MOONHACK 2024



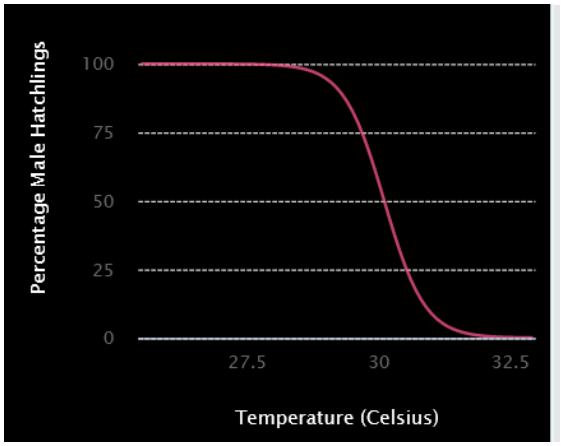
Turtles and Temperature

Write a program that uses temperature data to view the affects this has on whether turtle hatchlings will be male or female.

INTRODUCTION

What you will make

Create a program to graph the percentage of turtle hatchlings that are male against the temperature the eggs are incubated at. Then, create a quiz based on the results!



What you will learn

- **Print** text to screen
- Getting user **input**
- **If statements**
- Using **lists** to create **plots**

What you will need

HARDWARE

A computer capable of running Python 3, or an internet browser

SOFTWARE

Raspberry Pi Editor **(online)**

or

Mu Editor **(download)**

DOWNLOADS

Download starter coder here

OR

Access the starter project on Raspberry Pi Editor here https://editor.raspberrypi.org/en/projects/moonhack2024-starter

Additional notes for educators

Here is a link to the completed project files on Google Drive.

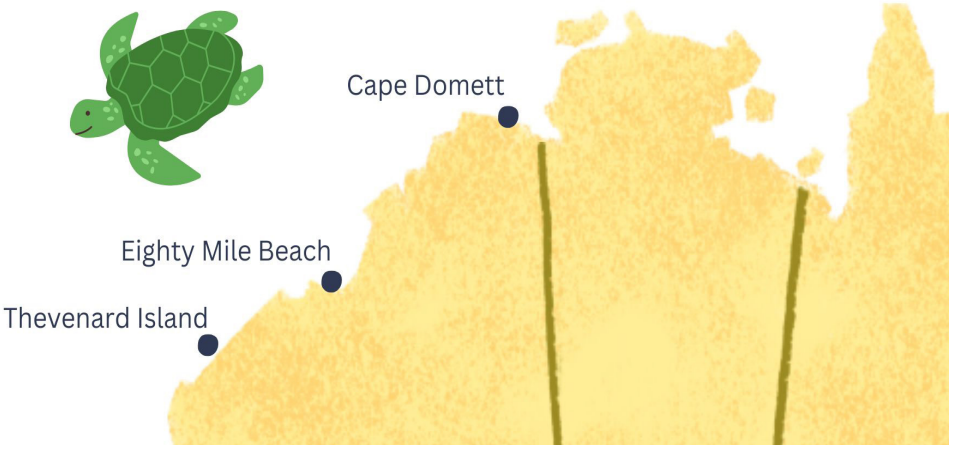
FLATBACK TURTLES AND CLIMATE CHANGE

During breeding season, female turtles lay eggs and bury them in the sand on beaches. These eggs will incubate in the sand before they hatch, and then the baby turtles will make their way down the beaches and into the ocean. But have you ever thought about what determines if a turtle hatchling is male or female?

The answer is that the sex of turtle hatchlings is determined by the incubation temperature of the eggs – so, by the temperature of the sand the eggs are buried in. This is called Temperature Dependent Sex Determination.

Greenhouse gases, which are released into the atmosphere by burning coal for electricity and petrol for cars, have caused the average temperature of the earth to rise. This occurs because the gases act like a blanket over the earth, which traps heat from the sun in the atmosphere. In the last 100 years, the temperature of the earth has risen by approximately 1 degree Celsius. By 2050, the temperature is predicted to rise another 1.5 degrees Celsius. By 2100, the temperature is predicted to rise 2-4 degrees Celsius. So, the question is, what will happen to the turtles as the beaches where they lay their eggs get hotter and hotter each year?

