



SCRATCH

Maths



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Scope & Sequence

Year 5 – Computing focus (20+ hours of teaching materials)

Module 1: Tiling Patterns



Module 2: Beetle Geometry



Module 3: Animating Sprites



Year 6 – Mathematics focus (20+ hours of teaching materials)

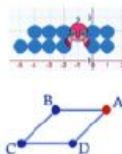
Module 4: Building with Numbers



Module 5: Exploring Mathematical Relationships



Module 6: Coordinates and Geometry



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Module 1: Tiling Patterns



Investigation 1

Moving, Turning,
and Stamping



Module 1: Tiling Patterns

Investigation 1

Moving, Turning,
and Stamping



Investigation 3

Creating Circular
Rose Patterns



Investigation 2

Repeating and
Alternating Patterns



Investigation 4

Defining Your Own
Pattern Blocks



Links to other learning

The theme of Module 1 is repeating patterns. You may like to make links it to areas, such as art or science, where similar patterns can be observed. Some examples are below.

Art: Islamic or Gothic Art

Geometric patterns have been used extensively in Islamic art for many centuries and can also be found in gothic architectural features, such as stained glass windows.



Science: Patterns in Nature

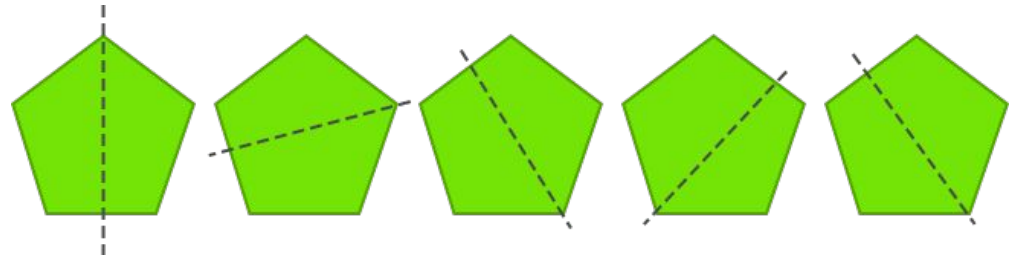
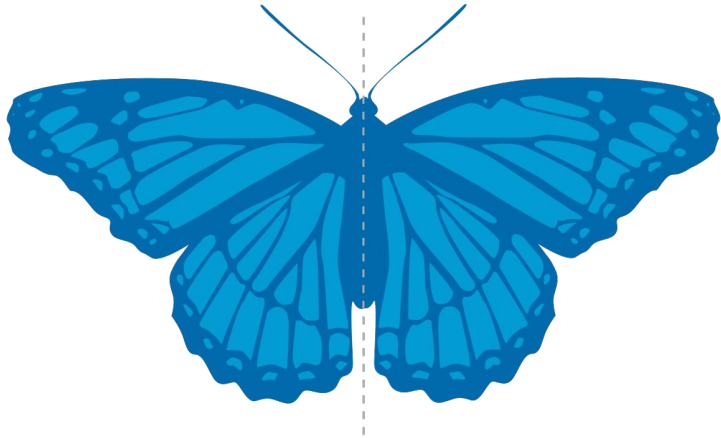
Geometric patterns are seen in nature for example in snowflakes or in the sand sculptures created by puffer fish on the ocean floor.



Links to Math concepts

Symmetry

Exploring symmetry is a 2D Space maths concept, which students can make many connections with in the world around them. This Scratch module explores reflection symmetry and rotational symmetry.

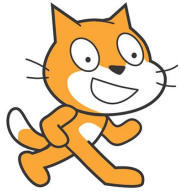


Symmetry in the real world

This module can be used to delve further into the concept of symmetry by showing students, or having them investigate and discover themselves, examples of symmetry in the real world.



SCRATCH Vocab



sprite: an object we control by our blocks and scripts e.g. a Tile, Scratch Cat.



stage: the area where you can see the sprites.

script: a sequence of blocks snapped together, a program; it can be run by clicking on any part of the script



hat block: is always placed at the top of a script

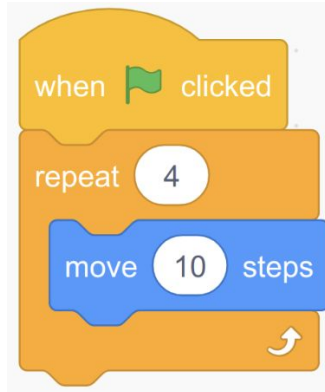
block: a command which tells the sprite what to do; it can be run by clicking on it.



a command which makes the sprite change its **direction**



a command which makes the sprite change its position



stamp: a block which tells the sprite to print its image on the stage

debugging: the process of fixing or improving a program or scripts

Code

Costumes

Sounds



Motion

Looks

Sound

Events

Control

Sensing

Operators

Variables

My Blocks

Pen

Motion

move 10 steps

turn 15 degrees

turn 15 degrees

go to random position

go to x: 0 y: 0

glide 1 secs to random position

glide 1 secs to x: 0 y: 0

point in direction 90

point towards mouse-pointer

change x by 10

set x to 0

Blocks

when clicked

go to x: 0 y: 0

erase all

clears everything and starts again from the beginning - DO NOT EDIT

stamp

Scripts area



Stage

Sprite

Title



x

0



y

0

Show



Size

100

Direction

0

Stage



Title

Sprites

Backdrops

1



SCRATCH

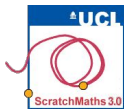
Maths



Investigation 1

Moving, Turning,
and Stamping





Module 1 • Investigation 1 • Activity 1.1.1

Moving, Turning, and Stamping

Learning Intention: Explore how to drag and stamp a sprite to create symmetrical patterns.

Success Criteria:

- Drag, turn, move, and stamp a sprite;
- Build a simple script to create a pattern without using unnecessary blocks.

This investigation introduces three important Scratch commands (**move**, **turn**, and **stamp**) and gradually builds up to using these in a program or script in order to create a simple pattern.

Investigation 1

Moving, Turning, and Stamping



Drag and
Stamp

Starter
project:
10-Tile
Stamp

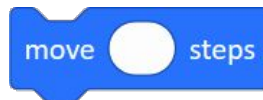
Drag, Turn
and Stamp

Starter
project:
11-Tile Turn

Move,
Turn and
Stamp

Starter
project:
12-Tile move

Unplugged:
Simple
Scripts



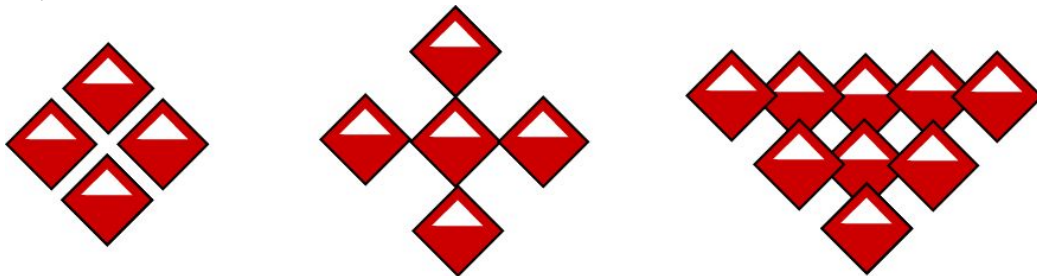
ACTIVITY INSTRUCTIONS

- 1 Open project [10-Tile Stamp](#), remix it, add your name to the title, save the project, and share it to our class studio, [Investigation 1](#).



Remixing a project allows you to create a copy for you to edit, without altering the original project.

- 2 Create a symmetrical pattern by dragging the Tile sprite and clicking on the **stamp** block in the Scripts area.



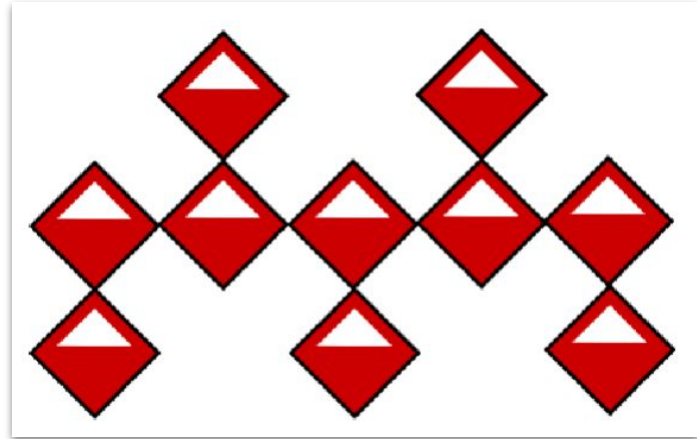
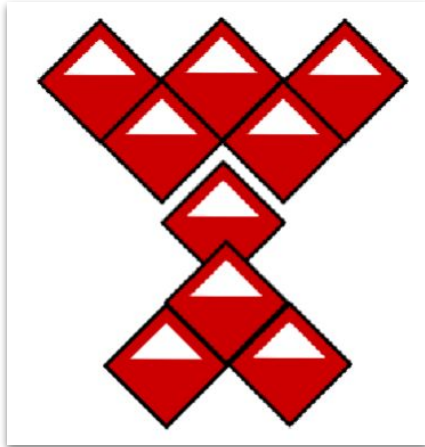
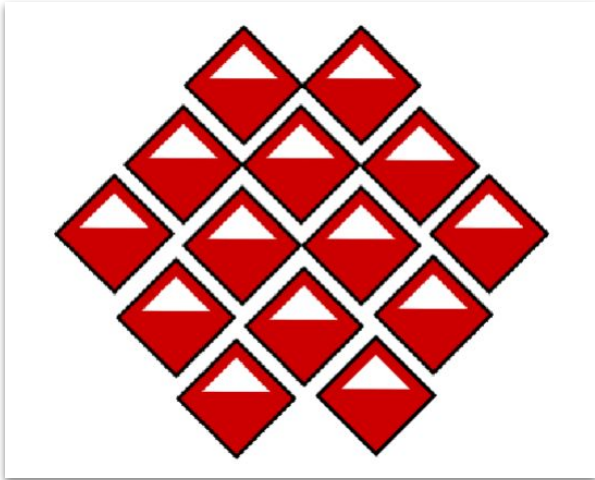
- 3 You can save your pattern by right-clicking (or Shift + click) on the stage and selecting **save picture of stage**.
- 4 Click on the green flag to run the **setup script** – this resets the stage and the sprite.

