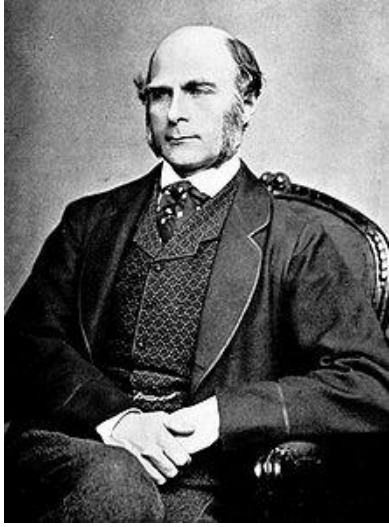
Correlation



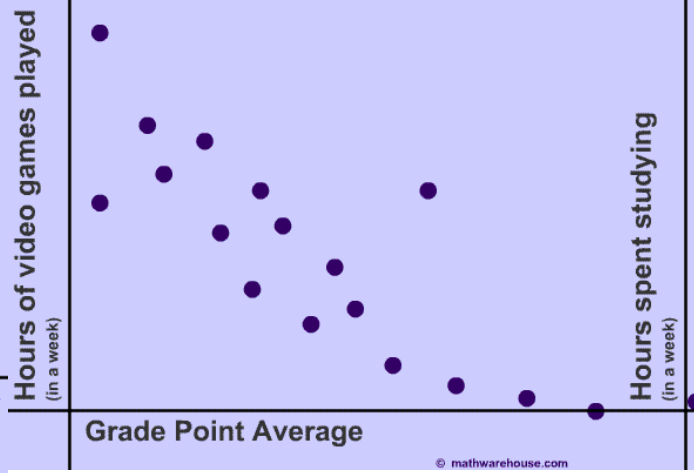
- Sir Francis Galton – regression toward a mean

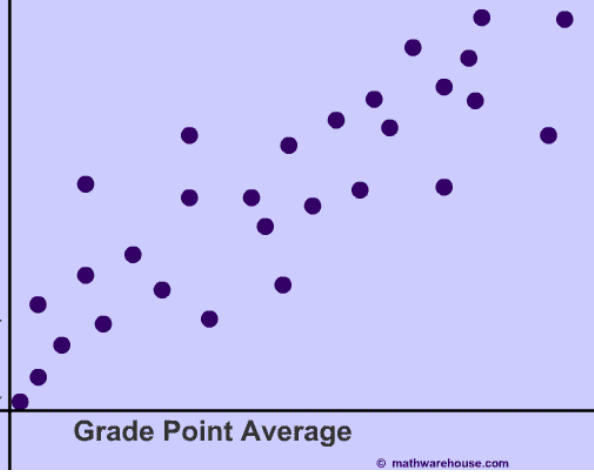
Population correlation coefficient. The correlation ρ between two variables is:

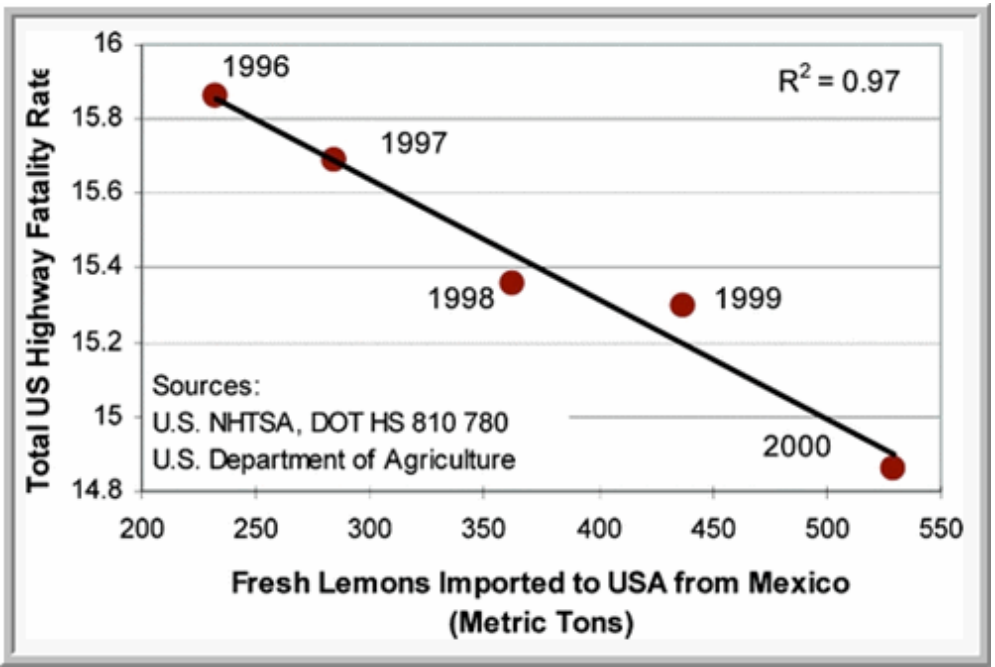
$$\rho = [1 / N] * \Sigma \{ [(Xi - \mu X) / \sigma x] * [(Yi - \mu Y) / \sigma y] \}$$