Blair Bentley, a researcher from the University of Western Australia, did his PhD on how this incubation temperature affects whether turtles are born male or female, by looking at three different populations of flatback turtles along the Western Australian coastline: at Cape Domett, Eighty Mile Beach, and Thevenard Island. To hear him talk about his research (and see some cool footage of turtles), you can follow this link.



Today, you will analyse some of the results from the mathematical models in his research paper, and create a quiz based on the conclusions you draw. The data you will analyse includes (x,y) points, which represent the incubation temperature, and the percentage of eggs that are male. 100% means that all of the hatchlings are male, and 0% means that none of the hatchlings are male (or, all of the hatchlings are female).



1. TURTLE HATCHLINGS AND TEMPERATURE

SECTION A: Open the Starter Code

STEP 1: Open the starter code that can be found here. You should see a screen that looks like this (plus a few additional lines that are only needed for the advanced activity):

main.py

```
1  import pygal
2
3  #Thevanard Island Model Data
4  TIpoints = [(25.5, 99.99), (25.6, 99.99), (25.7, 99.99), (25.8, 99.99), (25.9, 99.99), (26.0, 9
```

Line 1 **imports** the relevant package (pygal, which is used for plotting graphs) – if you are using Mu Editor, or another downloaded editor, you will need to **install** these packages prior to completing this step (follow the instructions for importing packages in Mu here).

Line 2 is just white space - this is like a paragraph break: does nothing, but makes the code easier to read.

Line 3 is a **comment**: comments are explanations for the person reading your code, so they know what it does. They start with a **#** symbol, which tells Python to ignore that line (these will appear throughout the activity - feel free to add some of your own!).

Line 4, 9 and 12 are where the fun begins! This is your turtle data - it is saved as a **list** called TIpoints, which is a series of (x,y) points, that you can plot later.

SECTION B: Print an introduction to the quiz

STEP 2: First, we will create a **print statement** to tell the **user** what the activity is going to be about. You can add a print statement to your code like this (along with a comment that describes what you are doing):

```
12  EMBpoints = [(25.5, 100.0), (25.6, 100.0), (25.7, 100.0), (25.8, 100.0), (25.9, 100.0), (26.0, 100.0), (26.
13
14  # Fifty Percent Line
15  fiftypercent = [(25.5, 50), (33,50)]
16
17  print("TEXT HERE")
```

Try running your code to see what happens.

You will find that 'TEXT HERE' is printed to the output window. Now, we don't want the code to print 'TEXT HERE', but rather, an introduction to the activity. So, next, copy the following paragraph of text, and put it where you see TEXT HERE (make sure you still have a bracket and a quotation mark on either side of your text afterwards, and that all of the text is on one line!).

Whether a turtle hatchling is male or female is determined by the incubation temperature of the eggs – so, by the temperature of the sand the eggs are buried in. The following data was gathered for a population of turtle hatchlings from Thevenard Island, off the coast of Western Australia. It shows how the percentage of male hatchlings depends on the incubation temperature. Note that at 100%, we have all male turtle hatchlings, and at 0%, we have all female hatchlings. Look carefully at the graph, because you will need to analyse its results for the quiz!

Don't miss a step. Make sure you tick the green circle as you go

SECTION C: Plot a graph

STEP 3: Remember the **list** called TIpoints from STEP 1? Here, we will plot this data. Add a comment describing what we will plot, and then a second comment which uses the **pygal** package to start a plot with an x-axis label of 'Temperature (Celsius)', and a y-axis label of 'Percentage Male Hatchlings'.

```
16
17  print("Whether a turtle hatchling is male or female is determined by the incubation temperature of the eg
18
19  xy_chart = pygal.XY(x_title='Temperature (Celsius)', y_title='Percentage Male Hatchlings')
```

STEP 4: Next, we add a line that uses the **pygal** package to add the data to the plot - in this case, our **list** of (x,y) points for the temperatures and percentage of male hatchlings for Thevenard Island (TIpoints).

```
16
17  print("Whether a turtle hatchling is male or female is determined by th
18
19  xy_chart = pygal.XY(x_title='Temperature (Celsius)', y_title='Percentag
20  xy_chart.add('Thevanard Island',TIpoints )
```