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applications for
learning

This activity can be used as an open-ended approach to learning about symmetry. Students can share their examples of symmetrical patterns. Ask students how many lines of symmetry each pattern has? Why do they only have 1? How could we create patterns with more lines of symmetry?





Module 1 • Investigation 1 • Activity 1.1.2

Drag, Turn, and Stamp

Learning Intention: Explore how to rotate a sprite both clockwise and anti-clockwise and change its direction to create a symmetrical pattern.

Success Criteria:

- Explain what the setup script does and how to set the direction of a sprite.

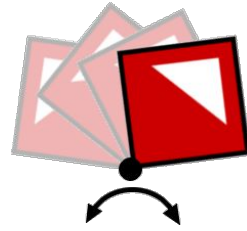
Investigation 1

Moving, Turning,
and Stamping



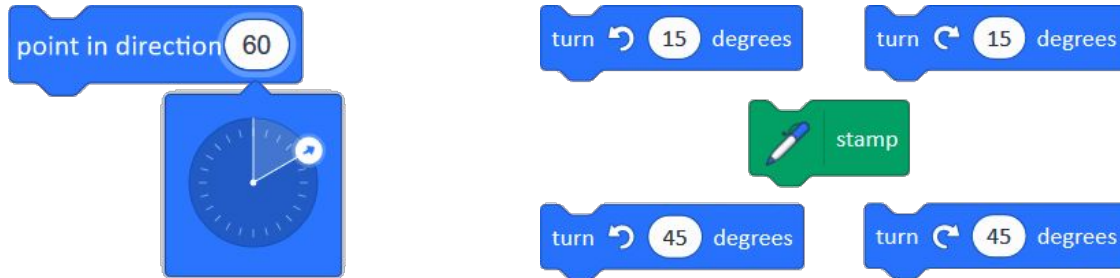
ACTIVITY INSTRUCTIONS

- 1 Open project [11-Tile Turn](#), save as a copy and add your name to the title, save the project, and share it to our class studio, [Investigation 1](#).
- 2 Explore how the Tile sprite reacts to clicking the turn blocks.



- 3 Look at the setup script and explain what has changed.

There is a new block in the setup script point in direction 0 which sets the Tile sprite to point upwards (north). This allows the pattern to be stamped from the initial starting position with initial direction after the setup script has been run.

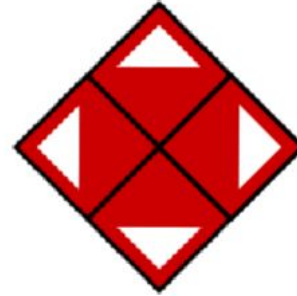
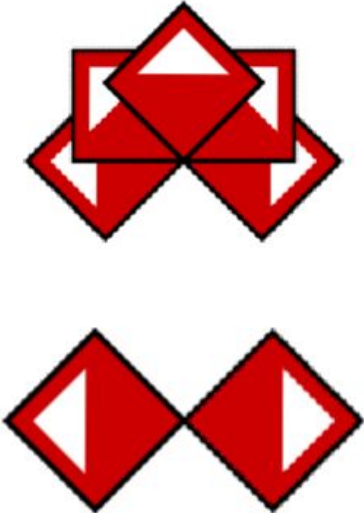


- 4 You will see blocks in the script area that will turn your Tile sprite 15° and 45° clockwise and anticlockwise.
- 5 Experiment with moving, turning, and stamping the Tile sprite. Try changing the angle of the turn and stamping to see how the pattern changes.

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learning

Here you can extend students by seeing if they can use the rotate block to create patterns that have more than one line of symmetry or rotational symmetry.





Module 1 • Investigation 1 • Activity 1.1.3

Move, Turn and Stamp

Learning Intention: Explore how to rotate a sprite both clockwise and anti-clockwise and change its direction to create a symmetrical pattern.

Success Criteria:

- Move the sprite without dragging it;
- Snap blocks together to create a script.

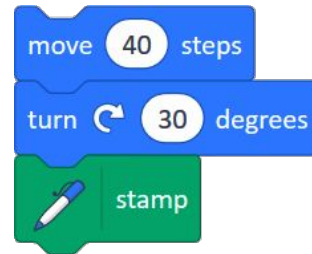
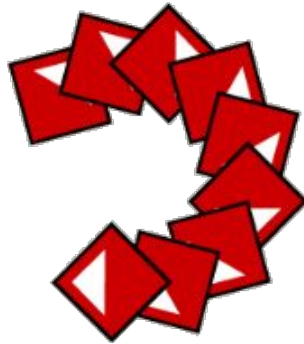
Investigation 1

Moving, Turning,
and Stamping



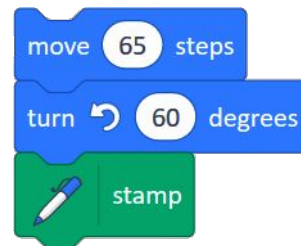
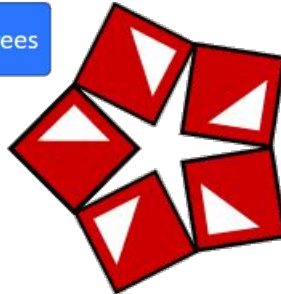
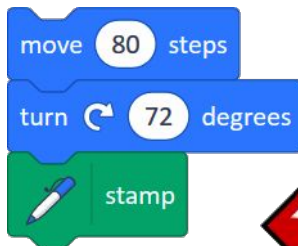
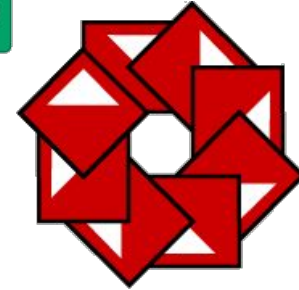
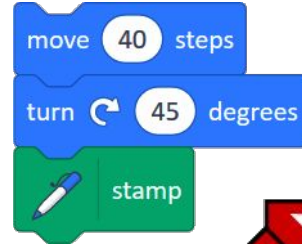
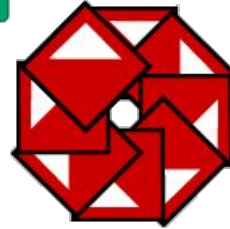
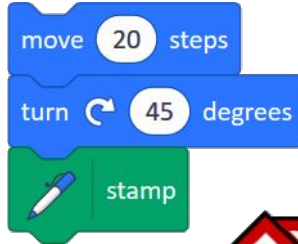
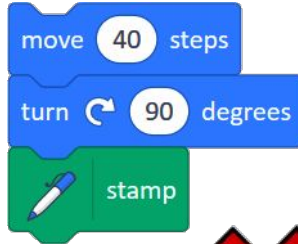
ACTIVITY INSTRUCTIONS

- 1 Open project [12-Tile Move](#), save as a copy and add your name to the title, save the project, and share it to our class studio, [Investigation 1](#).
- 2 Move the Tile along the stage by clicking on the [move 80 steps](#) or [move 40 steps](#) blocks in the scripts area – the Tile should now be moved only using the blocks, **no dragging allowed**.
- 3 Snap together one of the [move](#) blocks, one of the [turn](#) blocks and the [stamp](#) block and then click to run them as a whole script.



- 4 Try the same with the other blocks in the Scripts area.
- 5 Save your pattern by right-clicking (or Shift + click) on the stage and selecting **save picture of stage**.
- 6 Try using a different number of steps by changing the number in the [move](#) block.
- 7 Try turning the Tile sprite a different angle by changing the number in the [turn](#) block.

Explore different values of inputs and clicking the **move** - **turn** - **stamp** script several times. Note that some scripts below have different **move** and the same **turn**:



My Investigation 1 check list:

- I created a symmetrical pattern by stamping the Tile sprite .
- In my patterns, I turned the sprite by using the **turn** block.
- In my patterns, I moved the sprite by using the **move** block.
- I changed the values in my blocks.
- I snapped the blocks together and ran my script repeatedly.
- I saved the picture of my pattern in a file.
- I can simplify a script to make it easier to read, explain and debug.

