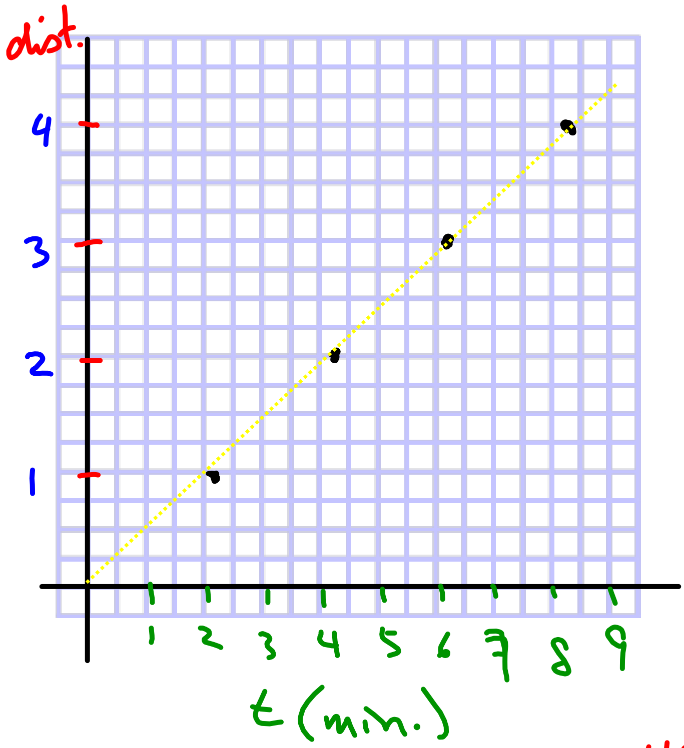
Get into pairs. One of you must have a watch with a seconds hand on it.



lap	time
1	2:12
2	4:13
3	6:12 = 372 sec.
4	8:19

$(8)(60)+19 = 499$ s

① $t_{Avg.}$ per trip $= \frac{499}{4} \doteq 125$ s

② $t_{Avg.}$ for trips 1 to 3 $= \frac{372}{3} = 124$ s

③ fastest lap: lap 3 @ 119 sec.

④ $t_{Avg.}$ for 2 to 4: $\frac{367}{3} = 122$ sec.

Average Rate of Change - AROC

definition - the average rate of change is how much the dependent variable (usually y) changes for a given interval of the independent variable (usually x)

$$AROC = \frac{\Delta y}{\Delta x} = \frac{y_2 - y_1}{x_2 - x_1}$$

look familiar? → slope

$$\boxed{AROC = \frac{f(x_2) - f(x_1)}{x_2 - x_1}}$$

Example 1:
For each function, determine the average rate of change on the intervals [0, 2] [2, 4] and [4, 6]

(a) f(x) = 2x - 7

$$[0,2] = \frac{f(2) - f(0)}{2-0}$$
$$= \frac{[2(2)-7]-[2(0)-7]}{2}$$
$$= \frac{(-3)-(-7)}{2}$$
$$= \frac{4}{2}$$
$$= 2$$

$$[2,4] = \frac{f(4) - f(2)}{4-2}$$
$$= \frac{(1)-(-3)}{2}$$
$$= \frac{4}{2} = 2$$

$$[4,6] = 2$$

...linear...
it will always be 2

(b) g(x) = x² - x

same →

$$[0,2] = \frac{[(2)^2-(2)]-[0^2-0]}{2-0}$$
$$= \frac{2-0}{2}$$
$$= 1$$

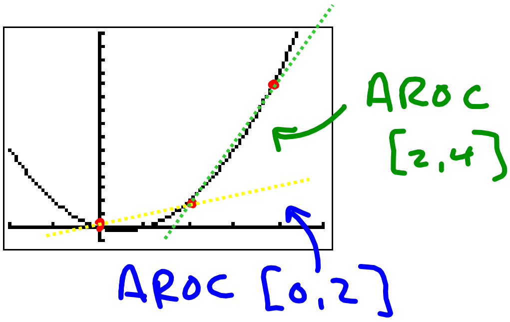
$$[2,4] = \frac{f(4)-f(2)}{4-2}$$
$$= \frac{[(4)^2-(4)]-[(2)^2-(2)]}{2}$$
$$= \frac{(12)-(2)}{2} = 5$$

$$[4,6] = \frac{[(6)^2-(6)]-[(4)^2-4]}{6-4}$$
$$= \frac{(30)-(12)}{2} = \frac{18}{2} = 9$$

AROC changes for non-linear functions

AROC... Graphically when we find the AROC we are finding the slope of the line connecting 2 points on the graph of the function

this line is called a secant

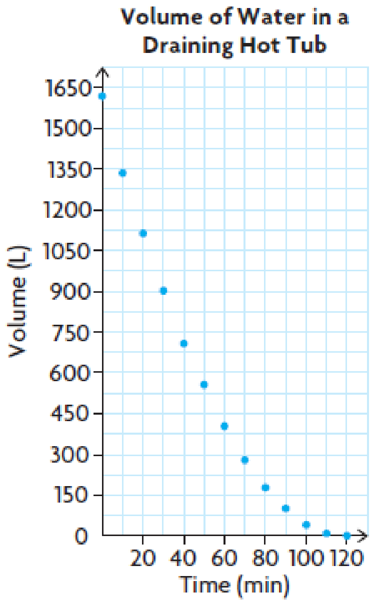


So another definition for AROC...

> The average rate of change on the interval $[x_1, x_2]$ is the slope of the secant passing through the points (x_1, y_1) and (x_2, y_2)

EXAMPLE 3 Using a graph to determine the average rate of change

Andrew drains the water from a hot tub. The tub holds 1600 L of water. It takes 2 h for the water to drain completely. The volume V, in litres, of water remaining in the tub at various times t, in minutes, is shown in the table and graph.



Time (min)	Volume (L)
0	1600
10	1344
20	1111
30	900
40	711
50	544
60	400
70	278
80	178
90	100
100	44
110	10
120	0

i) $AROC_{[30,90]} = \frac{100-900}{90-30} = \frac{-800}{60} = -13.3$ L/min

ii) $\frac{100-400}{90-60} = \frac{-300}{30} = -10$ L/min

iii) $\frac{10-100}{110-90} = \frac{-90}{20} = -4.5$ L/min

iv) $\frac{0-10}{120-110} = \frac{-10}{10} = -1$ L/min

a) Calculate the average rate of change in volume during each of the following time intervals.
   i) $30 \le t \le 90$
   ii) $60 \le t \le 90$
   iii) $90 \le t \le 110$
   iv) $110 \le t \le 120$

b) Why is the rate of change in volume negative during each of these time intervals? → H_2O is leaving the tub

c) Does the hot tub drain at a constant rate? Explain.

not constant... pressure is always changing with the level of H_2O

Homefun:

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