STEP 5: Then, we add a line to 'render' the plot: this means that the plot will appear in the visual output window. Run the code now to see the plot!

```
17  print("Whether a turtle hatchling is male or female is determined by the incubation temperature of
18
19  xy_chart = pygal.XY(x_title='Temperature (Celsius)', y_title='Percentage Male Hatchlings')
20  xy_chart.add('Thevanard Island',TIpoints )
21  xy_chart.render()
22
```

SECTION D: Make a quiz

STEP 6: Next, we ask the user to press enter to start the quiz. This is done through an **input** command, which allows the user to interact with the code by entering something.

```
18
19  xy_chart = pygal.XY(x_title='Temperature (Celsius)', y_title='Percentage Male Hatchlings')
20  xy_chart.add('Thevanard Island',TIpoints )
21  xy_chart.render()
22
23  input("Press enter to start the quiz!")
24
```

STEP 7: The quiz you create will be multiple choice. This means that when we ask the user a question, they input a single capital letter, A, B, or C etc. as an answer. Then if the answer is correct, we print that it's correct, and if it is not, we print that it is not. The first step of this is to ask the question. To do this, we use another **input** statement, but this time, we set the letter the user inputted equal to a **variable** called question_1. This will store the letter value inside question_1, which will be important later.

Don't miss a step. Make sure you tick the green circle as you go

```
20  xy_chart.add('Thevanard Island',TIpoints )
21  xy_chart.render()
22
23  input("Press enter to start the quiz!")
24
25  question_1 = input("TEXT HERE")
26
```

For TEXT HERE, copy and paste:

*Question 1: As the temperature increases, we see that: \n *
*A The percentage of male hatchlings decreases \n *
*B The percentage of male hatchlings stays the same\n *
*C The percentage of male hatchlings increases \n *
Type A, B, or C as your answer (remember to type a capital letter!)

Note that the **\n ** symbol is just python's way of writing 'enter', so the text appears on a new line (Optional Advanced: try removing one of them to see what happens).

STEP 8: Have a go at answering the multiple choice question based on the graph! You can check your answer when you get to STEP 13.

STEP 9: Now we need to tell the user if they got the correct answer or not. If the user is correct, we want to print a statement saying 'Correct!' and why they are correct. If they are incorrect, we want to print 'Incorrect' with a brief hint as to why that answer isn't correct. For Python to do this, we use an **if - else statement**: if what is stated after 'if' is **True**, Python will continue with the **indented code** after the if statement. If not, it will skip that section. In this case, if the inputted answer is 'A', we want to print that the user is correct, and print that they are incorrect for B and C.

Python considers capital letters to be different from lower case ones, so we need to tell the user specifically to enter capital letters. To see if the user inputted 'A', we compare 'A' to the variable 'question_1' using '**==**' – the **equality operator**. Our variable 'question_1' stores the letter that the user entered, so this line basically reads 'if the user entered 'A', execute the code that is indented below'. Don't forget the : at the end, or it won't work!

```
25  question_1 = input("Question 1: As the temperature increases, we see that: \n \
26      A The percentage of male hatchlings decreases \n \
27      B The percentage of male hatchlings stays the same\n \
28      C The percentage of male hatchlings increases \n \
29      Type A, B, or C as your answer (remember to type a capital letter!)")
30
31  if question_1 == 'A':
```

STEP 10: Next, we add what to print if the user has selected 'A'. To make this print statement happen only if 'A' is entered, we must **indent** the print statement with a tab.

```
25  question_1 = input("Question 1: As the temperature increases, we see that: \n \
26      A The percentage of male hatchlings decreases \n \
27      B The percentage of male hatchlings stays the same\n \
28      C The percentage of male hatchlings increases \n \
29      Type A, B, or C as your answer (remember to type a capital letter!)")
30
31  if question_1 == 'A':
32      print("TEXT HERE")
```

For TEXT HERE, copy and paste:

Correct! As the incubation temperature increases, the percentage of male hatchlings decreases.