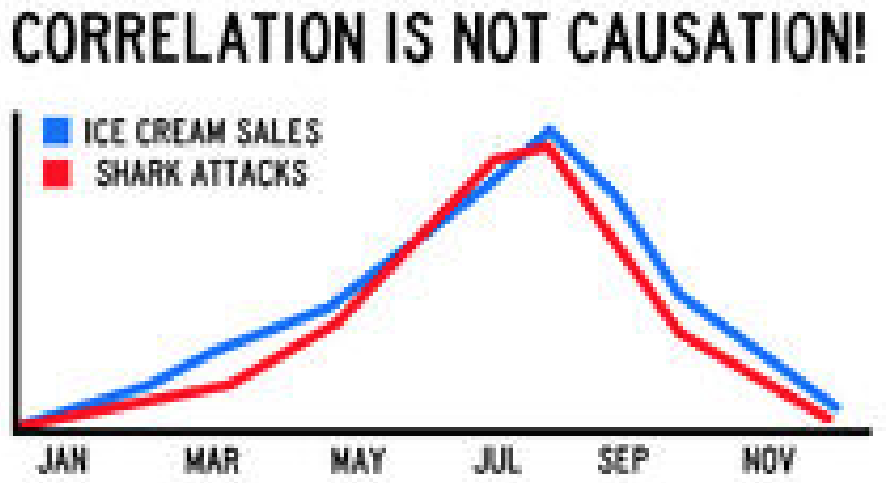
where N is the number of observations in the population, Σ is the summation symbol, Xi is the X value for observation i, μX is the population mean for variable X, Yi is the Y value for observation i, μY is the population mean for variable Y, σx is the population standard deviation of X, and σy is the population standard deviation of Y.

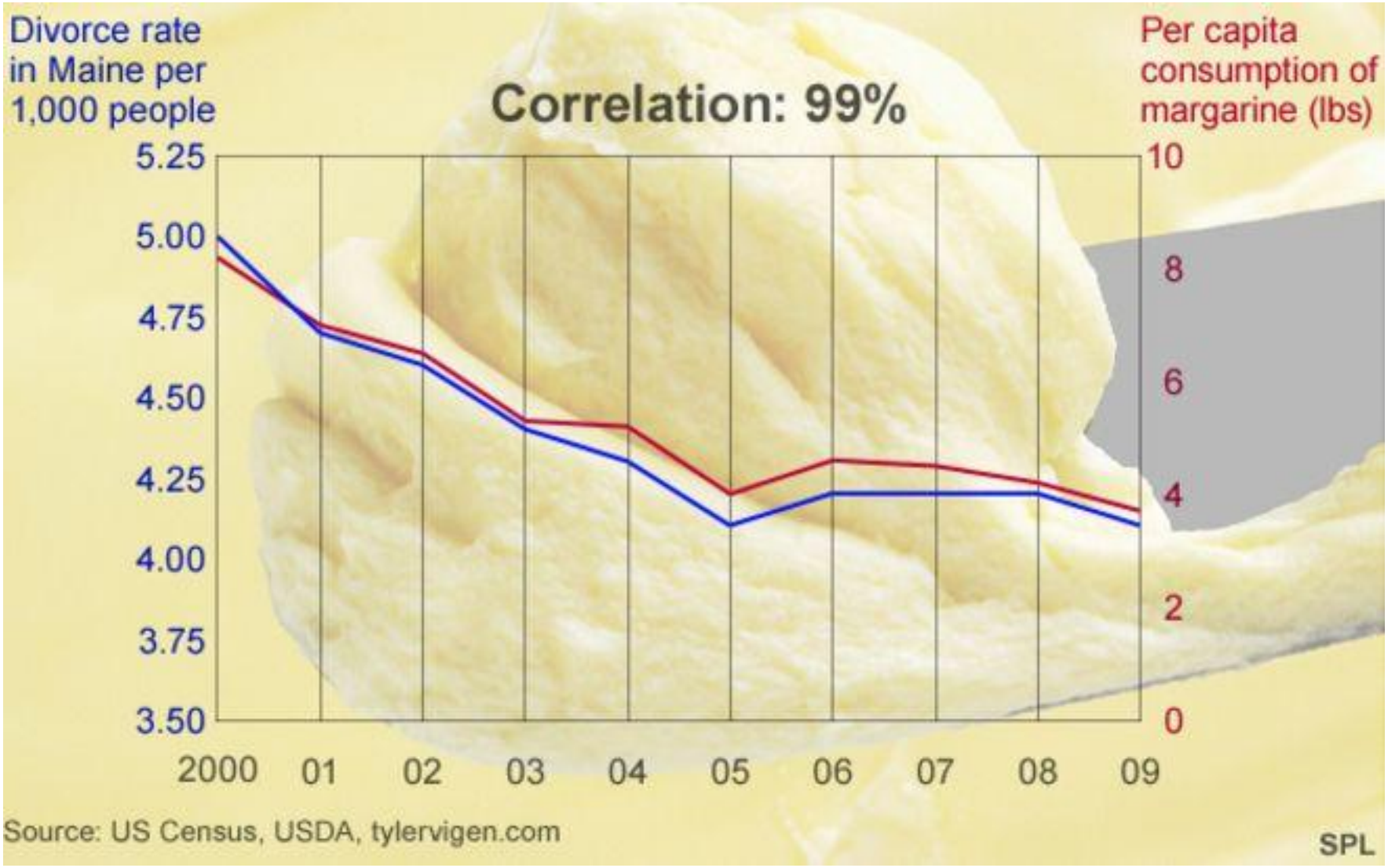

Size of television
(inches)
average time spent watching TV in a week
(in hours)
© mathwarehouse.com

