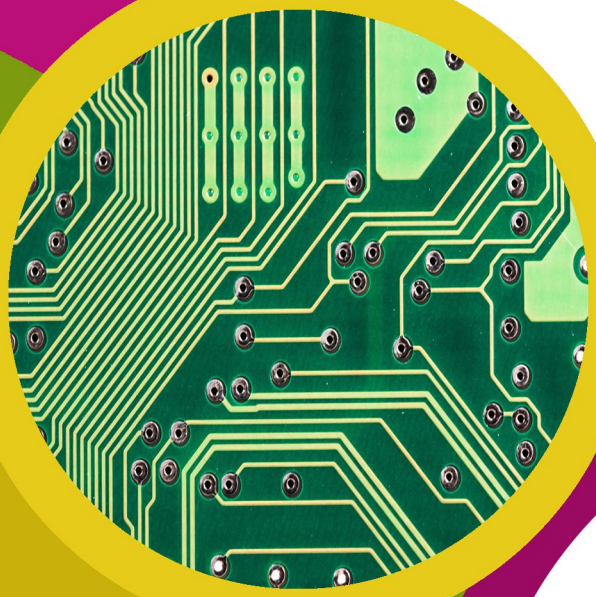
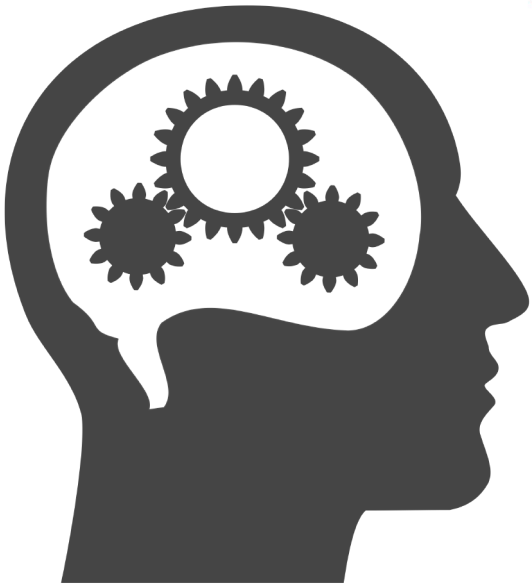
technocamps

Computational Thinking Session Plan





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Workshop Schedule

Introduction - 10 minutes

Computational Thinking - 20 minutes

Decomposition & Abstraction - 45 minutes

Pattern Recognition - 45 minutes

Machine Learning - 10 minutes

Labelled Transition Systems & Computational Thinking Puzzles - 45 minutes

Algorithms - 15 minutes

Traffic Lights - 1 hour

Conclusion - 10 minutes

Post-Day Questionnaires - 10 minutes

Note: These are estimated times, these will vary between classes, schools etc. so times will need to be adjusted accordingly.

Total: 4 hours 30 minutes

Preparation

1. Print out workbooks, one for each student attending the workshop.
2. Each student will need a pencil for answering questions in the workbook.

Learning Outcomes

1. Improved knowledge of Decomposition, Abstraction, Pattern Recognition and Algorithms.
2. Improved problem-solving abilities.
3. Improved programming skills in Scratch.

Attendee Prerequisites

1. Basic experience of Programming in Scratch.

Session Plan Key

In this session plan we use the following colours to differentiate the types of activities:

- **Yellow - Explain.** Teachers should explain the slide/example to the class.
- **Green - Discuss.** Teachers should start an open discussion with the class to get them to feedback some answers/ideas.
- **Purple - Activity.** Students are expected to complete an activity whether it be in their workbooks or on the computer, followed by a discussion of their solutions.
- **Green - Introduction/Conclusion.** The introduction/conclusion is also colour coded green. Teachers should hand out materials in the introduction and conclude the day and collect materials at the end.

Introduction

Begin with introductions, and a brief explanation of the Technocamps programme, before handing out pre-day questionnaires to be filled out by the students and teacher.

Activity: What is Computational Thinking?

Ask the students to write in their workbooks what they think the term computational thinking means.

Explain: The Strands of Computational Thinking

Computational Thinking is the thought processes involved in formulating problems and their solutions so that the solutions are represented in a form that can be effectively carried out by an information-processing agent.
Explain to the class that Computational Thinking is made up of four strands: Abstraction, Algorithms, Pattern Recognition and Decomposition and that we'll be learning more about these during the workshop.