STEP 11: Now, we need to print a message if the user chooses 'B' - for this, we use an **elif statement**: this works the same way as an **if statement**, but is for when you have multiple if statements in a row. So, this reads 'If the user didn't choose A, check to see if they chose B, and if they did, run the indented code under the **elif statement.**

```
28      C The percentage of male hatchlings increases \n \
29      Type A, B, or C as your answer (remember to type a capital letter!)")
30
31  if question_1 == 'A':
32      print("Correct! As the incubation temperature increases, the percentage of male hatchlings decreases.")
33  elif question_1 =='B':
34      print("TEXT HERE")
```

For TEXT HERE, copy and paste:

Incorrect! If the percentage of male hatchlings stayed the same, we would have a straight, horizontal line instead of a curved one.

STEP 12: The same process as STEP 11 is used if the user chooses C, but with the following text replacing TEXT HERE:

Incorrect! What percentage of male turtles do we start at? What percentage do we finish at?

Have a go at writing this yourself, and check your answer on PAGE 11.

STEP 13: After that, we need an answer if the user enters something that is not the three letters we specified. To do this, we use an **else statement**: Python will run this code if none of the **if** and **elif statements** conditions are met (i.e. if ython skips all of those statements).

```
32      print("Correct! As the incubation temperature increases, the percentage of male hatchlings decreases.")
33  elif question_1 =='B':
34      print("Incorrect! If the percentage of male hatchlings stayed the same, we would have a straight, horizontal l
35  elif question_1 =='C':
36      print("Incorrect! What percentage of male turtles do we start at? What percentage do we finish at?")
37  else :
38      print("This is not a valid response!")
39
```

STEP 14: Then, like we did in STEP 6, add an input statement for the user to press enter to continue. Run your code now to see how it works!

```
35  elif question_1 == 'C':
36      print("Incorrect! What percentage of male turtles do we start at? What percentage do we finish at?")
37  else :
38      print("This is not a valid response!")
39
40  input("Press enter to move onto the next question!")
41
```

STEP 15: Now it's time to write question 2! Copy and paste the code you wrote for question 1 directly underneath (So, everything after 'Press enter to start the quiz' will appear twice). Now, in the copied code only (don't change the question 1 text!) you need to change this into question 2!

The first step is to change the **variables** called **question_1** to **question_2**: and then copy the text for question 2.

STEP 16:

*Question 2: As the temperature increases, we see that: \n *
*A The percentage of female hatchlings decreases \n *
*B The percentage of female hatchlings stays the same\n *
*C The percentage of female hatchlings increases \n *
Type A, B, or C as your answer (remember to type a capital letter!):

Copy and paste this into your code, and it should look like the following (have a go at answering the multiple choice question yourself before moving on to the next page!).

```
    print("This is not a valid response!")

input("Press enter to move onto the next question!")

question_2 = input("Question 2: As the temperature increases, we see that: \n \
    A The percentage of female hatchlings decreases \n \
    B The percentage of female hatchlings stays the same\n \
    C The percentage of female hatchlings increases \n \
    Type A, B, or C as your answer (remember to type a capital letter!)")
```

STEP 17: Next, we need to change the printed answers in the **if-else statements** with the text below (check your answer to the question while you copy them across into your code!): Don't forget to change variables to **question_2**

If the answer is A:

Incorrect! We know from the previous question that the percentage of male turtles is decreasing, what does this mean for the percentage of female turtles?

If the answer is B:

Incorrect! If the percentage of female hatchlings stayed the same, we would have a straight, horizontal line instead of a curved one.

If the answer is C:

Correct! As the incubation temperature increases, the percentage of male hatchlings decreases, which means the percentage of female hatchlings must increase.

You should end up with something that looks like the following:

```
question_2 = input("Question 2: As the temperature increases, we see that: \n \
    A The percentage of female hatchlings decreases \n \
    B The percentage of female hatchlings stays the same\n \
    C The percentage of female hatchlings increases \n \
    Type A, B, or C as your answer (remember to type a capital letter!)")

if question_2 == 'A':
    print("Incorrect! We know from the previous question that the percentage of male turtles is decreasing, what does
elif question_2 =='B':
    print("Incorrect! If the percentage of female hatchlings stayed the same, we would have a straight, horizontal li
elif question_2 =='C':
    print("Correct! As the incubation temperature increases, the percentage of male hatchlings decreases, which means
else :
    print("This is not a valid response!")
```

STEP 18: Now you know how to make a multiple choice quiz question, let's write some more, following the same instructions as above! Below are the questions and answers for you to copy and paste. If you need help go to back to STEP 6. Don't forget to change the variable for question numbers!