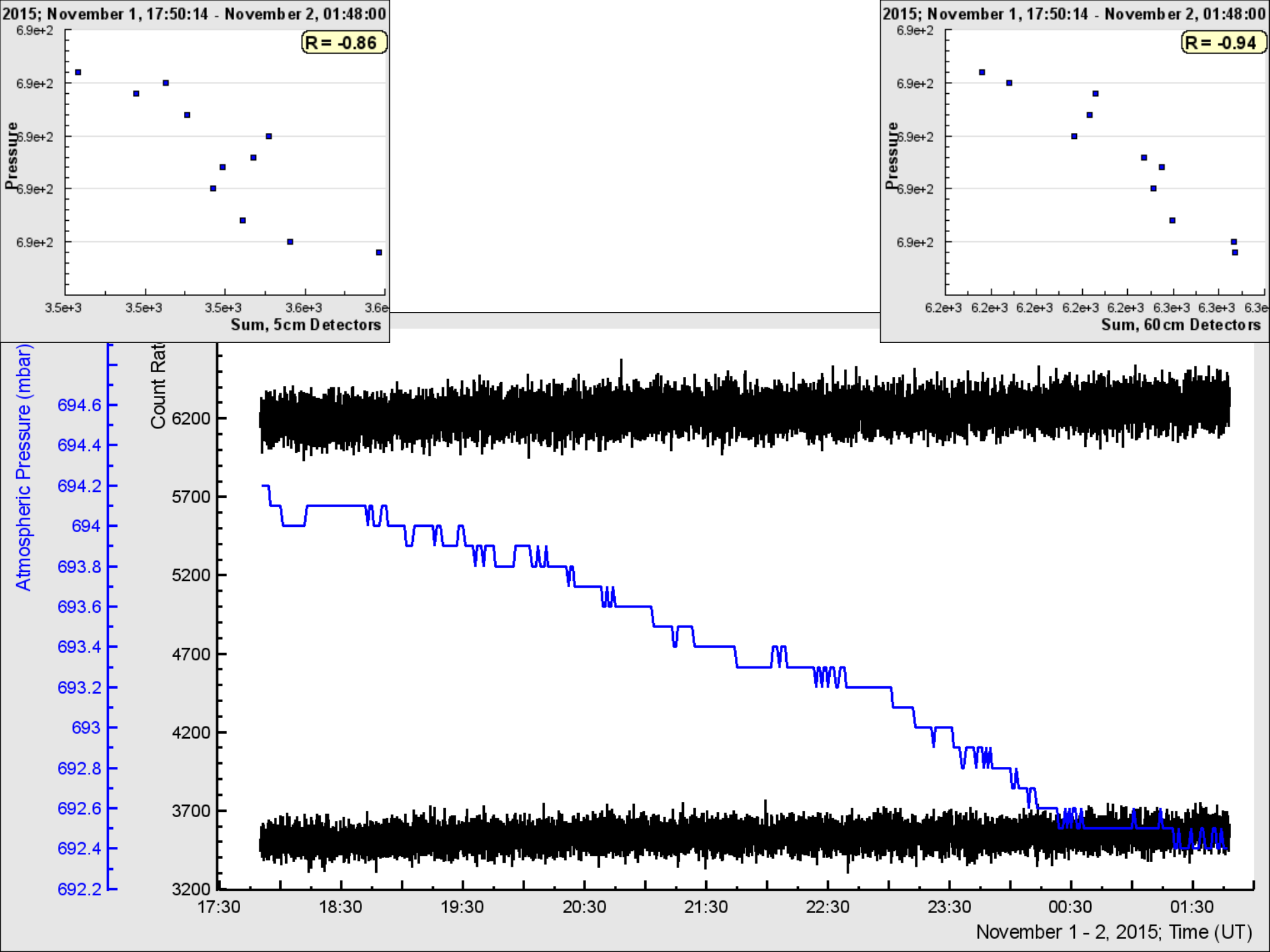

Hours of video games played
(in a week)
Grade Point Average
© mathwarehouse.com


Hours spent studying
(in a week)
Grade Point Average
© mathwarehouse.com

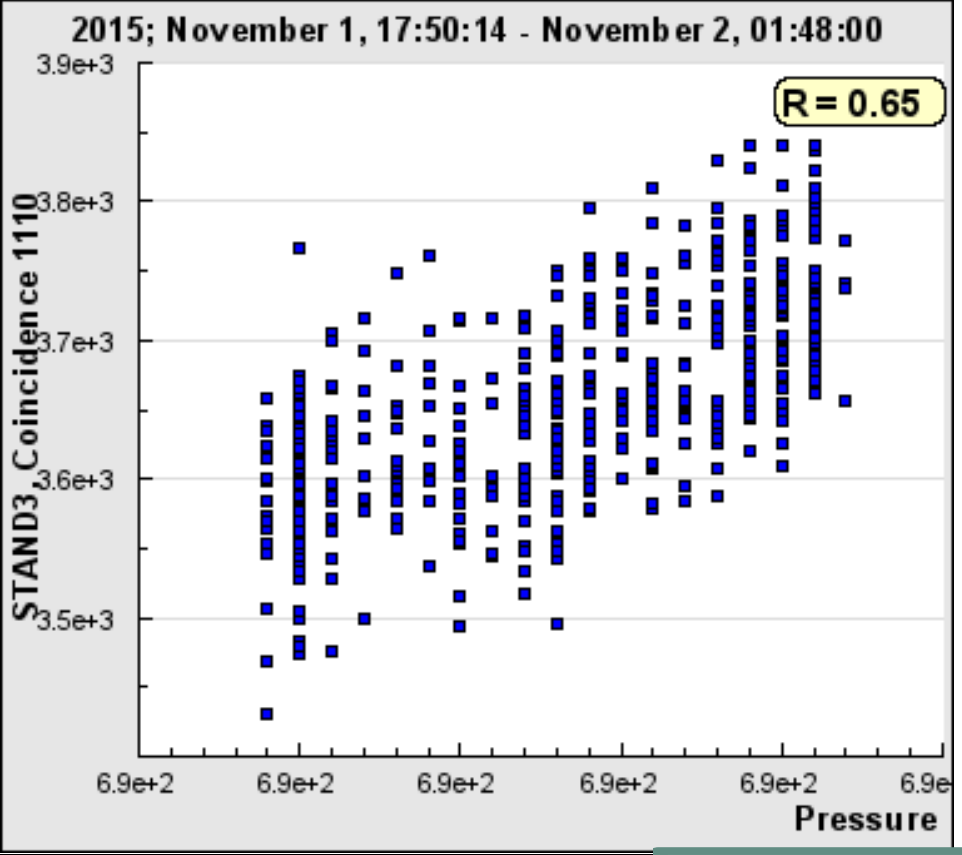

Total US Highway Fatality Rate
16
15.8
15.6
15.4
15.2
15
14.8
1996
1997
1998
1999
2000
$R^2 = 0.97$
Sources:
U.S. NHTSA, DOT HS 810 780
U.S. Department of Agriculture
200
250
300
350
400
450