Activity: Guess Who

The slide has pictures of numerous celebrities; each student selects a celebrity and in pairs they take turns in asking yes/no questions to work out their partner's chosen celebrity. First person to guess correctly wins.

Discuss: Guess Who Reflection

- How many questions were needed?
- Which questions were useful or not useful?
- Did your partner's answers influence your next question? How?

Activity: What is Decomposition?

Ask the students to write down what they think decomposition is in their workbooks.

Explain: Decomposition

Decomposition is the process of breaking down a complex problem or system into smaller parts that are more manageable and easier to understand. Some real world examples of using decomposition are breaking down the process of answering a maths problem, cooking, cleaning your room, or creating a video game.

Activity: Decomposition of a Game

Students should think about the following ideas for a game of their choice (e.g. a board game, a video game, a mobile app) and write down in their booklets:

- What is the objective of the game?
- Who are the characters?
- What is the world like?
- Is it a single-player game or multiplayer?
- How do the Characters interact with the World/Other Characters?

Activity: LEGO Building

You will need two volunteers.
Student A is given a handful of Lego bricks. With their partner not able to see what they are doing, student A is told to build the most interesting creation they can with the bricks they are given. Then Student B, still not able to see the creation, is given an identical set of LEGO bricks. Student A should give instructions on how to build the same creation, which Student B should follow without asking questions.

Discuss: LEGO Reflection

Students should answer questions in their workbooks:

- Did the creation look the same?
- Whose fault is it if they don't look the same?
- What would have made the task easier?
- Who or what may experience the same problems as Student B? (Computer)
- What makes a good algorithm? Students should write down four points.

Activity: Drawing Instructions

Students should make a small drawing/picture and try to give instructions to their partner on how to draw it. Remind them their partner is not allowed to see the drawing or ask questions, but only follow the instructions given.

Activity: Get Arty!

Students are shown a detailed picture on the slide which they must try to draw to the best of their ability. They should only have 1 minute to work on it.

Discuss: Artist Reflection

Has anyone drawn a perfect replica?
How did the students decide what to include?
What were their reasons for including the things they did, and leaving out the other details.

Explain: Abstraction

Abstraction is the process of removing unnecessary detail and simplifying.

Why is Abstraction useful and to whom? It allows you to focus on whats important, not unnecessary information. It is useful to everybody, from engineers to GCSE students.

Teachers using Abstraction:
Show the slide with the animal cell (at KS3/GCSE level) and ask the pupils if they can identify the parts of the cell. Point out that this is a simplified view of a cell to make it easier for GCSE pupils to understand. Show the A-level view of an animal cell to show what they'll enjoy learning about if they study it!
Do the same with the KS3/GCSE picture of an atom, and then the A-level view of an atom. This highlights the ways teachers and educators abstract detail in order to teach at appropriate levels of difficulty.

OPTIONAL: Show the video of the robot simulating a Cheetah's movement and explain how the unimportant details (skin, head, fur) are abstracted away and only the motion of the legs and body is important.

Activity: What is Abstraction?

Ask the students to fill in the section on abstraction in their workbooks.

Activity: What is Pattern Recognition?

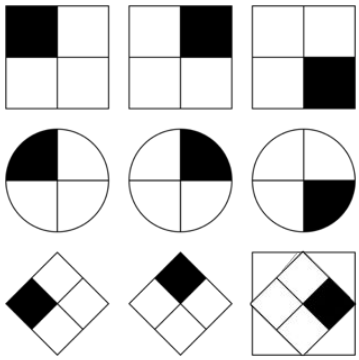
Ask the students to write down what they think pattern recognition is in their workbooks.

Explain: Pattern Recognition

Pattern recognition is the ability to recognise patterns in data sets.

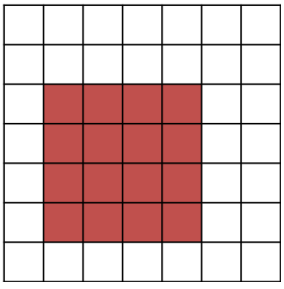
Activity: Complete the Pattern (1)

Students should complete the pattern by filling in the final box with the final square rotated 90 degrees as shown:

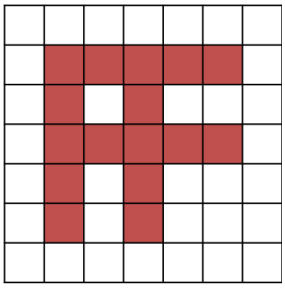


Activity: Complete the Pattern (2) - (3)

Students are to complete the pattern which increases in length and width by 1 square from the original square's position.