QUESTION 3 TEXT

*Question 3: If humans do not curb their use of greenhouse gas emitting fuels, like coal and petrol, \n\ the average temperature of the earth is expected to rise by around 4 degrees by 2100. If turtle eggs \n\ now are being incubated between 27-32 degrees Celsius, and assuming sand temperatures go up at \n\ around the same rate as global temperatures, what would the new temperature range be if the \n\ temperature rises by 4 degrees: \n *
*A. 27-32 degrees Celsius \n *
*B. 30-35 degrees Celsius \n *
*C. 31-36 degrees Celsius \n *
Type A, B, or C as your answer (remember to type a capital letter!):

QUESTION 3 ANSWERS

A: *Incorrect! If the average temperature increases by 4 degrees, you would expect the range of temperatures the turtles will be incubated at to also be higher.*

B: *Incorrect! Maybe check your maths: we need a raise in temperature of four degrees, not three!*

C: *Correct! You would have to add 4 degrees Celsius to both of the numbers to get the new range.*

QUESTION 4 TEXT

*Question 4: Think about the implications of the question above – if the beaches rise in temperature \n \ by 4 degrees, what sex will the hatchlings be? \n *
*A. Almost all male \n *
*B. Almost all female \n *
*C. Equal numbers of male and female turtles.\n *
Type A, B, or C as your answer (remember to type a capital letter!):

QUESTION 4 ANSWERS

A: *Incorrect! Eggs that are incubated at lower temperatures hatch male turtles. The temperature is increasing, so what would we expect?*

B: *Correct! Eggs that are incubated at higher temperatures hatch female turtles. So, if average global temperatures increase to this extent, we would expect to see either all female turtles (if incubated close to the higher number) or only a very small percentage of males (around 8% if the incubation occurs at 31 degrees – hover over the graph to see if you can find this point!).*

C: *Incorrect! If we have approximately equal ratios of male and female turtles now, and then increase the temperature, what would we expect?*

QUESTION 5 TEXT

*Question 5: If the temperature rises by even more than this, and all of the turtles that hatch are \n \ female, what would this mean for the turtle population? \n *
*A. All of the turtles would die out \n *
*B. The turtle population would stay the same \n *
*C. The turtle population would decrease, but not die out \n *
Type A, B, or C as your answer (remember to type a capital letter!):

QUESTION 5 ANSWERS

A: *Correct! Both male and female turtles are needed to reproduce, so the turtles would die out.*

B: *Incorrect! Can a female turtle lay viable eggs without a male turtle?*

C: *Incorrect! Both male and female turtles are needed to reproduce, so if all of the new hatchlings are female, what would happen?*

QUESTION 6 TEXT

*Question 6: What can humans do to help save the turtles from dying out? \n *
*A. Use less coal and petrol, by changing to renewable sources of energy \n *
*B. Use less electricity (e.g. air conditioning) \n *
*C. Use public transport rather than travelling by car \n *
*D. Cool down turtle nests on at-risk beaches, by wetting the sand, and putting the turtle nests under shade cloths \n *
*E. All of the above \n *
Type A, B, C, D or E as your answer (remember to type a capital letter!):

QUESTION 6 ANSWERS*:* Note that this question has more than just A, B and C as answers - you will need to construct some extra **elif statements** for D and E! (Check your answer on PAGE 12).

A: *Incorrect! Using less coal and petrol by changing to renewable energy will stop the global temperatures from growing, but there are some other things that can help in the meantime!*

B: *Incorrect! This is definitely something you should do to help the turtles, as reducing your personal greenhouse emissions is important, but there are also some other reasons.*

C: *Incorrect! Travelling using public transport uses less petrol, thus creating fewer emissions than travelling by car. This will help the turtles, but there are some other options, too!*

D: *Incorrect! This is something that the researchers are doing to cool down the turtle nests – this definitely helps the turtles in the short term, but as the temperature warms, we need to consider other things as well.*

E: *Correct! The main way to help save the turtles is to change from using coal and petrol to only using renewable energy. However, while the transition is happening, it is important to use less electricity where possible (even if that means not turning the air conditioner on much in summer!) and to use public transport, which uses less petrol per person than travelling by car. Additionally, some researchers are helping to cool down the turtle nests with shade cloths and water. However, this one's for the professionals! Wouldn't want to trample any turtle eggs by accident while trying to help!*

STEP 19 - Come up with your own question!