500
550
Fresh Lemons Imported to USA from Mexico
(Metric Tons)

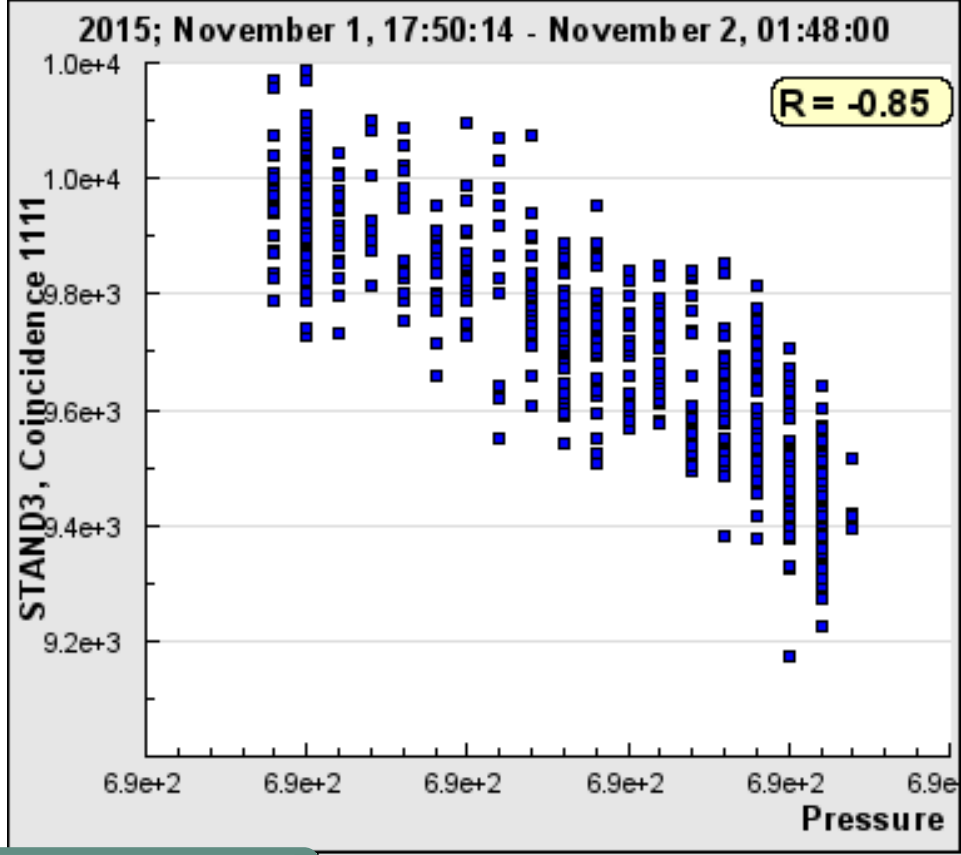

CORRELATION IS NOT CAUSATION!
ICE CREAM SALES
SHARK ATTACKS
JAN
MAR
MAY
JUL
SEP
NOV
Both ice cream sales and shark attacks increase when the weather is hot and sunny, but they are not caused by each other (they are caused by good weather, with lots of people at the beach, both eating ice cream and having a swim in the sea)

