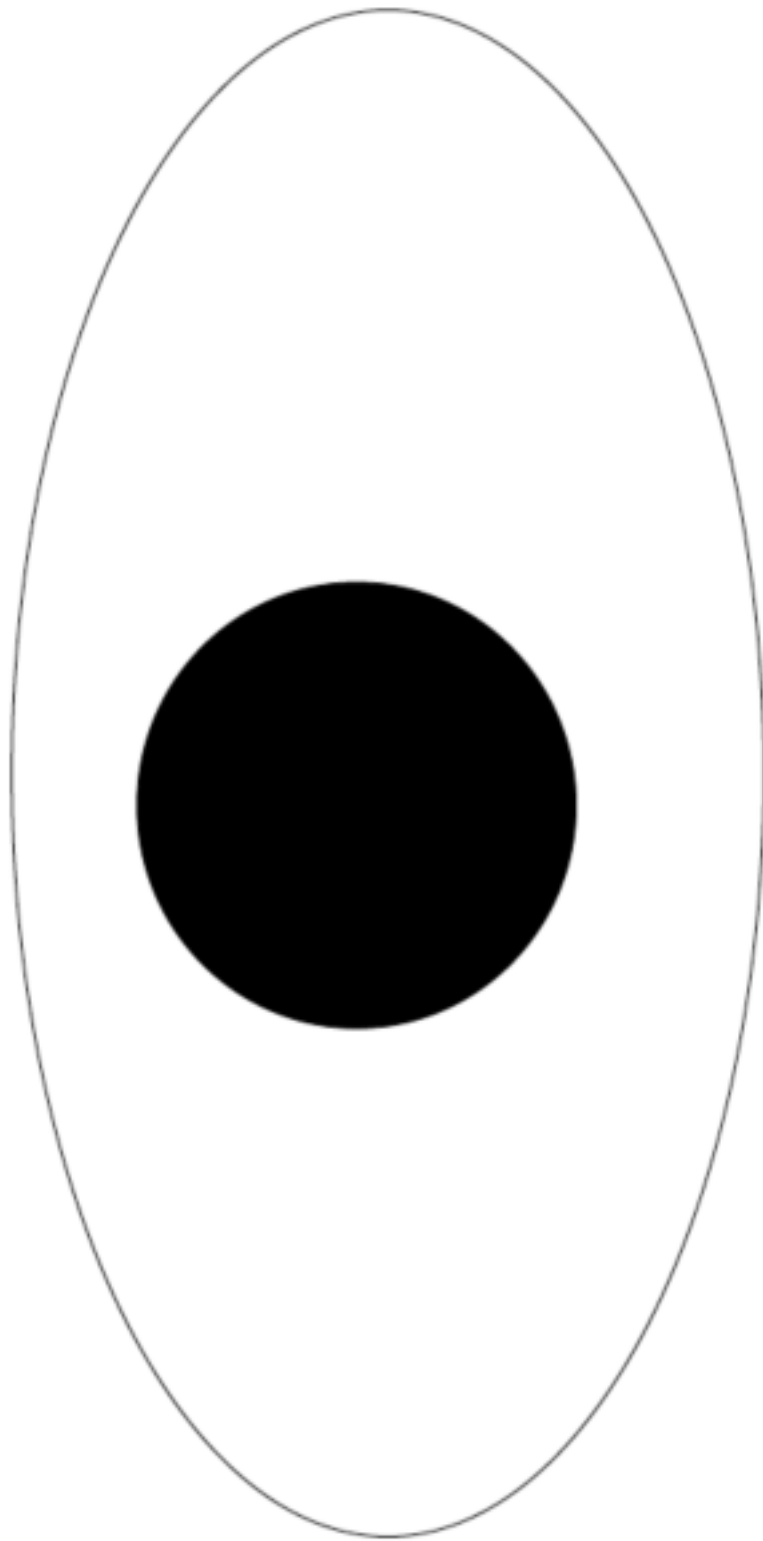


Eyebrow (double this size) x 2





Wide Eye (double this size) x 2



Narrow Eye (double this size) x 2