The third pattern is deliberately vague to encourage debates. One potential pattern is a horizontal line is drawn, then a vertical one, then a horizontal one with a gap between it and the first, and so the next pattern would be an additional vertical line from the "middle" red square on the top horizontal line as shown:



Activity: Create Your Own Patterns

Using the grid provided, ask the students to start a pattern and ask their partner to see if they can draw what will come next. Remind them they'll need to leave enough space for their partner.

Activity: Number Sequences

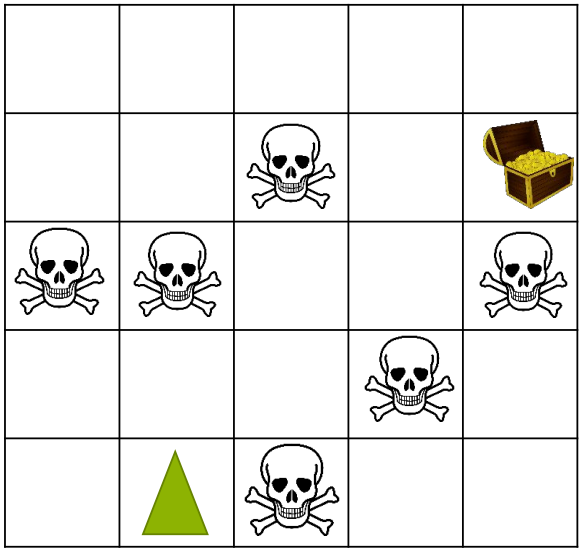
Ask the students to try to spot the pattern in these sequences and what will come next

Sequence	Next Number	Why?
1 2 3 4 5	6	+1 each time
2 4 6 8 10	12	+2 each time
8 4 0 -4 -8	-12	-4 each time
1 2 4 7 11 16 22	29	+1, +2, +3, +4, +5 etc.
1 1 2 3 5 8 13 21 34	34 + 21 = 55	Add previous 2 terms (Fibonacci Sequence)

Activity: Buried Treasure (1) - (2)

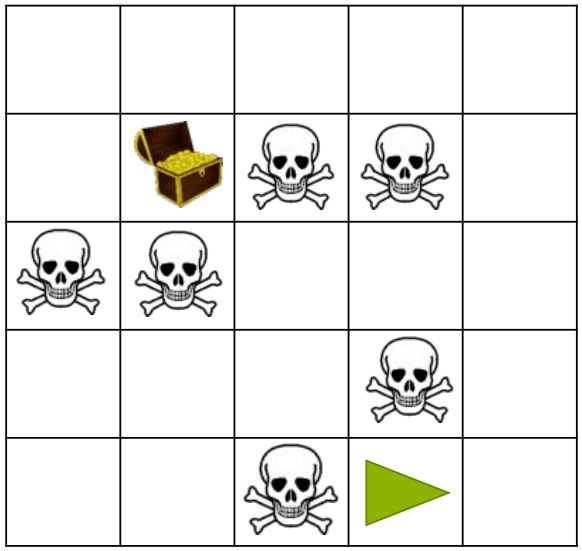
Pupils to list instructions for the arrow to reach the buried treasure, avoiding the skulls. Solutions:

	Instruction		Instruction
1	Move Forward	8	Turn Left
2	Turn Right	9	Move Forward
3	Move Forward	10	Turn Right
4	Turn Left	11	Move Forward
5	Move Forward	12	
6	Turn Right	13	
7	Move Forward	14	



Buried Treasure (2):