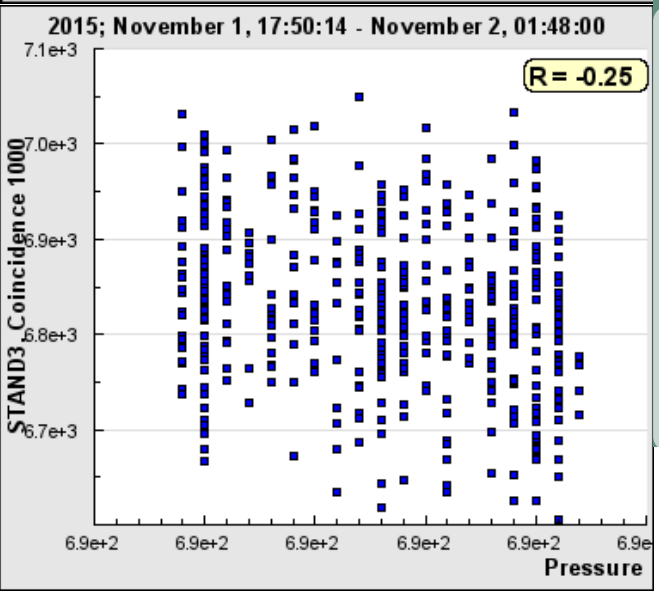

Divorce rate in Maine per 1,000 people
Correlation: 99%
Per capita consumption of margarine (lbs)
5.25
5.00
4.75
4.50
4.25
4.00
3.75
3.50
10
8
6
4
2
0
2000
01
02
03
04
05
06
07
08
09
Source: US Census, USDA, tylervigen.com
SPL

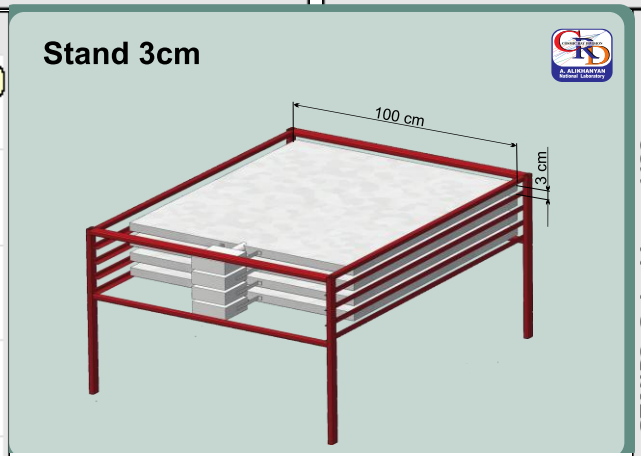

2015; November 1, 17:50:14 - November 2, 01:48:00
R = -0.86
Pressure
6.9e+2
Sum, 5cm Detectors
3.5e+3
3.6e+3
2015; November 1, 17:50:14 - November 2, 01:48:00
R = -0.94
Sum, 60cm Detectors
6.2e+3
6.3e+3
Atmospheric Pressure (mbar)
694.6
694.4
694.2
694
693.8
693.6
693.4
693.2
693
692.8
692.6
692.4
692.2
Count Rat
6200
5700
5200
4700
4200
3700
3200
17:30
18:30
19:30
20:30
21:30
22:30
23:30
00:30
01:30
November 1 - 2, 2015; Time (UT)

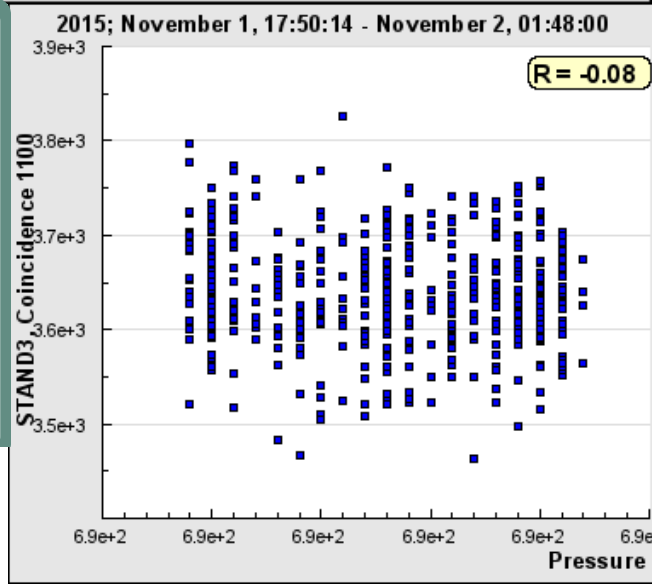

© Radboud University

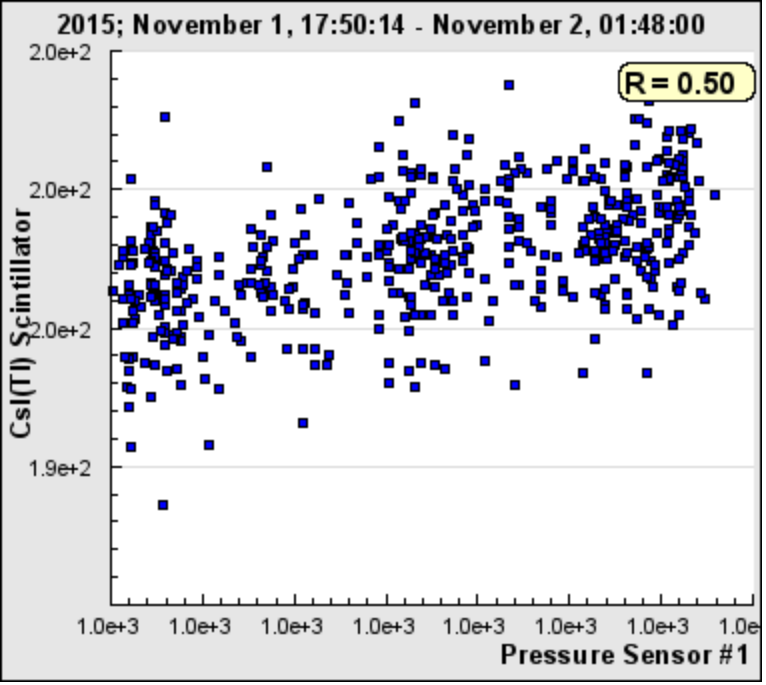

2015; November 1, 17:50:14 - November 2, 01:48:00
R = 0.65
STAND3, Coincidence 1110
3.9e+3
3.8e+3
3.7e+3
3.6e+3
3.5e+3
6.9e+2
6.9e+2
6.9e+2
6.9e+2
6.9e+2
6.9e
Pressure