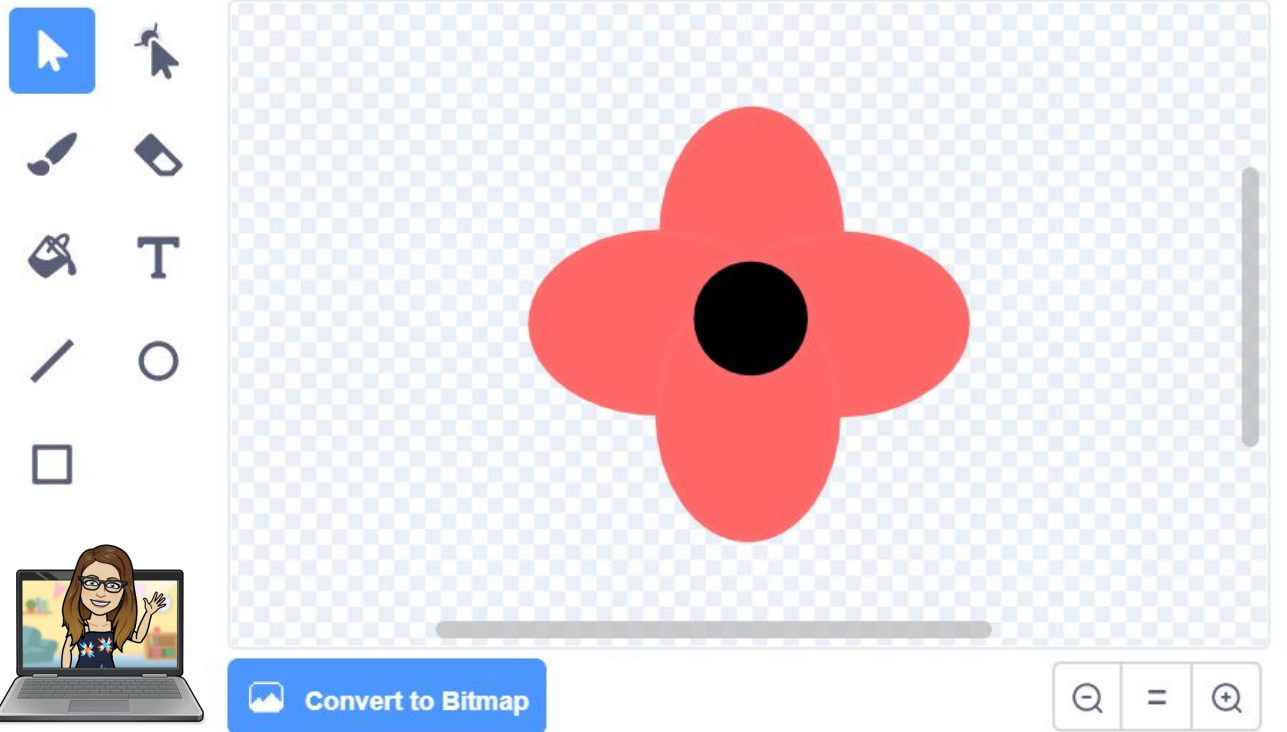
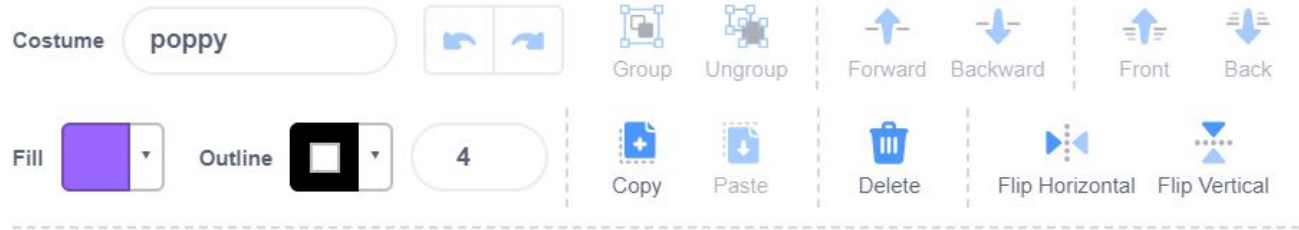
SCRATCH

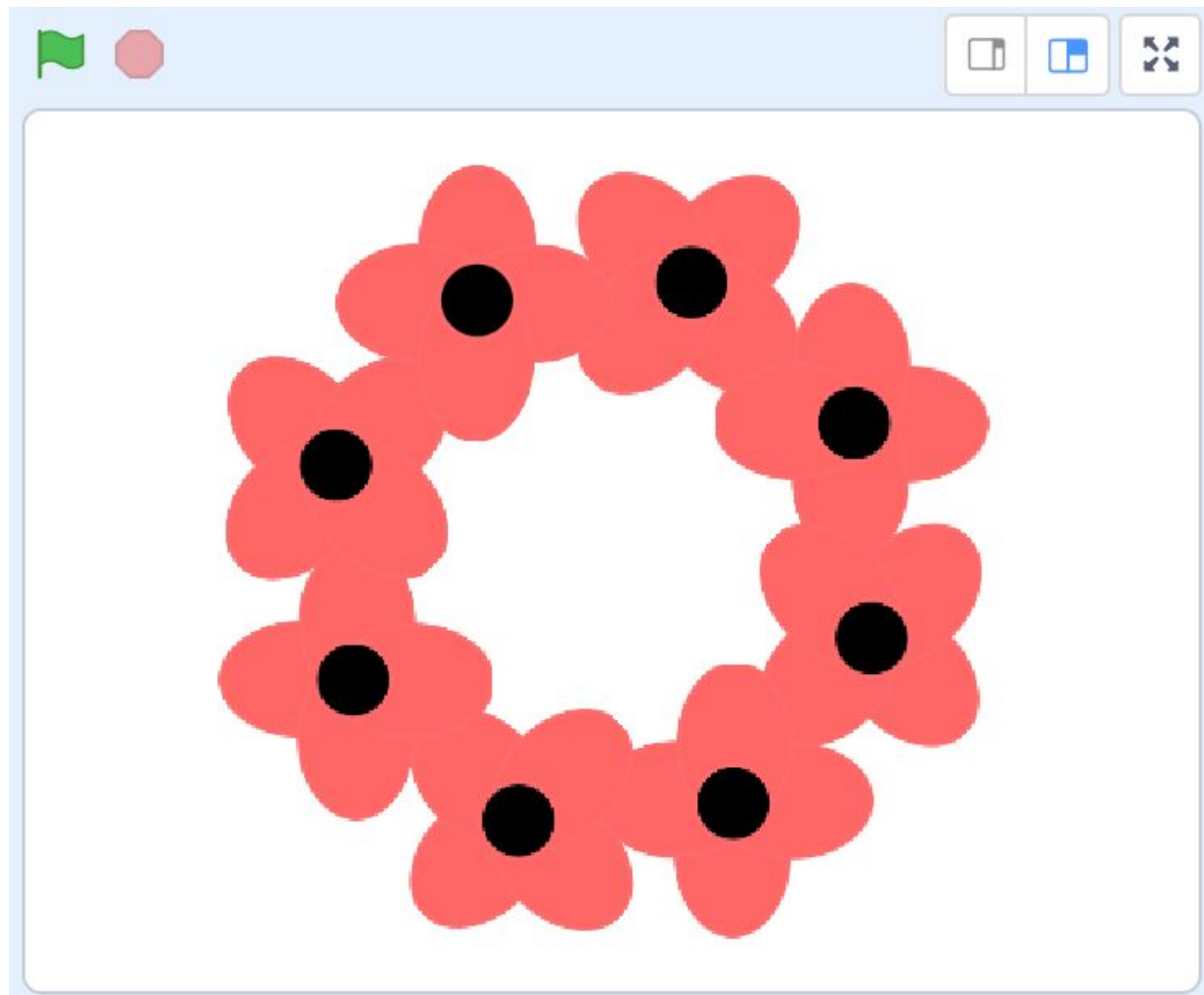
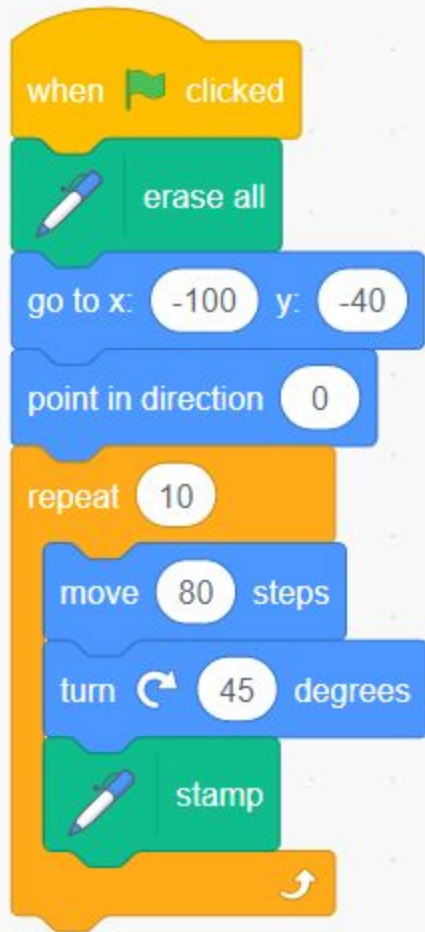
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applications for learning

Once students have mastered this investigation, they can get creative and experiment with creating a design, such as an ANZAC or Remembrance Day wreath:

How to: students create a new costume and then code it to repeat.





Be creative!

Encourage students to be creative with their Sprite design. It can be as simple or complex as they like.



Costume poppy

Group Ungroup Forward Backward Front Back

Fill Outline 4

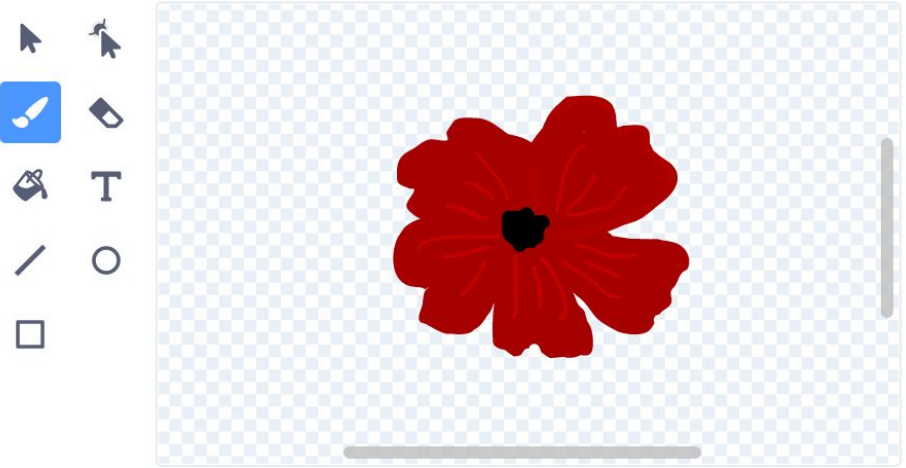
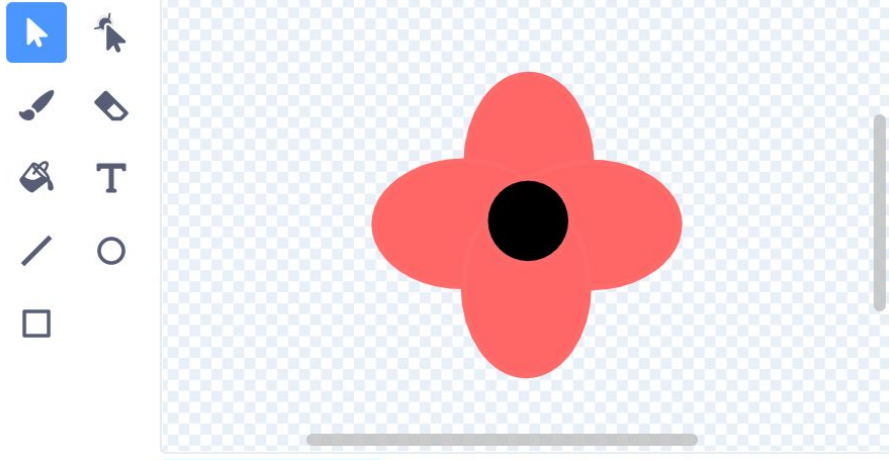
Copy Paste Delete Flip Horizontal Flip Vertical

