Individual Project

Benjamin Whelan

Fontys ICT

Cybersecurity Advanced

Contents

[Version 1](#_Toc114040889)

[Introduction 1](#_Toc114040890)

[2D Vectors 2](#_Toc114040891)

[References 4](#_Toc114040892)

# Version

|  |  |  |
| --- | --- | --- |
| Version (v) | Date | Changes |
| 1 | 12/09/2022 | Introduction Added |
| 2 | 14/09/2022 | Exercises 2.1 |
| 3 | 20/09/2022 | Exercises 2.2/2.3 |

# Introduction

I have decided to focus my individual project on learning math topics related to programming, since I feel like those areas have been lacking in my HBO study thus far. I will be working from a [book](https://www.manning.com/books/math-for-programmers) whereby my proof of work will consist of exercises and mini projects.

# 2D Vectors

Chart, line chart

Description automatically generated

**Exercise 2.1**: What is the x- and y-coordinates of the point at the tip of the dinosaur’s toe?

**Answer**: (-1, -4)

**Exercise 2.2**: Draw the point in the plane and the arrow corresponding to the point (2, −2).

**Answer**:

Chart, line chart

Description automatically generated

**Exercise 2.3/2.4**: Complete Dino and Segment Lines.

**Answer**:

Chart, line chart

Description automatically generated

**Exercise 2.5**: Draw the vectors (x,x\*\*2) for *x* in the range from *x* = −10 to *x* = 11) as points (dots) using the draw function. What is the result?

Chart, scatter chart

Description automatically generated

**Exercise 2.6**: If the vector **u** = (−2, 0), the vector **v** = (1.5, 1.5), and the vector **w** = (4, 1), what are the results of **u** + **v**, **v** + **w**, and **u** + **w**? What is the result of **u** + **v** + **w**?

**Answer:**

* u + v = (-0.5, 1.5)
* v + w = (5.5, 2.5)
* u + w = (2, 1)
* u + v + w = (3.5, 2.5)

**Exercise 2.7-Mini Project**: Implement a revised add function that takes any number of vectors as arguments.

Text

Description automatically generated

**Exercise 2.8**: Write a function translate (translation, vectors) that takes a translation vector and a list of input vectors, and returns a list of the input vectors all translated by the translation vector:

Text

Description automatically generated

**Exercise 2.9−Mini Project**: Any sum of vectors **v** + **w** gives the same result as **w** + **v**. Explain why this is true using the definition of the vector sum on coordinates. Also, draw a picture to show why it is true geometrically.

Text

Description automatically generated

Chart, line chart

Description automatically generated Chart, line chart

Description automatically generated

**Exercise 2.10**: Among the following three arrow vectors (labelled **u**, **v**, and **w**), which pair has the sum that gives the longest arrow? Which pair sums to give the shortest arrow?

A picture containing text, clock, watch, device

Description automatically generated

**Answer:** If vectors are placed tip-to-tail we can measure the sums and see which is shortest.

**Exercise 2.11-Mini Project**: Write a Python function using vector addition to show 100 simultaneous and non-overlapping copies of the dinosaur.

A picture containing text

Description automatically generated

**Exercise 2.12**: Which is longer, the *x* or y component of (3, −2) + (1, 1) + (−2, −2)?

The result is (2, -3), thus the y component is longer by 1 unit.

**Exercise 2.13**: What are the components and lengths of the vectors (−6, −6) and (5, −12)?

Components:

* (-6, 0)
* (0, -6)
* (5, 0)
* (0, -12)

Lengths: (Pythagoras theorem)

* 8.48528137423857
* 13

**Exercise 2.14**: Suppose I have a vector **v** that has a length of 6 and an *x* component (1, 0). What are the possible coordinates of **v**?

1 + y\*\*2 = 36

y\*\*2 = 35

y = 5.916079783099616

The vector’s y component is either 5.9161 or -5.9161

**Exercise 2.15**: What vector in the dino\_vectors list has the longest length?

(6, 4)

**Exercise 2.16**: Suppose a vector **w** has the coordinates (√2, √3). What are the approximate coordinates of the scalar multiple π · **w**? Draw an approximation of the original vector and the new vector.

(4.442882938158366, 5.441398092702653)

Chart, line chart

Description automatically generated

**Exercise 2.17**: Write a Python function scale(s,v) that multiplies the input vector **v** by the input scalar *s*.

Text

Description automatically generated

**Exercise 2.19−Mini Project**: Suppose *z* = (−1, 1) and **v** = (1, 1), and suppose *r* and *s* are real numbers. Specifically, let’s assume −3 < *r* < 3 and −1 < *s* < 1. Where are the possible points on the plane where the vector *r* · **u** + *s* · **v** could end up?

Chart, scatter chart

Description automatically generatedText

Description automatically generated

**Exercise 2.20**: Show algebraically why a vector and its opposite have the same length.

A picture containing shape

Description automatically generated

**Exercise 2.21**: Of the following seven vectors, represented as arrows, which two are a pair of opposite vectors?

A picture containing text, clock, gauge, watch

Description automatically generated

V3 **and V7**

**Exercise 2.22**: Suppose **u** is any 2D vector. What are the coordinates of **u** + −**u**?

(0, 0)

Exercise 2.23: For vectors u = (−2, 0), v = (1.5, 1.5), and w = (4, 1), what are the results of the vector subtractions v − w, u − v, and w − v?