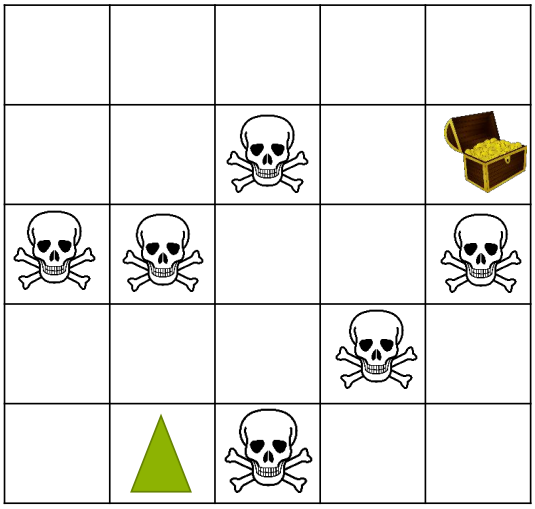
	Instruction		Instruction
1	Move Forward	8	Move Forward
2	Turn Left	9	Move Forward
3	Move Forward	10	Move Forward
4	Move Forward	11	Turn Left
5	Move Forward	12	Move Forward
6	Move Forward	13	
7	Turn Left	14	



Activity: Was There a Pattern?

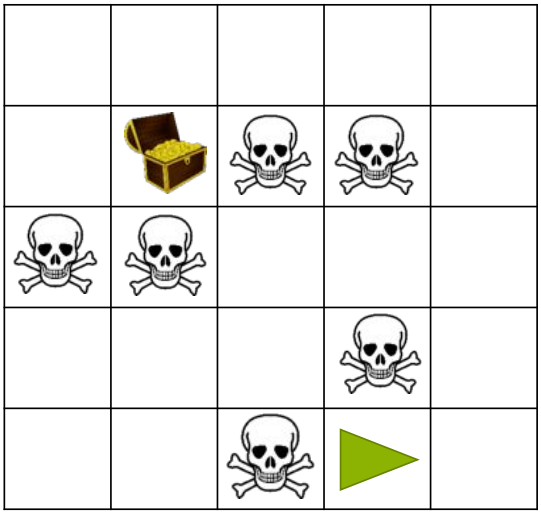
Ask the pupils if there is a pattern in the solutions. Ask them to re-write the instructions but adding repeat instructions like Move Forward x3 or to repeat steps 1-5.

	Instruction		Instruction
1	Move Forward	8	Move Forward
2	Turn Right	9	
3	Move Forward	10	
4	Turn Left	11	
5	Repeat steps 1-4	12	
6	Move Forward	13	
7	Turn Right	14	



Buried Treasure (2):

	Instruction		Instruction
1	Move Forward	8	
2	Turn Left	9	
3	Move Forward x4	10	
4	Turn Left	11	
5	Move Forward x3	12	
6	Turn Left	13	
7	Move Forward	14	



Discuss: Everyday Patterns

Ask the pupils if they can work out why each image is being shown on the slide and what they represent.

First is the Human Genome. This is a sequence of all of the DNA bases or molecules which make up a human being. Other animals have different genomes to human beings and this is what causes us to look and behave differently.

Second is Ed Sheeran. Songs follow a sequence, this may be the rhymes of a verse, or the structure of the song itself. Most have a Verse then a Pre-Chorus and a chorus and repeat, with the occasional guitar solo thrown in for good measure!

Third is a bus. Buses follow a schedule which repeats and also will stop at a sequence of places along the route it takes.

Fourth is language. Words are a sequence of symbols arranged in an order to give a meaning or sound. If a mistake is made or the sequence is wrong then likely the meaning or information is lost.

Discuss: What Use Is Pattern Recognition?

Go through the different applications of computers using pattern recognition techniques.

Ask the pupils if they can think of any other applications where pattern recognition is used.

Explain: Machine Learning

Explain that Machine learning is the study of computers trying to learn patterns from data in order to carry out a task without being explicitly told how to do so.

Computers may be given thousands of pictures of cats and thousands of pictures of dogs and by recognising the shapes and features will build up a basic model of the differences between them. The computer could then be given a picture of either a cat or a dog and output which one it thinks it is based on its own understanding of the two.

Explain that by watching some play Mario and then playing the game itself over and over again, the computer was able to work out, by itself, how to beat the level. Explain that pattern recognition coupled with powerful computers is shaping technology every day.

Explain: The River Crossing Conundrum

A Man needs to cross a river. There is no other way to cross safely other than the use of a rowing boat nearby. The Man cannot swim across. The Man has three things with him:

- a sack of corn
- a chicken
- a fox

He must safely bring these across, however, the boat can only carry two objects at a time e.g. the man and the sack of corn counts as a pair.

Another problem is that the 'chicken' cannot be left alone with the 'sack of corn', and the 'chicken' can not be left alone with the 'fox'. How can John cross the river?