Costume poppy

Group Ungroup Forward Backward Front Back

Fill Outline 0

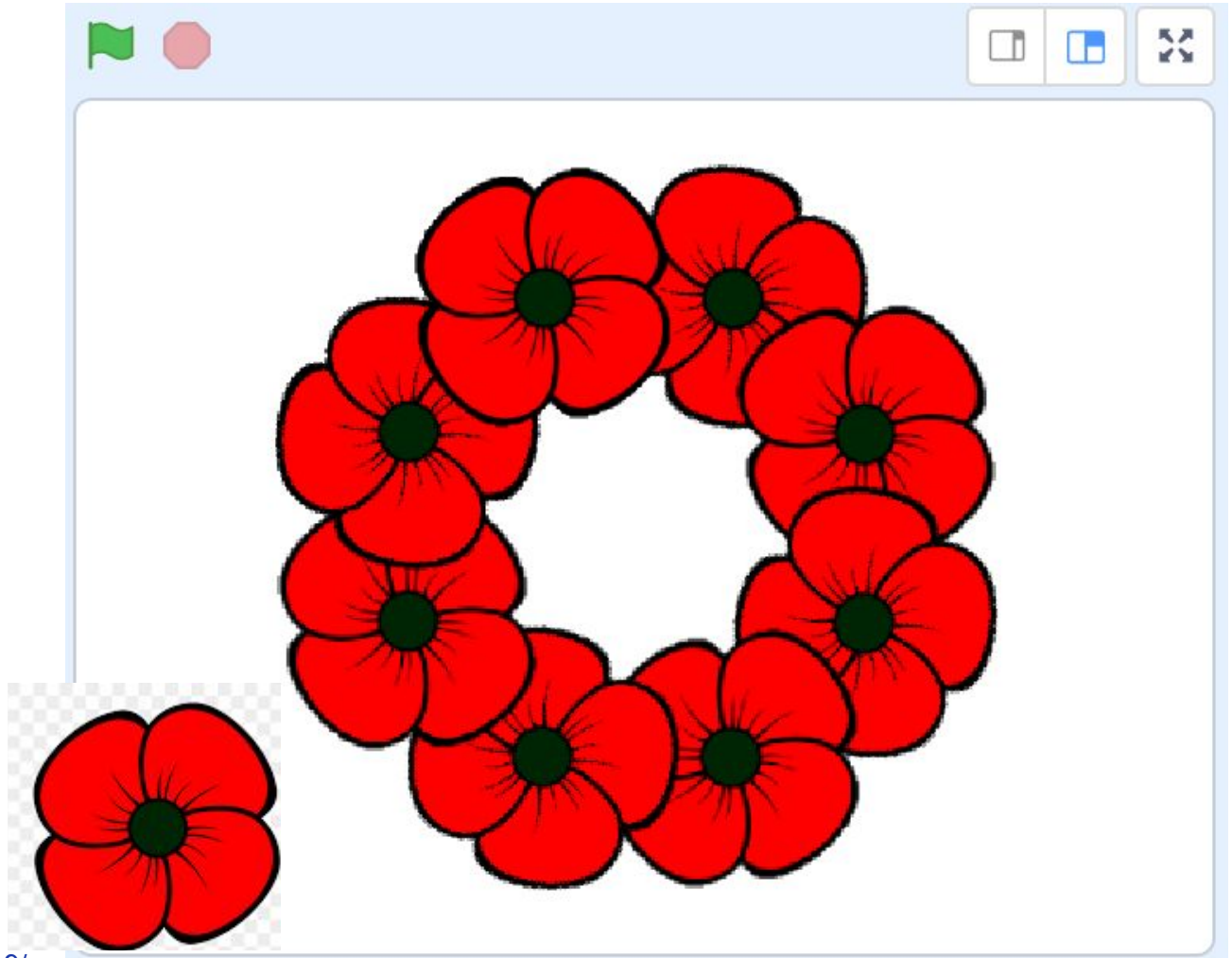
2





TIP

If students are not confident with drawing their own Sprite, they can find an image from Google and upload it as their Sprite, then code to create a wreath design.



Spot the difference

Students can experiment with changing the number of movements their Sprite will take when stamped. Depending on the size and shape of their Sprite, this can create a loosened or tightly coiled wreath design.



The image shows two Scratch code editors side-by-side, each with a 'when clicked' event and a sequence of blocks: 'erase all', 'go to x: -100 y: -40', 'point in direction 0', a 'repeat' loop, 'turn 45 degrees', and 'stamp'. The 'repeat' loop in both contains a 'move' block followed by a 'turn' block. In the left editor, the 'move' block is set to 80 steps, and the resulting wreath is composed of 10 red flower stamps with a loose, open structure. In the right editor, the 'move' block is set to 70 steps, and the resulting wreath is composed of 10 red flower stamps with a tighter, more coiled structure. The 'move' blocks in both editors are circled in pink.

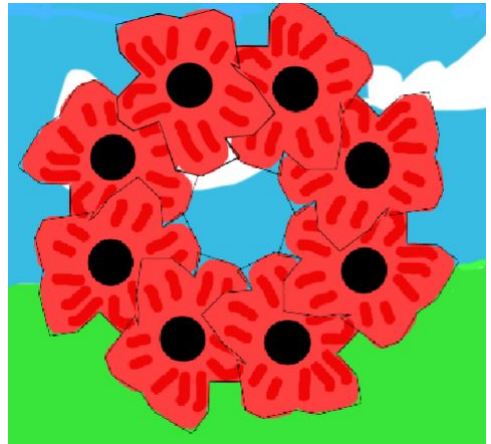
```
when clicked
  erase all
  go to x: -100 y: -40
  point in direction 0
  repeat 10
    move 80 steps
    turn 45 degrees
  stamp
```

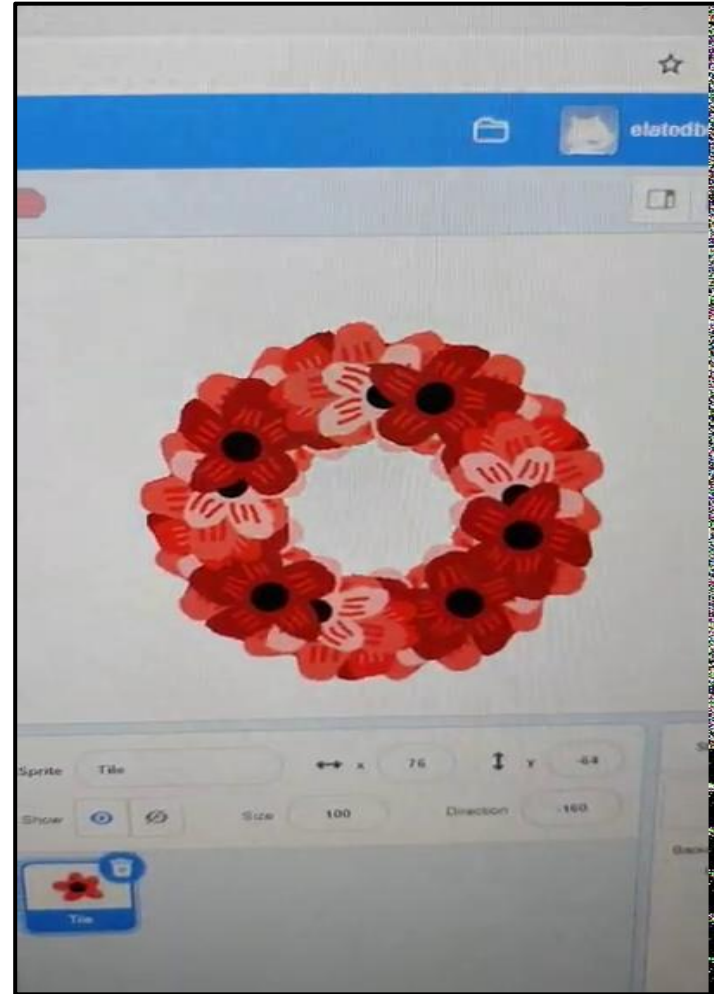
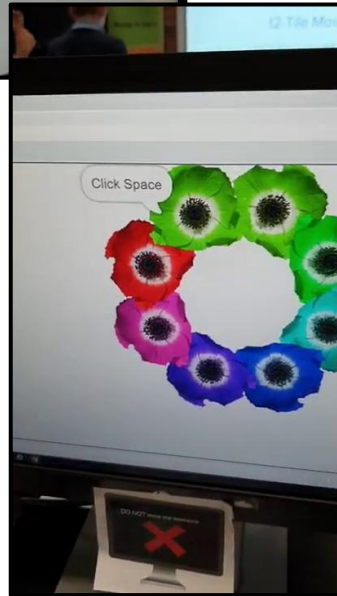
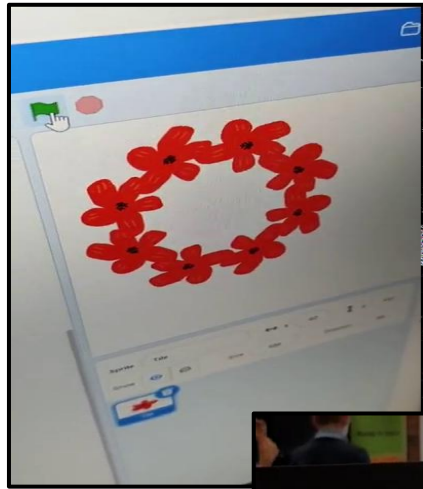
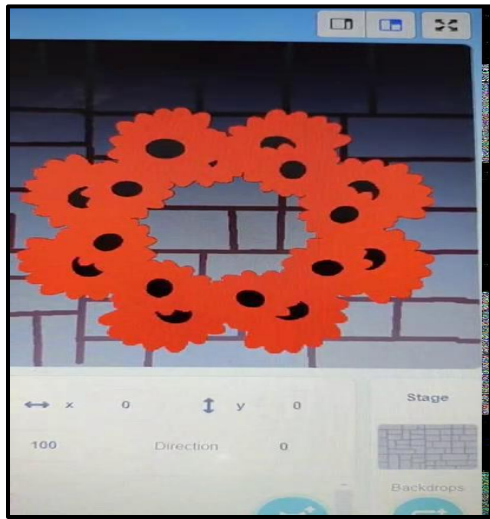
```
when clicked
  erase all
  go to x: -100 y: -40
  point in direction 0
  repeat 10
    move 70 steps
    turn 45 degrees
  stamp
```