**v** − **w** = (−2.5, 0.5)

**u** − **v** = (−3.5, −1.5)

**w** − **v** = (2.5, −0.5)

**Exercise 2.24**: Write a Python function subtract (v1, v2) that returns the result of v1 - v2, taking two 2D vectors as inputs and returning a 2D vector as an output.

Text

Description automatically generated

**Exercise 2.25**: Write a Python function distance (v1, v2) that returns the distance between two input vectors. (Note that the subtract function from the previous exercise already gives the *displacement*.)

Write another Python function perimeter(vectors) that takes a list of vectors as an argument and returns the sum of distances from each vector to the next, including the distance from the last vector to the first. What is the perimeter of the dinosaur defined by dino\_vectors?

Distance:

Text

Description automatically generated

Perimeter:

Text

Description automatically generated

Perimeter of dinosaur:

44.77115093694563

**Exercise 2.26−Mini Project**: Let **u** be the vector (1, −1). Suppose there is another vector **v** with positive integer coordinates (*n*, *m*) such that *n* > *m* and has a distance of 13 from **u**. What is the displacement from **u** to **v**?

Text

Description automatically generated

**Exercise 2.27**: Confirm that the vector given by Cartesian coordinates (−1.34, 2.68) has a length of approximately 3 as expected.



**Exercise 2.28**: The figure shows a line that makes a 22° angle in the counterclockwise direction from the positive *x*-axis. Based on the following picture, what is the approximate value of tan(22°)?

Chart, line chart

Description automatically generated

4 / 10 = **0.4**

**Exercise 2.29**: What are the *x* and *y* components of a vector with length 15 pointing at a 37° angle?

A screenshot of a computer

Description automatically generated with medium confidence

(11.48121077918015, -9.653072000354992)

**Exercise 2.30**: Suppose I travel 8.5 units from the origin at an angle of 125°, measured counter clockwise from the positive *x*-axis. Given that sin (125°) = 0.819 and cos (125°) = −0.574, what are my final coordinates?

*x* = *r* · cos (*θ*) = 8.5 · −0.574 = −4.879

*y* = *r* · sin (*θ*) = 8.5 · 0.819 = 6.962

**Exercise 2.31**: What are the sine and cosine of 0°? Of 90°? Of 180°?

|  |  |
| --- | --- |
| Input | Value |
| Sine 0° | 0 |
| Sine 90° | 1 |
| Sine 180° | 0 |
| Cosine 0° | 1 |
| Cosine 90° | 0 |
| Cosine 180° | -1 |

**Exercise 2.32**: The following diagram gives some exact measurements for a right triangle:

First, confirm that these lengths are valid for a right triangle because they satisfy the Pythagorean theorem. Then, calculate the values of sin (30°), cos(30°), and tan(30°) to three decimal places using the measurements in the diagram.

Diagram

Description automatically generated

Sin (30) = 0.5/1 = 0.5

Cos (30) = 3^0.5/2 = 0.866 (approx.)

Tan (30) = 0.5 / (3^0.5/2) = 0.577 (approx.)

**Exercise 2.33**: Looking at the triangle from the previous exercise from a different perspective, use it to calculate the values of sin (60°), cos (60°), and tan (60°) to three decimal places.

Sin (60) = (3^0.5/2)/1 = 0.866 (approx.)

Cos (60) = 0.5/1 = 0.5

Tan (60) = (3^0.5/2)/0.5 = 1.732 (approx.)

**Exercise 2.34**: The cosine of 50° is 0.643. What is sin (50°) and what is tan (50°)?

Sin (50) = 0.766  
Tan (50) = 1.192

**Exercise 2.35**: What is 116.57° in radians? Use Python to compute the tangent of this angle and confirm that it is close to −2 as we saw previously.

116.56 / 57.296 = **2.035**

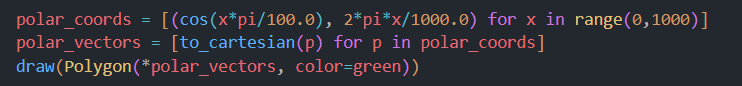
**Exercise 2.36**: Locate the angle 10π/6

1π/6 (112th of circle) -> 10/12 of circle -> 360 / 12 = 30 -> 10 \* 30 = 300 degrees

**Exercise 2.37**: The following list comprehension creates 1,000 points in polar coordinates:

[(cos(5\*x\*pi/500.0), 2\*pi\*x/1000.0) for x in range(0,1000)]

In Python code, convert these to Cartesian coordinates and connect them in a closed loop with line segments to draw a picture.



Chart

Description automatically generated

**Exercise 2.38**: Find the angle to get to the point (−2, 3) by “guess-and-check.”

Tan (angle) = -(3/2)

**Tan (2.159rad)**

**Exercise 2.39: Find another point in the plane with the same tangent as *θ*, namely −3/2. Use Python’s implementation of the arctangent function, math. Tan, to find the value of this angle.**

Arctan (-3/2) = **−0.982793723247329**

**Exercise 2.40**: What are the polar coordinates corresponding to the Cartesian coordinates (1, 1) and (1, −1)?

((0.5403, 0.8414), (0.5403, -0.8414))

# References

1 -