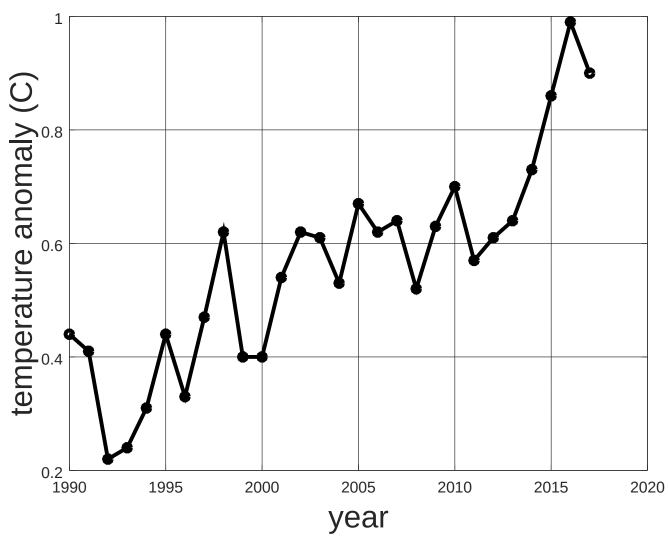
1. Here is a table of temperature data, for recent years, from NASA. The first column is the year, namely the time t. The second column is the difference of the globally-averaged temperature for that year minus the average of the 1951–1980 period, in Celsius. This is the so-called *temperature anomaly*. We regard this as a function of time; the temperature anomaly is $f(t)$. 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 for the graph of $f(t)$, 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 §2.1.*) The point $P(2,-1)$ lies on the curve $y = \dfrac{1}{1-x}$.

a) Pick a value x which gives a point on the curve $Q(x, \dfrac{1}{1-x})$. 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 tangent line at $P(2,-1)$.

3. (*Like Exercise 2 in §2.1. Compare the nice result here to problem 1.*) A cardiac monitor continuously measures the heart rate of a patient after surgery. It compiles the number of heartbeats after t minutes; in a certain period it gets the data in the table below:

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

The slope of the tangent line to the graph of this data should represent the heart rate in beats per minute. In fact the monitor estimates the heart rate using secant line slopes.

Use the data to estimate the patient's heart rate at 40 minutes using the secant line between the points

a) $t = 36$ and $t = 44$

b) $t = 38$ and $t = 42$

c) $t = 38$ and $t = 40$

d) $t = 40$ and $t = 42$

Conclude with an estimate of the patient's heartbeat at 40 minutes and a "$\pm x$" statement of your uncertainty.