REMEMBRANCE



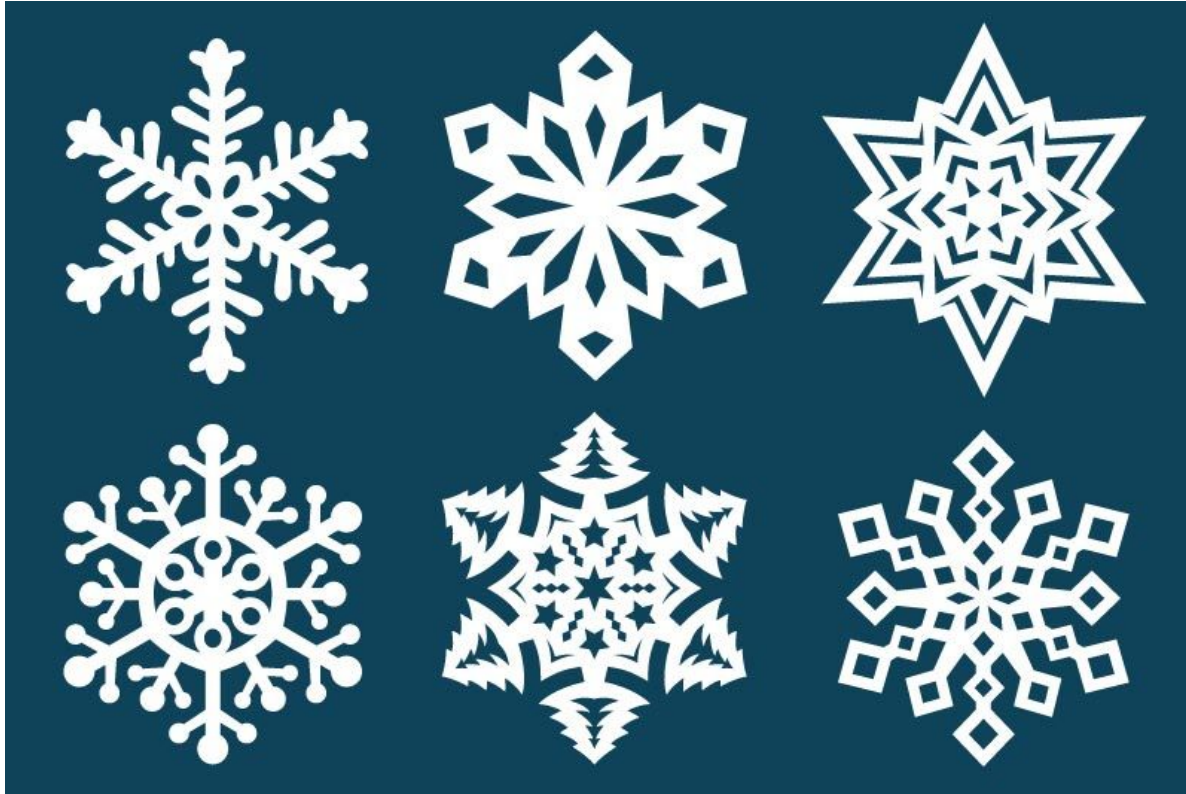
DAY





Snowflake Design

Students can research different snowflake patterns in nature to use as inspiration to create their own design. I have used the snowflake image in the top left as my inspiration for the following Scratch project.



Activity Modifications

You can modify this activity to focus just on angles and symmetry by instructing students to design a branch that they will code to create a snowflake design. I created this design using the line and square tool.

The screenshot displays a digital drawing application interface. At the top, there is a toolbar with various tools and options. The 'Costume' dropdown is set to 'branch'. The 'Fill' dropdown is set to a blue color. The 'Outline' dropdown is set to a white color. The 'Copy' and 'Paste' buttons are visible. The 'Delete' button is also present. The 'Flip Horizontal' and 'Flip Vertical' buttons are also visible. The 'Group' and 'Ungroup' buttons are also visible. The 'Forward' and 'Backward' buttons are also visible. The 'Front' and 'Back' buttons are also visible. The 'Fill' dropdown is set to a blue color. The 'Outline' dropdown is set to a white color. The 'Copy' and 'Paste' buttons are visible. The 'Delete' button is also present. The 'Flip Horizontal' and 'Flip Vertical' buttons are also visible. The 'Group' and 'Ungroup' buttons are also visible. The 'Forward' and 'Backward' buttons are also visible. The 'Front' and 'Back' buttons are also visible.

The main workspace shows a blue snowflake design on a checkerboard background. The snowflake is composed of a central vertical stem with three horizontal branches extending from it. The top of the stem is a diamond shape. The design is centered on the workspace.

At the bottom of the workspace, there is a blue button labeled 'Convert to Bitmap'. To the right of the button, there are three icons: a magnifying glass, an equals sign, and a magnifying glass with a plus sign.

Students can experiment with the repeat block and angle block to create a design. They can change the numbers to be factors of 360 and compare the different results.

```
when green flag clicked
go to x: 0 y: 0
repeat 8
  turn 45 degrees
  stamp
```



```
when green flag clicked
go to x: 0 y: 0
repeat 10
  turn 36 degrees
  stamp
```



```
when green flag clicked
go to x: 0 y: 0
repeat 9
  turn 40 degrees
  stamp
```



```
when green flag clicked
go to x: 0 y: 0
repeat 6
  turn 60 degrees
  stamp
```





End of Investigation 1

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Module 1: Tiling Patterns



Investigation 2

Repeating and Alternating Patterns





Module 1 • Investigation 2 • Activity 1.2.1

Repeating Flowers

Learning Intention: Use a script to make a circular pattern.

Success Criteria:

- Use the repeat block as an alternative to repeatedly clicking a script to create a circular pattern.

Investigation 2

Repeating and
Alternating Patterns



SCRATCH Vocab

repetition: running a sequence of commands a certain number of times



is a control block which runs the blocks inside a specified number of times



is a command which waits a specified number of seconds, e.g. 1, 2, or 0.2, then continues with the next blocks

total turn: total number of degrees the sprite turns when running a script

costumes: are alternative ways that a sprite can look on the stage

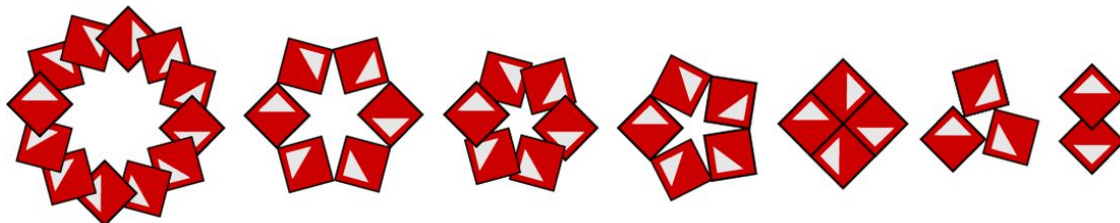


is the block which, when clicked, switches the sprite's costume to the next one in the list.

unplugged: activity away from the computer

ACTIVITY INSTRUCTIONS

- 1 Open project [13-Tile Repeat](#), remix, add your name to the title, save the project, and share it to our class studio, [Investigation 2](#).
- 2 Click on the **move-turn-stamp** script repeatedly until they create a complete circular pattern i.e. **one whole turn**.
- 3 Discuss the *minimum number of clicks* we needed to complete the pattern.
- 4 Click the green flag to clear the stage.
- 5 Find the **repeat** block in the **Control** group and put it around the script.
- 6 In the **repeat** block, type the *minimum number of clicks* that you previously calculated to create the same pattern and run the script.
- 7 Duplicate your script by right-clicking (or Shift + click) on it and selecting **duplicate**.
- 8 Place this script in the scripts area and change the numbers in the **repeat** and **turn** blocks to create different flower patterns.



- 9 You can add the **wait** block to your script to see how the pattern is created.



Module 1 • Investigation 2 • Activity 1.2.3

Alternating Flowers

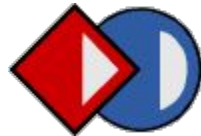
Learning Intention: Use a script with 2 costumes to make a circular pattern.

Success Criteria:

- Create a circular pattern that alternates between 2 different costumes.