QUESTION 7 TEXT (Bonus points if you research a fun fact about flatback turtles to include here - some suggestions include: How big are flatback turtle hatchlings? How long do flatback turtles live for? What do flatback turtles eat?)

*Question 7: [your question] \n *
*A. [your incorrect answer 1] \n *
*B. [your incorrect answer 2] \n *
*C. [your incorrect answer 3] \n *
*D. [your correct answer] \n *
Type A, B, C or D as your answer (remember to type a capital letter!):

QUESTION 7 ANSWER: Write your own responses to your question here - make sure you match them up correctly with the answers to your question!

A: Incorrect! [hint as to why this is incorrect]

B: Incorrect! [hint as to why this is incorrect]

C: Incorrect! [hint as to why this is incorrect]

D: Correct! [explanation of why this is correct]

STEP 20: Now, we add an input statement to press enter to see the answers; then, we print the answers:

```
elif question_7 =='B':
    print("Incorrect! If the percentage of female hatchlings stayed the same, we would have a straight, horizontal line
elif question_7 =='C':
    print("Correct! As the incubation temperature increases, the percentage of male hatchlings decreases, which means the
else :
    print("This is not a valid response!")

input("To see the answers, press enter:")

print("TEXT HERE")

```

Copy the following (on this page and the next one) to replace TEXT HERE:

*ANSWERS \n *
*Question 1: A \n *
*As the incubation temperature increases, the percentage of male hatchlings decreases. \n \n *

*Question 2: C \n *
*As the incubation temperature increases, the number of male hatchlings decreases, which means the number of female hatchlings must increase. \n \n *

*Question 3: C \n *
*You would have to add 4 degrees Celsius to both of the numbers to get the new range. \n \n *

*Question 4: B \n *
*Eggs that are incubated at higher temperatures hatch female turtles. So, if average global temperatures increase to this extent, we would expect to see either all female turtles (if incubated close to the higher number) or only a very small number of males (around 8% if the incubation occurs at 31 degrees – hover over the graph to see if you can find this point!) \n \n *

*Question 5: A \n *
*Both male and female turtles are needed to reproduce, so the turtles would die out. \n \n *

*Question 6: E \n *
*The main way to help save the turtles is to change from using coal and petrol to only using renewable energy. However, while the transition is happening, it is important to use less electricity where possible (even if that means not turning the air conditioner on much in summer!) and to use public transport, which uses less petrol per person than travelling by car. Additionally, some researchers are helping to cool down the turtle nests with shade cloths and water. However, this one's for the professionals! Wouldn't want to trample any turtle eggs by accident while trying to help! \n \n *

Question 7: [your own correct answer here]

SECTION E: Check your answers

STEP 12 ANSWER

```
    print("Correct! As the incubation temperature increases, the percentage of male hatchlings decreases.")
elif question_1 =='B':
    print("Incorrect! If the percentage of male hatchlings stayed the same, we would have a straight, horizont
elif question_1 =='C':
    print("Incorrect! What percentage of male turtles do we start at? What percentage do we finish at?")
```

Challenges:

More Questions and answers

From coding question 6, you know how to add extra **elif statements** to include more letter options for your quiz. If you like, you can include an extra, incorrect answer to each question. (Just remember to put the new letter in the question text as well as the **elif statement**!). Make up some of your own questions to add in too!

Extending the program

Program the questions and answers in a csv file . You could -

- track answers using a scoring system
- plot results for identifying trends in answers, identifying misconceptions and growth areas

Using more data

The program has data for 2 other locations - Cape Domett and Eight Mile Beach. How might you use this data in your program?

- add to graph
- add mulitple choice quesitons for the new data

Congratulations! You're a Moonhack changemaker. You can try one of our other projects or try one of the challenges above.

Don't forget to talk to an adult about registering your participation and downloading your certificate at moonhack.com