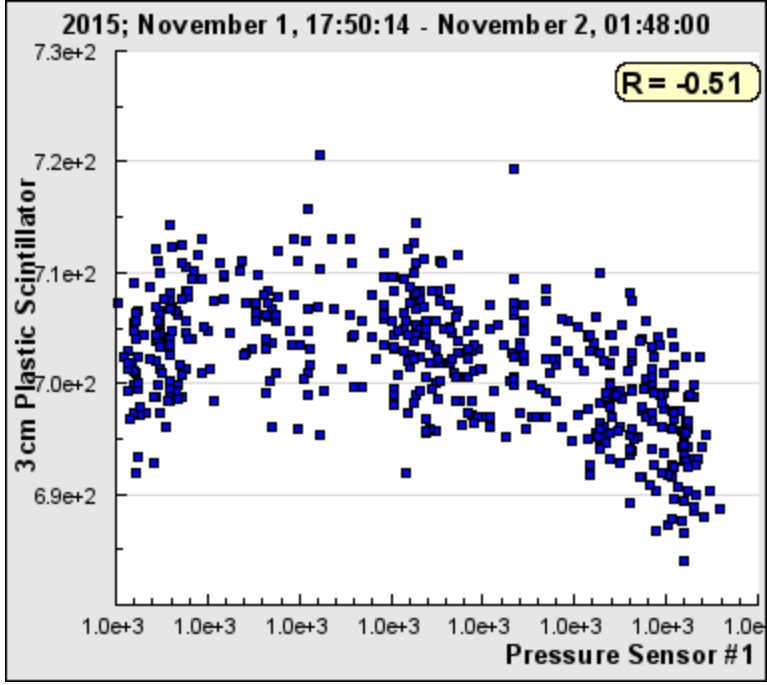

2015; November 1, 17:50:14 - November 2, 01:48:00
R = -0.85
STAND3, Coincidence 1111
1.0e+4
1.0e+4
9.8e+3
9.6e+3
9.4e+3
9.2e+3
6.9e+2
6.9e+2
6.9e+2
6.9e+2
6.9e+2
6.9e
Pressure

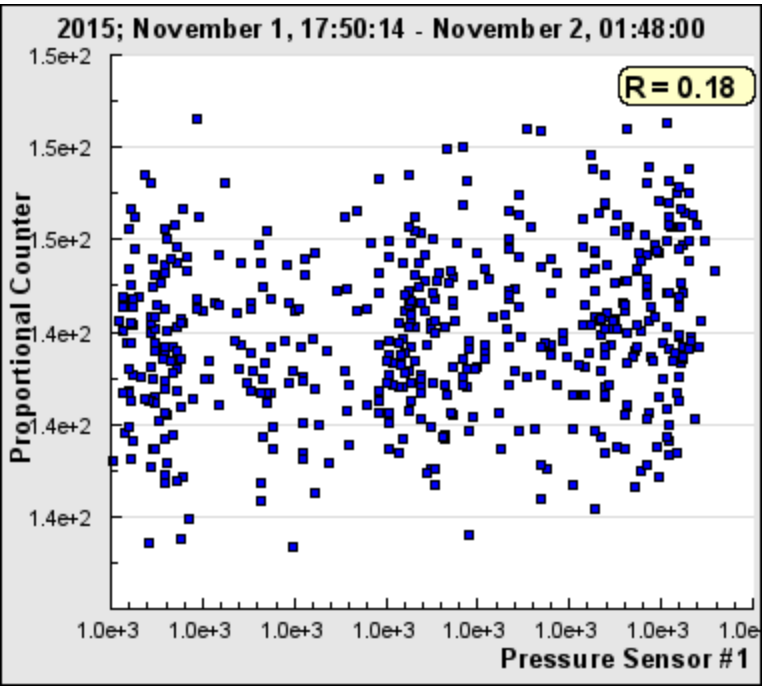

2015; November 1, 17:50:14 - November 2, 01:48:00
R = -0.25
STAND3, Coincidence 1000
7.1e+3
7.0e+3
6.9e+3
6.8e+3
6.7e+3
6.9e+2
6.9e+2
6.9e+2
6.9e+2
6.9e+2
6.9e
Pressure