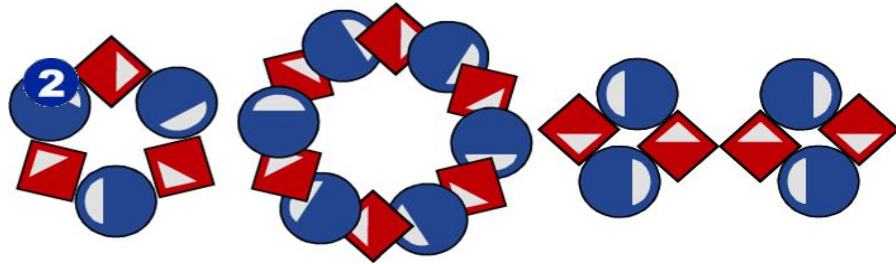
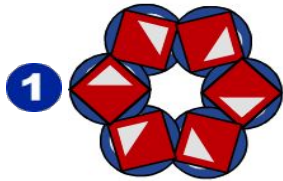
Investigation 2

Repeating and
Alternating Patterns



ACTIVITY INSTRUCTIONS

- 1 Continue in your copy of the [13-Tile Repeat](#) project.
- 2 Clear the stage and choose one of your previous flower scripts to use.
- 3 Click on the **Costumes** tab between the stage and the scripting area. You will find the Tile sprite has two different shapes or 'costumes'.
- 4 Click on the second costume – the circle. Go back to the **Scripts** tab and run their script.
- 5 Go to the **Costumes** tab again and select the first costume – the square. Run your script again.
- 6 Drag the **next costume** block from the **Looks** blocks to the Scripts area.
- 7 Try to create example pattern 1 below, then experiment with other patterns (e.g. 2).



- 8 As before to save their pattern, students can right-click on the stage (or Shift + click) and select **save picture of stage**.

EXTRA SUPPORT

The screenshot below shows how to create patterns using multiple costumes.

The screenshot illustrates the process of creating a pattern using multiple costumes in Scratch. On the left, a code block is shown with a 'repeat' loop set to 8. Inside the loop, the following actions are performed: 'move 50 steps', 'turn 45 degrees', and 'stamp'. Below the code, a red star-like pattern is shown, composed of 8 red squares with white triangles pointing towards the center, arranged in a circular pattern.

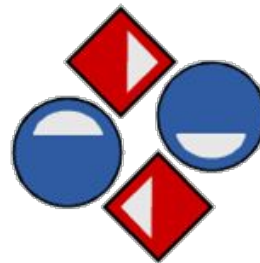
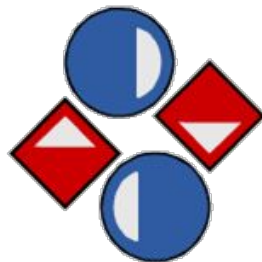
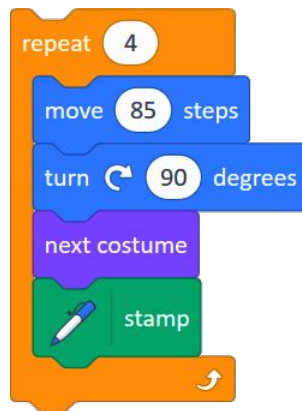
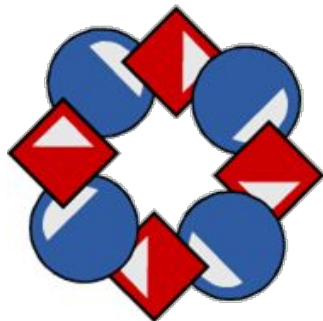
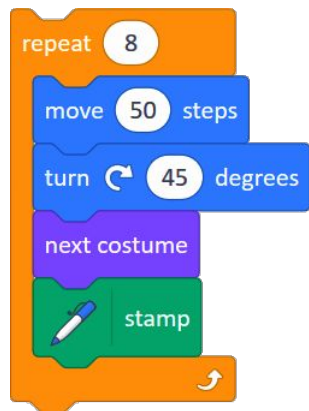
In the center, the 'Costumes' panel is visible, showing two costumes. Costume 1 is a red square with a white triangle pointing towards the center. Costume 2 is a blue circle with a white triangle pointing towards the center. Both costumes are labeled 'square 66 x 66' and 'circle 66 x 66' respectively.

On the right, the 'next costume' button is shown, which is a purple button with the text 'next costume'.

Below the costumes, two circular patterns are shown. The top pattern is a ring of 8 blue circles, each with a white triangle pointing towards the center. The bottom pattern is a ring of 8 red squares, each with a white triangle pointing towards the center, arranged in a circular pattern.

EXTRA SUPPORT

Below are the scripts for some alternating costume patterns.

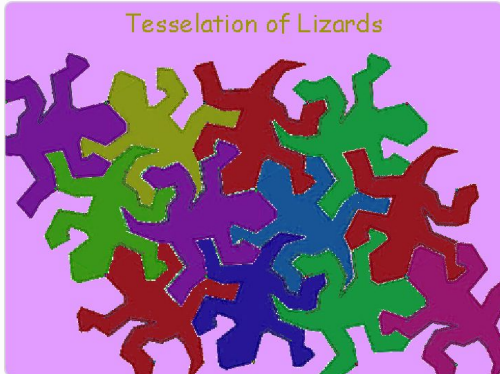


Links to other learning

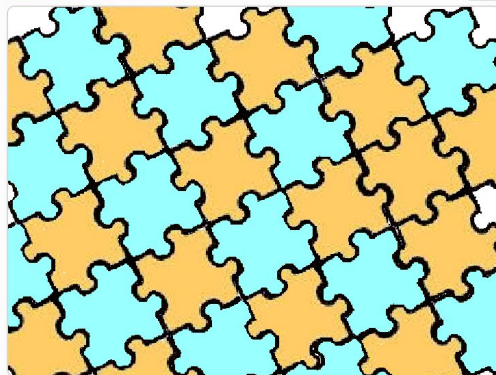
The theme of Module 1 is repeating patterns. You may like to make links it to areas, such as art or science, where similar patterns can be observed. Some examples are below.

Tessellations

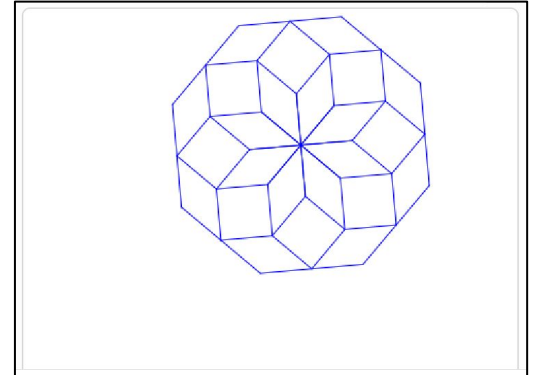
Exploring tessellations is an excellent 2D Space maths activity, which also links to art and creativity. This Scratch module is perfect for this!



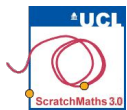
<https://scratch.mit.edu/projects/872507/>



<https://scratch.mit.edu/projects/2537749/>



<https://scratch.mit.edu/projects/305345814/>



Module 1 • Investigation 2 • Activity 1.2.4

[Extension] Repeating & Alternating

Learning Intention: Use a script to create a repeating and alternating pattern.

Success Criteria:

- Create a circular pattern that alternates between different costumes and repeats.

Investigation 2

Repeating and
Alternating Patterns

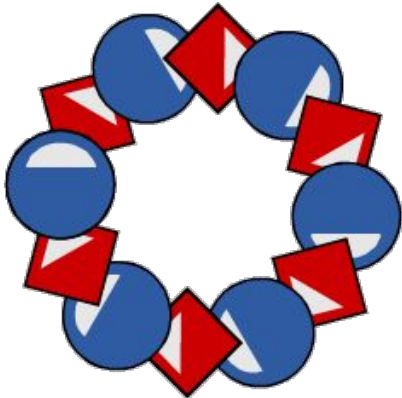
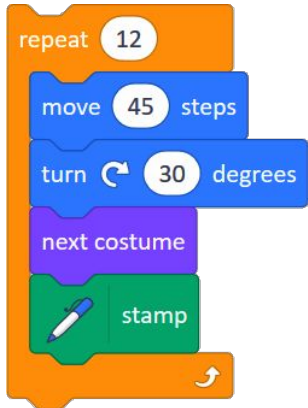


ACTIVITY INSTRUCTIONS

- 1 Continue in your copy of the [13-Tile Repeat](#) project.
- 2 Rearrange the blocks inside the **repeat** block of your flower scripts so that you create patterns similar to those below.

Hint: You might need to remove some of the blocks or use them more than once.

