Lambda School LaTeX Assignment

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Abstract

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1 Functions

$$y = f(x)$$

In this equation X represents the input of the process and Y the output of the procees and f the function of the variable X.
Y is the dependent output variable of a process. It is used to monitor a process to see if it is out of control, or if symptoms are developing within a process

For Example,$f(x) = x^2 - 4$

In this example I am describing the function f by the way it operates. By f(x)=x2−4 I am telling you that if you input a number x to this function then the function squares x, subtracts 4 and returns the result. Thus for example if x=3 then y=f(3)=32−4=9−4=5. To graph this function I would start by choosing some values of x and since I get to choose I would select values that make the arithmetic easy. For example x=0,x=1,x=−1 and so on. I am going to keep track of what I am doing by using a table.

x	y = f(x)
0	-4
1	-3
-1	-3
2	0
3	5

2 Equation of a line

The equation of a straight line is usually written this way:
y = mx + b where,
y = how far up
x = how far along
m = Slope or Gradient (how steep the line is)
b = the Y Intercept (where the line crosses the Y axis)

2.1 finding m and b:

- b is easy: just see where the line crosses the Y axis.
- m (the Slope) needs some calculation: $m = \frac{ChangeinY}{changeinX}$
  Example: y = 2x + 1
  With that equation you can now ...

... choose any value for x and find the matching value for y
For example, when x is 1:
y = 2×1 + 1 = 3
Check for yourself that x=1 and y=3 is actually on the line.
Or we could choose another value for x, such as 7:
y = 2×7 + 1 = 15
And so when x=7 you will have y=15

3 Differentiation

Differentiation allows us to find rates of change. For example, it allows us to find the rate of change of velocity with respect to time (which is acceleration). It also allows us to find the rate of change of x with respect to y, which on a graph of y against x is the gradient of the curve.

If y = some function of x (in other words if y is equal to an expression containing numbers and x's), then the derivative of y (with respect to x) is written dy/dx.

Differentiating x to the power of something:

1. If $y = xn, dy/dx = nx^(n - 1)$
2. If $y = kxn, dy/dx = nkx^(n - 1)(wherekisaconstant - inotherwordsanumber)$

Therefore to differentiate x to the power of something you bring the power down to in front of the x, and then reduce the power by one.

Examples:

$y = x^4, dy/dx = 4x^3$
$y = 2x^4, dy/dx = 8x^3$
$y = x^5 + 2x - 3, dy/dx = 5x^4 - 6x - 4$

4 Finite Differences

With a set of x values, a set of y values, and a position at_x that you want to know the derivative, the finite different method gives you the answer without calculus or formal mathematics.
A finite difference is a mathematical expression of the form f(x + b) − f(x + a).The approximation of derivatives by finite differences plays a central role in finite difference methods for the numerical solution of differential equations, especially boundary value problems.

5 Vector Properties

5.1 Definition of a vector

A vector is an object that has both a magnitude and a direction.
Geometrically, we can picture a vector as a directed line segment, whose length is the magnitude of the vector and with an arrow indicating the direction. The direction of the vector is from its tail to its head.

Two vectors are the same if they have the same magnitude and direction. This means that if we take a vector and translate it to a new position (without rotating it), then the vector we obtain at the end of this process is the same vector we had in the beginning.
we denote vectors using arrows as in $\vec{A}$ or$\vec{B}$ .The magnitude of the vector a is denoted by ‖A‖.

5.2 Operations on Vectors:

Dot Product:

The dot product between two vectors is based on the projection of one vector onto another. Let's imagine we have two vectors A and B, and we want to calculate how much of a is pointing in the same direction as the vector b.
The dot product $A \cdot B = \parallel A \parallel \parallel B \parallel \cos\theta$, where θ is the angle between A and B.
Example:

Calculate the dot product of a=(1,2,3) and b=(4,−5,6).

Solution: Using the component formula for the dot product of three-dimensional vectors,
$a \cdot b = a_1b_1 + a_2b_2 + a_3b_3$,
we calculate the dot product to be
a·b=1(4)+2(−5)+3(6)=4−10+18=12.

Since a·b is positive, we can infer from the geometric definition, that the vectors form an acute angle.

Cross Product:

There are two ways to take the product of a pair of vectors. One of these methods of multiplication is the cross product, which is the subject of this page. The other multiplication is the dot product.
The cross product is defined only for three-dimensional vectors. If a and b are two three-dimensional vectors, then their cross product, written as a×b.

Example 1: Calculate the cross product between $(a_1, a_2, a_3) = a_1i + a_2j + a_3k$
$(b_1, b_2, b_3) = b_1i + b_2j + b_3k$

First, we'll assume that a3=b3=0. We calculate:
$a \times b = (a_1i + a_2j) \times (b_1i + b_2j) = a_1b_1(i \times i) + a_1b_2(i \times j) + a_2b_1(j \times i) + a_2b_2(j \times j)$

Since we know that i×i=0=j×j and that i×j=k=−j×i, this quickly simplifies to:
$a \times b = (a_1b_2 - a_2b_1)k$

6 Vector Magnitude

In mathematics, magnitude is the size of a mathematical object, a property which determines whether the object is larger or smaller than other objects of the same kind.

Magnitude(a,b) = $\sqrt{a^2 + b^2}$.

7 L1 norm

L1-norm is also known as least absolute deviations (LAD), least absolute errors (LAE). It is basically minimizing the sum of the absolute differences (S) between the target value (Y_i) and the estimated values ($f(x_i)$): S = $\sum_{i=1}^{n}(y_i - x_i)$

8 L2 norm

L2-norm is also known as least squares. It is basically minimizing the sum of the square of the differences (S) between the target value (Y_i) and the estimated values ($f(x_i)$):

S = $\sum_{i=1}^{n}(y_i - x_i)^2$

9 Matrix Multiplication

If A is an n × m matrix and B is an m × p matrix, their matrix product AB is an n × p matrix, in which the m entries across a row of A are multiplied with the m entries down a column of B and summed to produce an entry of AB.

$$A = \begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix} \quad B = \begin{bmatrix} b_{11} & b_{12} & b_{13} \\ b_{21} & b_{22} & b_{23} \\ b_{31} & b_{32} & b_{33} \end{bmatrix}$$

$$c_{ij} = a_{i1}b_{1j} + ... + a_{im}b_{mj} = \sum_{k=1}^{m} a_{ik}b_{kj}$$

for i = 1, ..., n and j = 1, ..., p.