# MATH 185 – Homework 5
## Due Monday, 05/30/2016, by 11:59 PM

*Send your code to* `math185ucsd@gmail.com`. *Follow the following format exactly. For Homework 1, in subject line write "MATH 185 (HW 1)" and nothing else in the body. There should only be one file attached, named* `hw1-lastname-firstname.R`. *Make sure your code is clean, commented and running. Keep your code simple, using packages only if really necessary. If your code does not run, include an explanation of what is going on.*

**Problem 1. (Correlation tests)** Consider the setting where $X \sim \text{Unif}[-1, 1]$ and $Y = X^2$. Perform simulations to evaluate the performance of the permutation Pearson, Spearman, and Kendall (two-sided) tests. Use a large sample size $n$, say, $n = 10{,}000$, and a decent amount of repeats, say, $B = 999$. Produce side-by-side boxplots of p-values, one for each test. Offer some brief comments.

**Problem 2. (Hoeffding's independence test)** We saw this test in the lecture notes. The test statistic is implemented in the package `Hmisc`. Using that, write a function that implements the test. Name it `hoeff.test(z, B=999)`, where `z` is a matrix with two columns storing the data and `B` is the number of permutations sampled to compute the p-value, which is what the function will return. Evaluate the power of this test in the context of Problem 1. Offer some brief comments.

**Problem 3. (Arctic sea ice)** Read as much of the following paper as you feel inclined
http://www.amstat.org/publications/jse/v21n1/witt.pdf
The corresponding dataset is available at
http://www.amstat.org/publications/jse/v21n1/witt/sea_ice_data.txt

A. Fit an affine function (as in Figure 2 of the paper).

B. Fit a polynomial function. Start with a quadratic (as in Figure 5 of the paper) and increase the degree until the improvement is minimal.

C. Fit a monotone function.

D. Draw a scatterplot overlaying all these curves. Add a legend. (Make it nice.)

Offer some brief comments.

**Problem 4. (Bootstrap inference for regression)** Write a function `boot.regression(x, y, conf=0.95, residual=FALSE, B=999)` taking in a prediction vector `x`, a response vector `y`, a confidence level `conf`, a boolean parameter `residual`, and a number of bootstrap replicates `B`, and returns the corresponding bootstrap Studentized pivotal confidence intervals for the least squares slope and intercept. The boolean `residual` indicates whether a residual bootstrap is used or not. [Note: in this particular case, a double-loop is not required because an estimate for the standard error of the least squares estimates is known. See the lecture notes.]