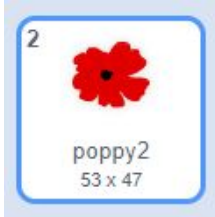
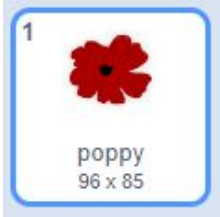
Below are the scripts for some patterns that you might like to try:



SCRATCH

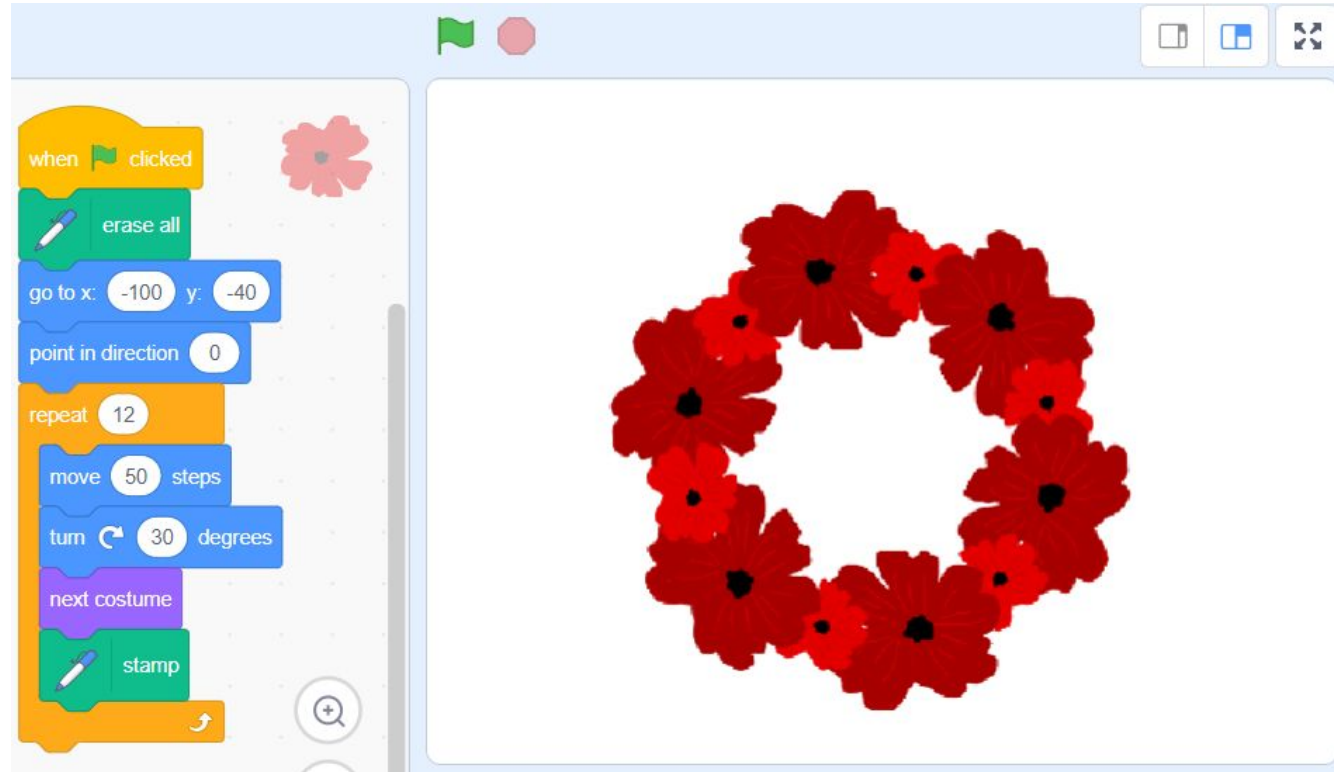
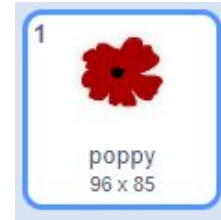
Maths

applications for learning



Students can duplicate or create a second Sprite to alternate between. Then they can experiment with their repeat, movement, and turning numbers to create a wreath design.

To create this design, I duplicated my original poppy Sprite, made the size smaller, and changed the colour.



SCRATCH Maths

applications for learning

Students can design multiple Sprites to alternate between. Then they can experiment with their repeat, movement, and turning numbers to create a Christmas wreath design.



when clicked

erase all

go to x: -20 y: -120

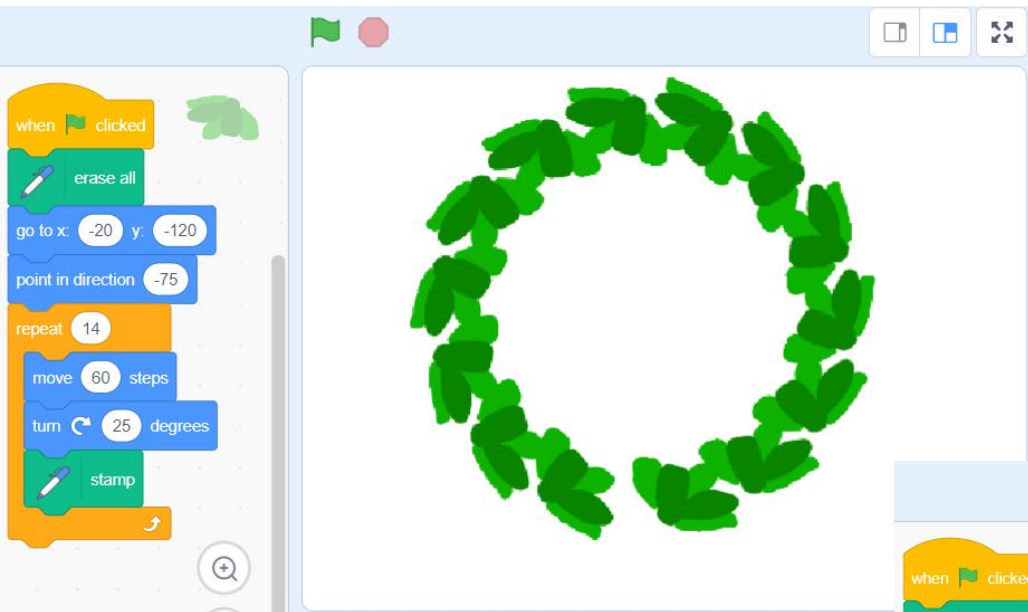
point in direction -75

repeat 14

move 60 steps

turn 25 degrees

stamp



The image shows a Scratch script designed to create a circular wreath. It starts with a 'when clicked' event block. The first block is 'erase all', which clears the stage. The second block is 'go to x: -20 y: -120', which moves the sprite to the center of the stage. The third block is 'point in direction -75', which sets the initial direction. A 'repeat' loop block is set to 14 iterations. Inside the loop, there are three blocks: 'move 60 steps', 'turn 25 degrees', and 'stamp'. The 'stamp' block uses a green leaf icon. The final result is a circular wreath composed of 14 green leaves arranged in a ring.

when clicked

erase all

go to x: -20 y: -120

point in direction -75

repeat

move

turn

stamp

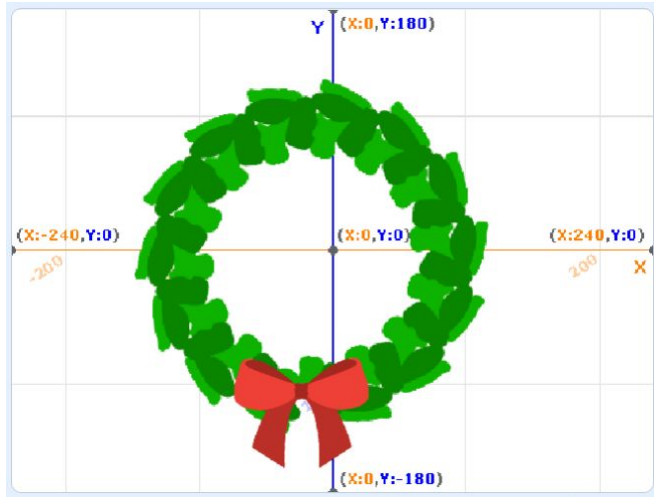


This image shows the same Scratch script as the first image, but with a blue clock overlay on the 'repeat' block. The clock is used to visualize the 14 iterations of the loop. The script is identical to the one in the first image, starting with 'when clicked', followed by 'erase all', 'go to x: -20 y: -120', 'point in direction -75', and a 'repeat' loop of 14 iterations. Each iteration contains 'move 60 steps', 'turn 25 degrees', and 'stamp' blocks. The final result is a circular wreath of 14 green leaves.

Add more detail

Students can learn more about the x and y axis by uploading a Christmas bow as a Sprite, then positioning it at the base of the wreath.

Tip: in backgrounds, you can select the xy grid, which will help your students visualise the x and y axis.



```
when clicked
  erase all
  switch costume to green
  go to x: -20 y: -120
  point in direction -75
  repeat 14
    move 50 steps
    turn 25 degrees
    stamp
  switch costume to xmasbow
  go to x: -25 y: -106
  stamp
  switch costume to Ball-a
  go to x: -91 y: -72
  point in direction -72
  repeat 5
    stamp
    turn 52 degrees
    move 88 steps
    change color effect by 35
```



To extend students who are looking for something more complex:

Instruct them to use the ball Sprite and code baubles to appear on the wreath as well.



End of Investigation 2

SCRATCH

Maths

Module 1: Tiling Patterns

Investigation 3

Creating Circular
Rose Patterns





Module 1 • Investigation 3 • Activity 1.3.1

Moving Forwards and Backwards

Learning Intention: Use a script to make a circular pattern using a different algorithm.

Success Criteria:

- Create a circular pattern;
- Explain how I have moved the sprite backwards.

Investigation 3
Creating Circular
Rose Patterns



ACTIVITY INSTRUCTIONS

- 1 In the previous investigation, you used the algorithm **move-turn-stamp** to create patterns. You will now use a different algorithm to create a rose pattern – **move-stamp-move back-turn**.
- 2 How do you think you could program your sprite to move backwards? Physically step through the algorithms.
- 3 Open the [14-Rose Patterns](#) project, remix, add your name to the title, save the project, and share it to our class studio, [Investigation 3](#).
- 4 Build a script to create the circular rose pattern below using the **repeat** block. Include a **wait** block to slowly demonstrate how the pattern is created.



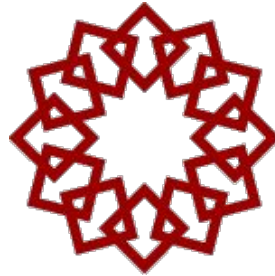
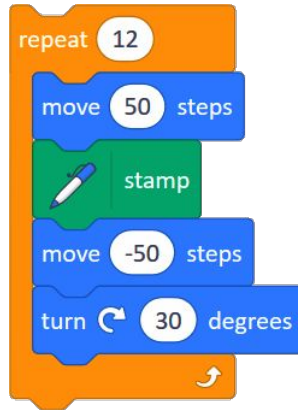
- 5 Experiment with changing the number of steps in the **move** block, the number of degrees in the **turn** block and the number in the **repeat** block.
- 6 Try changing the numbers in your scripts to create some of the patterns below.