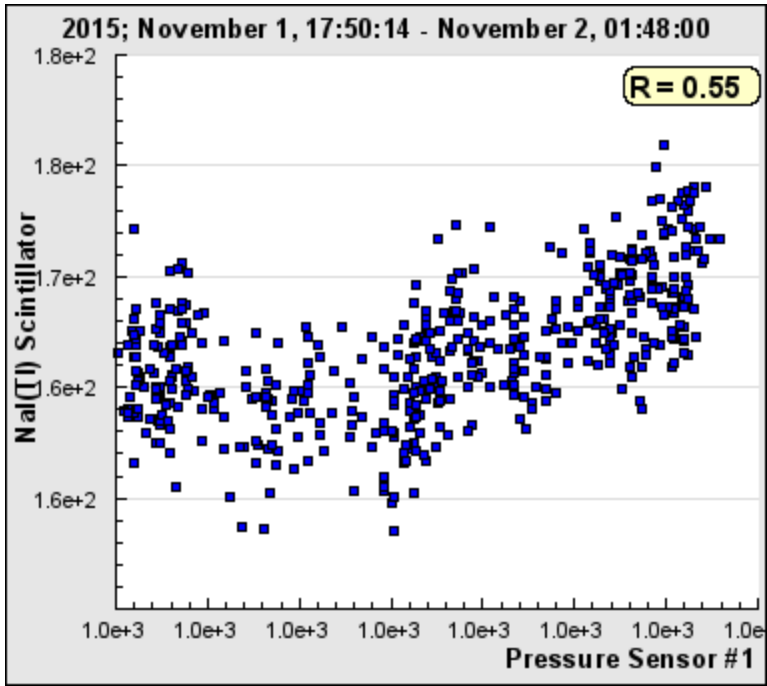

Stand 3cm
100 cm
3 cm

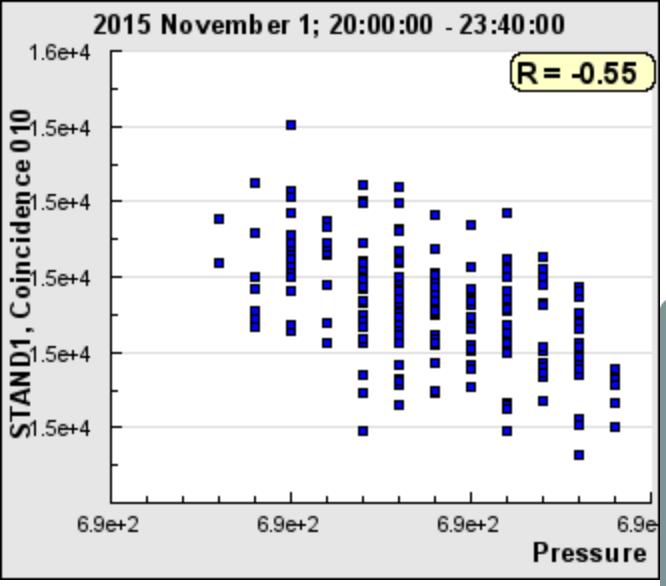

2015; November 1, 17:50:14 - November 2, 01:48:00
R = -0.08
STAND3, Coincidence 1100
3.9e+3
3.8e+3
3.7e+3
3.6e+3
3.5e+3
6.9e+2
6.9e+2
6.9e+2
6.9e+2
6.9e+2
6.9e
Pressure

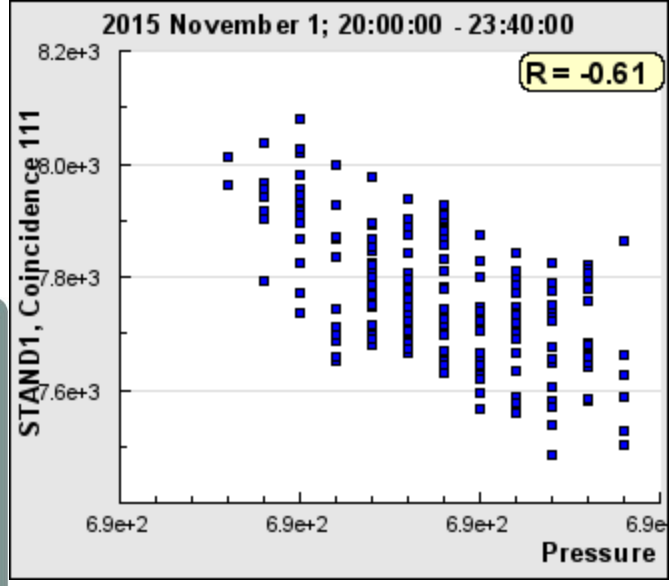

2015; November 1, 17:50:14 - November 2, 01:48:00
R = 0.50
CsI(Tl) Scintillator
2.0e+2
2.0e+2
2.0e+2
1.9e+2
1.0e+3
Pressure Sensor #1

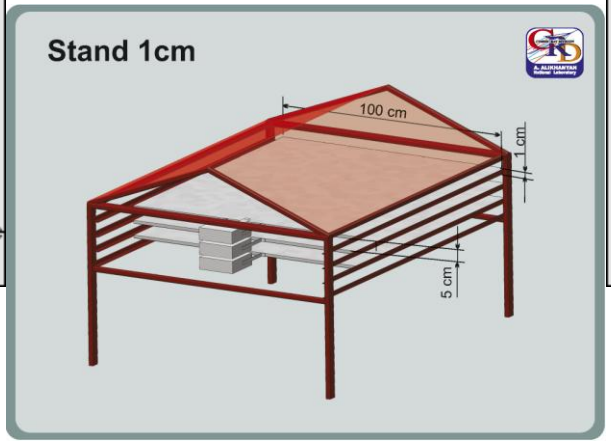

2015; November 1, 17:50:14 - November 2, 01:48:00
R = -0.51
3cm Plastic Scintillator
7.3e+2
7.2e+2
7.1e+2
7.0e+2
6.9e+2
1.0e+3
Pressure Sensor #1