Explain: Labelled Transition Systems

Explain that a labelled transition system is a diagram which shows the different states the world can be in, and the transitions that go from one state to another. This can include both valid and invalid states i.e. some that are allowed in the puzzle, and some which would cause us to fail the puzzle, such as leaving the Fox with the Chicken.

Only necessary information is included i.e. which side of the river the Man and his three items are as well as the boat.

The transitions are then just the initials of the man and the other item that he takes in his boat. i.e. the Man and the Chicken is a transition labelled MC.

Activity: River Crossing LTS

Pupils to complete the LTS diagram for solving the puzzle in their workbooks. The first transition is given to them on the slide.

Solution:

1. Man and Chicken cross - **MC**
2. Man travels back alone - **M**
3. Man takes Sack of Corn across (Or Fox) - **MS (or MF)**
4. Man travels back with Chicken - **MC**
5. Man takes Fox across (Or Sack of Corn depending on step 3 choice) - **MF (or MS)**
6. Man travels back alone - **M**
7. Man takes Chicken across - **MC**

Activity: Water Jug Challenge

Solutions:

1. Fill 5 litre jug.
2. Pour into other jug.
3. Empty 3 litre jug.
4. Pour remaining 2 litres into 3 litre jug.
5. Fill 5 litre jug.
6. Pour 1 litre into 3 litre jug, leaving 4 litres.

1. Fill 3 litre jug.
2. Pour into 5 litre jug.
3. Fill 3 litre jug.
4. Pour into 5 litre jug.
5. Empty 5 litre jug,
6. Pour the 1 litre into 5 litre jug.
7. Fill 3 litre jug.
8. Pour into 5 litre jug to combine 1 and 3 for 4 litres.

Activity: The Bridge Crossing Conundrum

Solution:

1. Alice and Bob cross. (1 and 2)
2. Alice crosses back alone. (1)
3. Carol and Dave cross. (5 and 10)
4. Bob crosses back alone. (2)
5. Alice and Bob cross. (1 and 2) - Total of 17 minutes.

Activity: What is an Algorithm?

Students should write down what they think an algorithm is in their own words in their workbooks.

Explain: Algorithms

Explain that an algorithm is a simple set of instructions that are done in a certain order to solve a problem.

Explain using the algorithm for making and eating toast. Refer back to the LEGO activity and what was important to remember about Algorithms.

It is important to remember when writing an algorithm to keep instructions:

- simple
- in the correct order,
- unambiguous
- relevant to solving the problem

Ask for an example of where we use algorithms in everyday life.

Activity: Defining an Algorithm

Using the slide, students should fill out the section in their workbooks on defining an algorithm.

Explain: Iteration

Explain that an iteration is a single pass through a set of instructions. Most programs contain a set of instructions that are executed over and over again. The computer iterates through the loop.

Explain that some processes include steps or a series of steps that are iterated.

Use the example of the Traffic Lights on the slide. Ask the pupils what instructions would be needed for the process i.e. Turn red light on wait 30 seconds, turn amber light on etc.

Ask them what needs to be iterated and whether the process ever ends.

Activity: Traffic Lights Algorithm

Pupils are to create a simple scratch program which simulates the process on the board.

They will need to design an environment with traffic lights like the example shown on the "How Could We Design It?" slide.

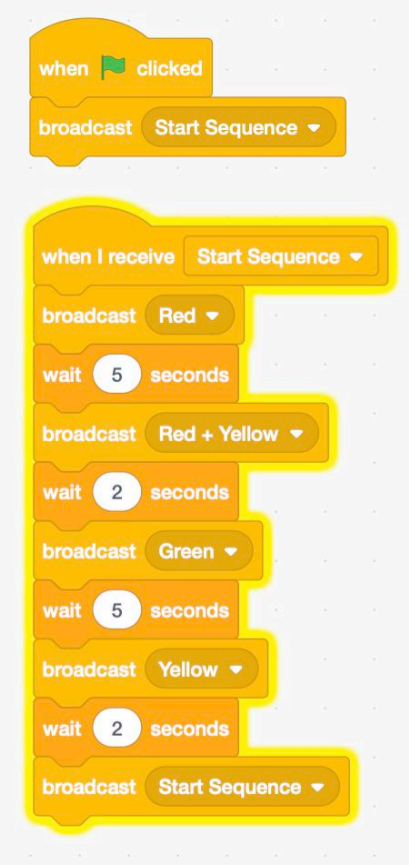
They will then need individual sprites for each of the lights, red, amber and green.

