Investigation 1: Ice cream prices?
(assigned on Mon Sept 26, due on Mon Oct 3)

You may work with in a group of as many as three students on this assignment, handing in one report with all names, provided that you all contribute to the work. Your report must be word-processed, with computer output integrated into the report.

The file diceprices.R (available from the “R code” link on our course webpage) contains R code for simulating the random process described in Example 1-3 about ice cream prices.

a) Run the code after changing the number of repetitions to 1,000,000. Report the approximate probability that the cone costs 50 cents or less. Also report an error bound for this approximation. Is the approximate probability within the error bound of the exact probability? (Recall that we determined the exact probability in class.)

b) Insert a line in the code to produce a histogram of the prices: hist(price). Run the code with 1,000,000 repetitions, and submit the histogram.

c) Insert a line in the code to calculate the average price of the ice cream prices: mean(price). Run the code with 1,000,000 repetitions, and report the average price of the 1,000,000 simulated ice cream cones.

Opposite Rule

Now suppose that the rules are changed so that the price is the smaller number followed by the larger number, in cents.

d) Revise the R code to simulate this random process. Include the changes/additions from questions a) – c). Submit the revised code, with your changes highlighted.

e) Run your revised code with 1,000,000 repetitions. Report the approximate probability that the cone costs 50 cents or less and the average price. Also submit a histogram of the prices.

f) Determine the (exact) probability that the cone costs 50 cents or less. (As always, show your work.)

g) Is the approximate probability in e) within the error bound of the exact probability in f)? Explain.

h) Comment on how the approximate probability and average price changed when we changed the rule for calculating the price. Explain why this makes intuitive sense.
**Three Dice**

Now suppose that the rules are changed so that three (fair, six-sided) dice are rolled. The price is calculated as the largest number followed by the smallest number, in cents.

i) Revise the R code to simulate this random process. Include the changes/additions from questions a) – c). Submit the revised code, with your changes highlighted.

j) Run your revised code with 1,000,000 repetitions. Report the approximate probability that the cone costs 50 cents or less and the average price. Also submit a histogram of the prices.

k) Comment on how the approximate probability and average price changed when you increased the number of dice from 2 to 3. Explain why this makes intuitive sense.

l) Determine the exact probability that the cone costs 50 cents or less. Explain your answer. *(Hint: Do not bother to write out the sample space of all possible outcomes, but think about how many outcomes would be in the sample space, and think about how best to count the outcomes for which the price is 50 cents or less.)*

**More Dice**

Now consider rolling even more dice, with the price calculated as the largest number rolled followed by the smallest number rolled, in cents.

m) Revise the R code to simulate this random process rolling 4 dice. Run the code with 1,000,000 repetitions. Report the approximate probability that the cone costs 50 cents or less, and the average price.

n) Repeat m) with 5 dice, and then with 6, 7, and 8 dice. Submit a table reporting the approximate probability and average price for all of the different numbers of dice from 2 – 8.

o) Use R to produce a graph of the approximate probabilities as a function of the number of dice:

```
n = (2:8)
prob = c(INSERT APPROX PROBS SEPARATED BY COMMAS)
plot(n,prob)
```

Describe how the approximate probabilities change as a function of the number of dice.

p) Repeat o) for the average price rather than the approximate probability that the cone costs 50 cents or less.