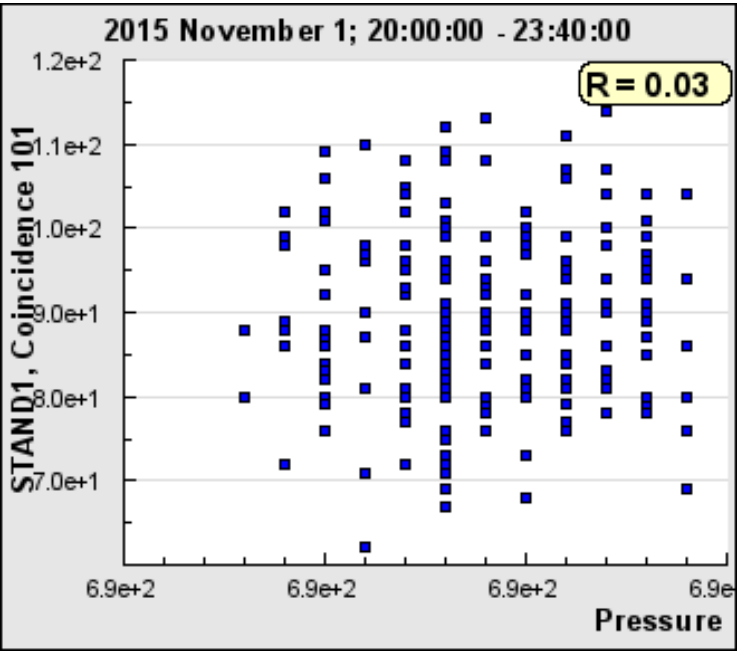

2015; November 1, 17:50:14 - November 2, 01:48:00
R = 0.18
Proportional Counter
1.5e+2
1.5e+2
1.4e+2
1.4e+2
1.0e+3
Pressure Sensor #1

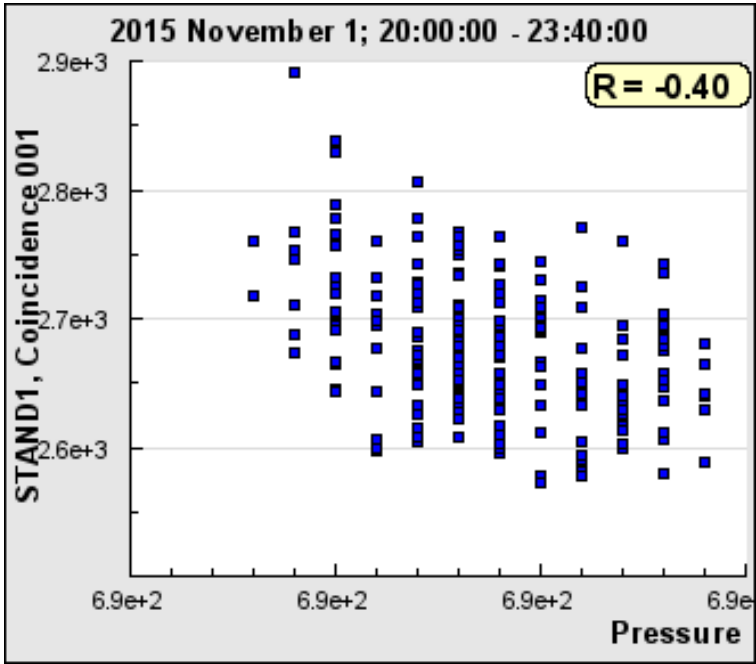

2015; November 1, 17:50:14 - November 2, 01:48:00
R = 0.55
NaI(Tl) Scintillator
1.8e+2
1.8e+2
1.7e+2
1.6e+2
1.6e+2
1.0e+3
Pressure Sensor #1


2015 November 1; 20:00:00 - 23:40:00
R = -0.55
STAND1, Coincidence 010
1.6e+4
1.5e+4
1.5e+4
1.5e+4
1.5e+4
1.5e+4
6.9e+2
6.9e+2
6.9e+2
6.9e
Pressure


2015 November 1; 20:00:00 - 23:40:00
R = -0.61
STAND1, Coincidence 111
8.2e+3
8.0e+3
7.8e+3
7.6e+3
6.9e+2
6.9e+2
6.9e+2
6.9e
Pressure


Stand 1cm
100 cm
1 cm
5 cm


2015 November 1; 20:00:00 - 23:40:00
R = 0.03
STAND1, Coincidence 101
1.2e+2
1.1e+2
1.0e+2
9.0e+1
8.0e+1
7.0e+1
6.9e+2
6.9e+2
6.9e+2
6.9e
Pressure


2015 November 1; 20:00:00 - 23:40:00
R = -0.40
STAND1, Coincidence 001
2.9e+3
2.8e+3
2.7e+3
2.6e+3
6.9e+2
6.9e+2
6.9e+2
6.9e
Pressure

Beginning of nuclear and high-energy physics

- Elementary particles – electron-experiment of JJ Thompson;
- Atoms – planetary model –Ernest Rutherford experiment;
- Elementary particle masses and charges Robert A. Millikan experiment;
- Electricity; radioactive elements \victor Hess experiment;
- What are cosmic rays? Millikan – Compton controversy; longitude effect; east-west assymetry.

Physical experiment Data analysis

- Random and deterministic variables, measurement model;
- Probability, 3 ways to calculate and assign it;
- Parametric and non-parametric estimates of population parameters (mean, median…);
- Time series and histograms; what information we can acquire from both;
- Connection of 2 variables, correlation and causal relation; scatter plot, correlation coefficient.