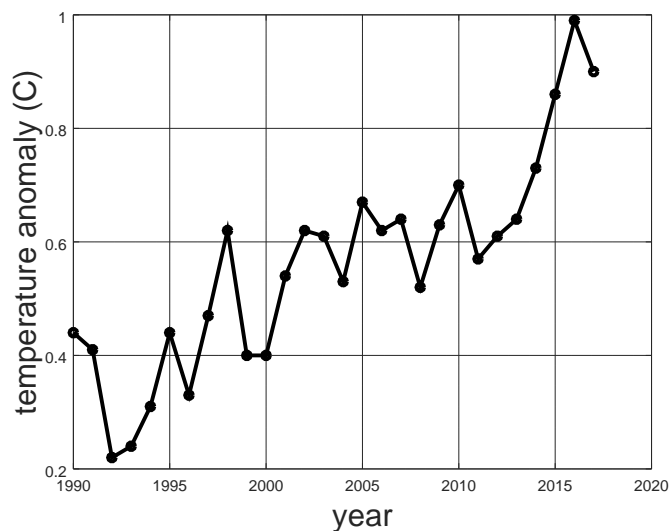


1. Here is a table of the temperature anomaly data, for recent years, from NASA. I showed the whole 1880–2017 data set in class. The first column is the year. The second column is the difference of the globally-averaged temperature for that year minus the average of the 1951–1980 period, in Celsius. The plot below shows this data.

1990	0.44
1991	0.41
1992	0.22
1993	0.24
1994	0.31
1995	0.44
1996	0.33
1997	0.47
1998	0.62
1999	0.4
2000	0.4
2001	0.54
2002	0.62
2003	0.61
2004	0.53
2005	0.67
2006	0.62
2007	0.64
2008	0.52
2009	0.63
2010	0.7
2011	0.57
2012	0.61
2013	0.64
2014	0.73
2015	0.86
2016	0.99
2017	0.9



Compute from the data:

1. the average rate of change of temperature (i.e. slope of the secant line) in the period 1990–2017
2. the highest average rate of change you can compute for a ten-year period
3. the lowest rate of change you can compute for a ten-year period
4. your estimate of the rate of change in the year 2010

*This example shows that slopes can always be computed, but that noisy data does not really have a slope when you look at a small period. See the next page for better-behaved functions. Math 251 Calculus I will be entirely about well-behaved functions. You see, Calc I is not real life.*

2. (*Exercise 3 in section 2.1.*) The point  $P(2, -1)$  lies on the curve  $y = 1/(1 - x)$ .

- a) Pick a point on the curve  $(x, 1/(1 - x))$ , not too far from  $P$ , and call it  $Q$ . Sketch the curve, the points  $P$  and  $Q$ , and the secant line  $PQ$ .
- b) Use your calculator to find the slope of the secant line  $PQ$  correct to six decimal places, for the following values of  $x$ :

(i) 1.5   (ii) 1.9   (iii) 1.99   (iv) 1.999

(v) 2.5   (vi) 2.1   (vii) 2.01   (viii) 2.001

- c) Using the results of part a), guess the value of the slope of the tangent line to the curve at  $P(2, -1)$ .
- d) Find an equation for the same tangent line as in c).

3. (*Exercise 2 in section 2.1. Compare the nice result here to problem 1.*) A cardiac monitor is used to measure the heart rate of a patient after surgery. It compiles the number of heartbeats after  $t$  minutes, as in the table below. When the data are graphed, the slope of the tangent line represents the heart rate in beats per minute.

$t$ (min)	36	38	40	42	44
heartbeats	2530	2661	2806	2948	3080

The monitor estimates the heart rate using secant line slopes. Use the data to estimate the patient's heart rate at 42 minutes using the secant line between the points

- a)  $t = 36$  and  $t = 42$
- b)  $t = 38$  and  $t = 42$
- c)  $t = 40$  and  $t = 42$
- d)  $t = 42$  and  $t = 44$

Give an (estimated) conclusion about the patient's heartbeat at 42 minutes.