EXTRA SUPPORT

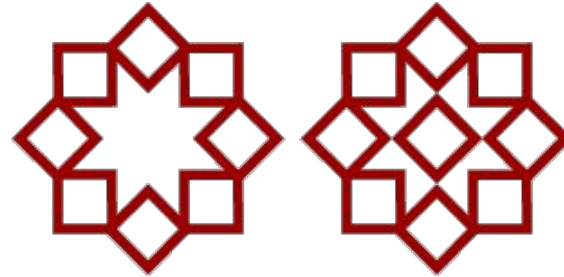
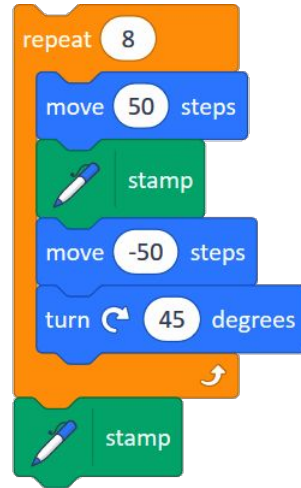
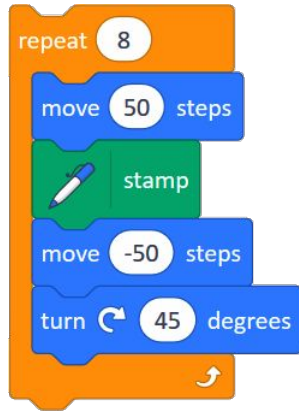
You might like to **physically demonstrate** for yourself how the rose pattern is stamped – e.g. take 1 step forward, stamp your foot, take 1 step backward, rotate slightly to the right and repeat...

You can use the script below to create the rose pattern on the right. Use the script that includes the **wait** blocks to slowly demonstrate how the pattern is stamped.



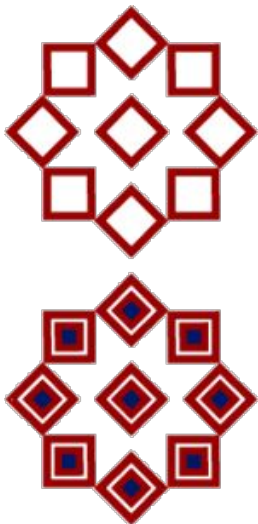
EXTRA SUPPORT

The scripts below create rose patterns without and with a **stamp** in the centre.



EXTRA SUPPORT

You can use the script below to create the first rose pattern on the left.



```
switch costume to square
repeat 8
  move 60 steps
  stamp
  move -60 steps
  turn 45 degrees
stamp
```

```
switch costume to small square dark
repeat 8
  move 60 steps
  stamp
  move -60 steps
  turn 45 degrees
stamp
```



Module 1 • Investigation 3 • Activity 1.3.3

Combining Different Costumes

Learning Intention: Use a script to make a rose pattern.

Success Criteria:

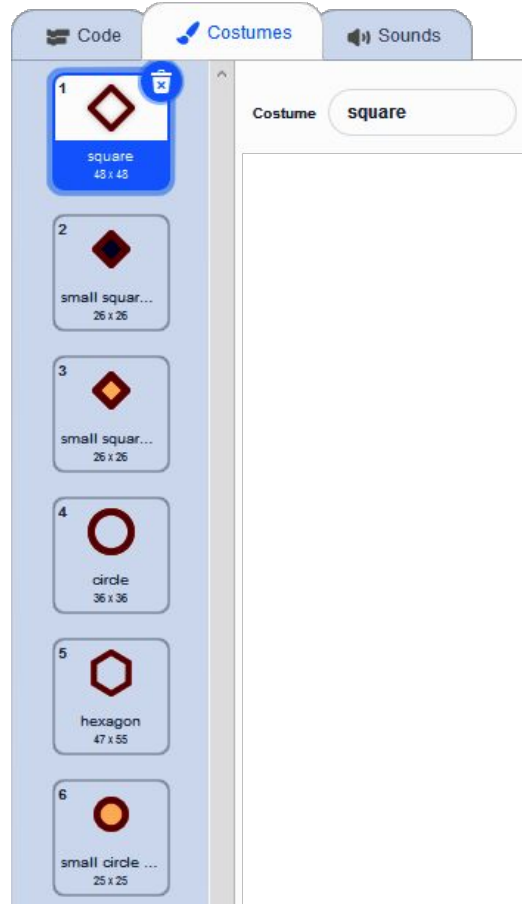
- Create a rose pattern;
- Switch between specific costumes.

Investigation 3
Creating Circular
Rose Patterns



ACTIVITY INSTRUCTIONS

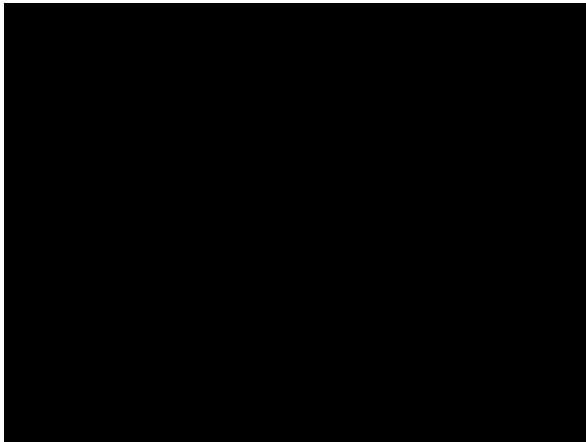
- 1 Continue in your copy of the [14-Rose Patterns](#) project.
- 2 Go to the Costumes tab and explore how many costumes the Tile sprite has. Look at each of the different costumes and notice each costume has its own name.
- 3 Find the **switch costume to ...** block and click on its drop down menu: this has the same list of costume names.
- 4 Use this block in your scripts to create your own rose patterns.



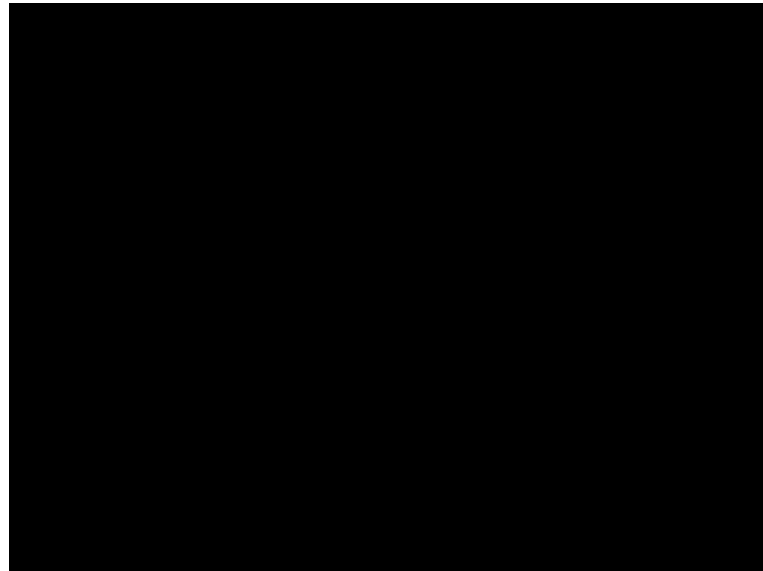
Links to other learning

Art: The Mandala

Using the idea of a circular repeated pattern makes the mandala an obvious choice for exploration. Check out these examples on Scratch - or make your own!



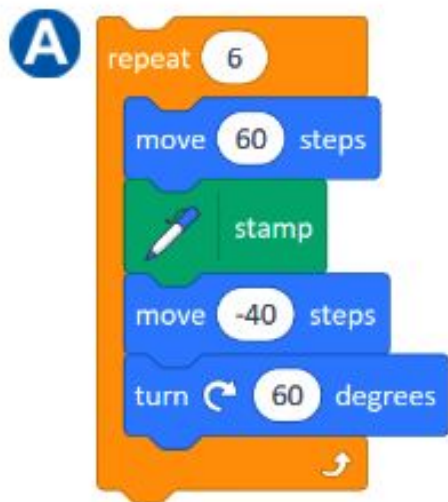
<https://scratch.mit.edu/projects/349957316/>



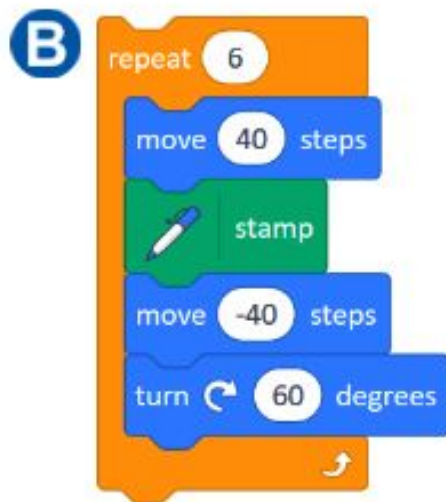
<https://scratch.mit.edu/projects/208138925/>



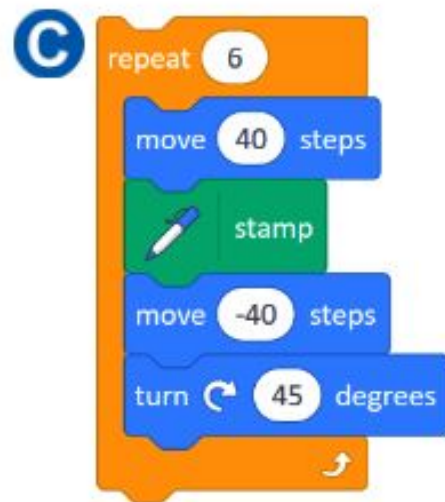
End of Investigation 3



Explain why **Script A** would or would not create the pattern above.



Explain why **Script B** would or would not create the pattern above.



Explain why **Script C** would or would not create the pattern above.