Using broadcast and wait blocks in a loop we can then make the lights carry out the process on the slide.

Programming the main loop in the backdrop helps keep track of our code easier so we always know where it is.

For broadcasting Red for example, the Red Light sprite should include a "when I receive" block connected to a "show" block. The other two lights should be off and so they will have a "hide" block. (See the cheat sheet for clarification on this.)

To extend this activity, pupils can add more sprites such as a button for pedestrians to press and therefore the lights would stay green until this happens. They would also need a green man light to indicate that it is safe to cross.



Activity: Modifying Your Lights (1)

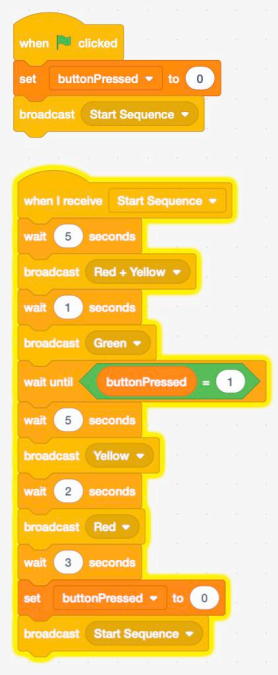
To implement adding a button and lights for pedestrians:

1. Make a Sprite for the button with two costumes, one saying “please wait”.

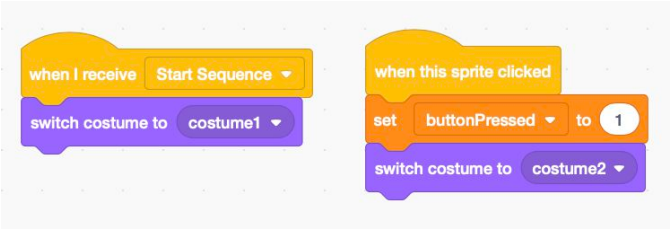
2. Create a variable named buttonPressed or something similar and set this to 1 when the button is pressed. Implement the variable into the code as shown.

3. Create a pedestrian crossing light with two costumes, one with a red man, and another a green man showing.

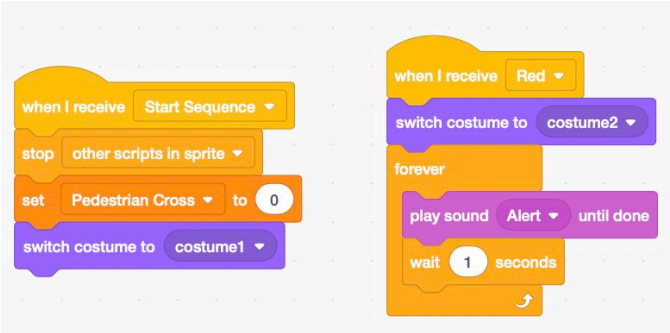
Main Code:



Button Code:



Pedestrian Light Code:



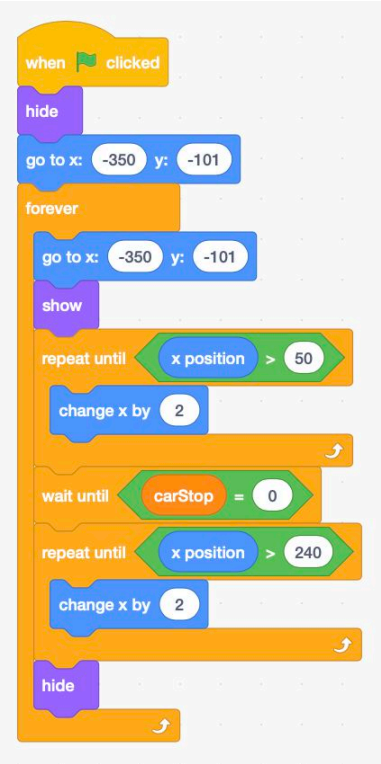
Activity: Modifying Your Lights (2)

To implement adding cars which stop at a crossing:

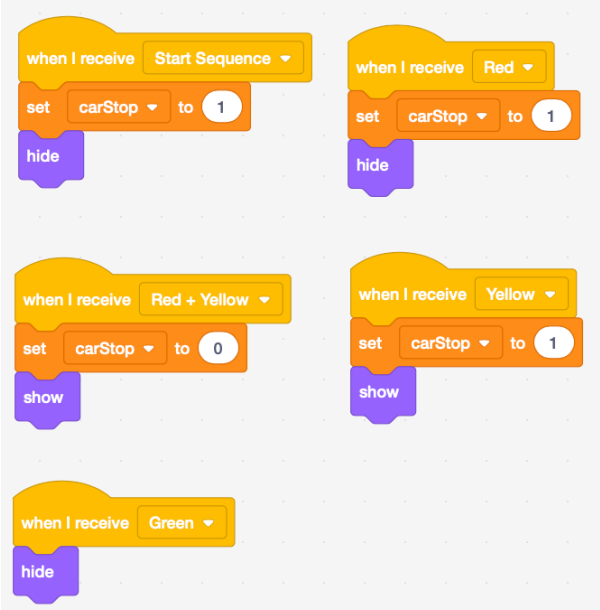
1. Edit the background to add a crossing for the car to stop at if the light is red.

2. Create a variable named carStop or something similar which will have a value of 0 or 1. If carStop = 1 we want the car to stop. Otherwise it is free to carry on.

3. Implement a car which starts off the screen and drives until it reaches the crossing. Once it does, make it wait until carStop = 0, i.e. it is free to move on again. This will mean it will only stop if the light is red.



4. A car should stop when the lights are yellow or red, and ignore the lights if they are green. We can implement this in the yellow light sprite like so:

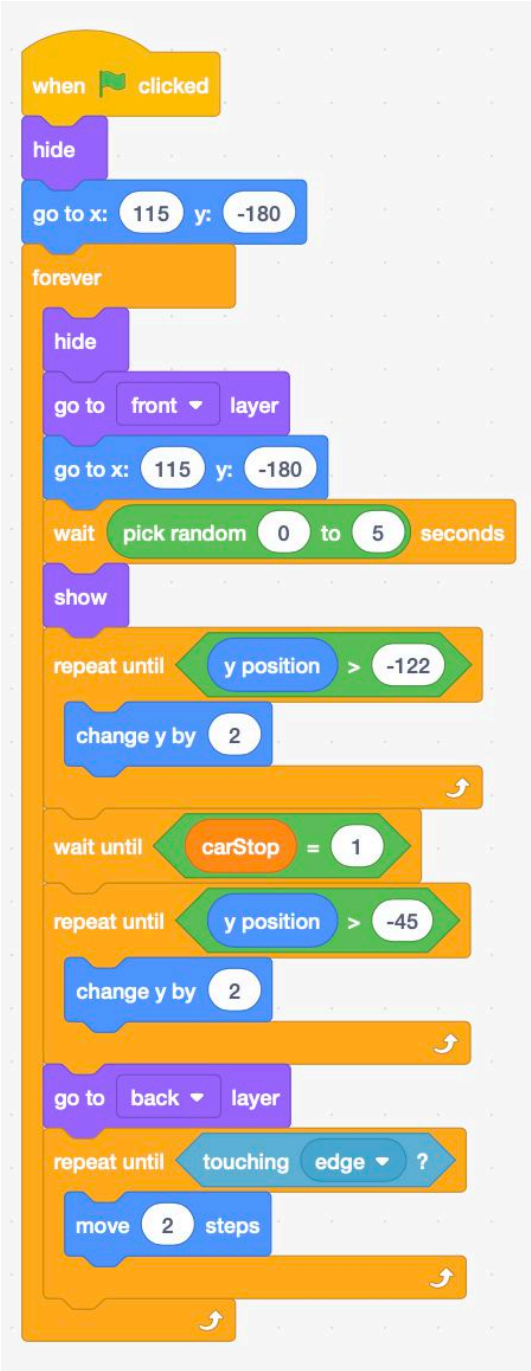


This can be extended by having the cars change costume before showing each time, and waiting a random amount of time before before showing.

You could also apply the same logic to cars coming from the other direction.

Activity: Modifying Your Lights (3)

Code for implementing pedestrians using same logic as car:



The differences here being that the character is walking in the y-direction on the screen to cross the road.

They also need to go back layers so it appears they are walking behind vehicles and other sprites once they cross the road.

The main difference is that the pedestrian should wait until the variable carStop = 1 so that it is safe to cross before crossing the road.

The final repeat block is used after the pedestrian has crossed the road to walk off to the right hand-side of the screen.

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