PROBABILITY

9.30.2020

PROBLEM SET 2

* Due **Friday by 10:59am**

* TA Ria Paul will be holding office hours immediately after class today (12pm CST)

  * see Canvas announcement for Zoom link

RECAP

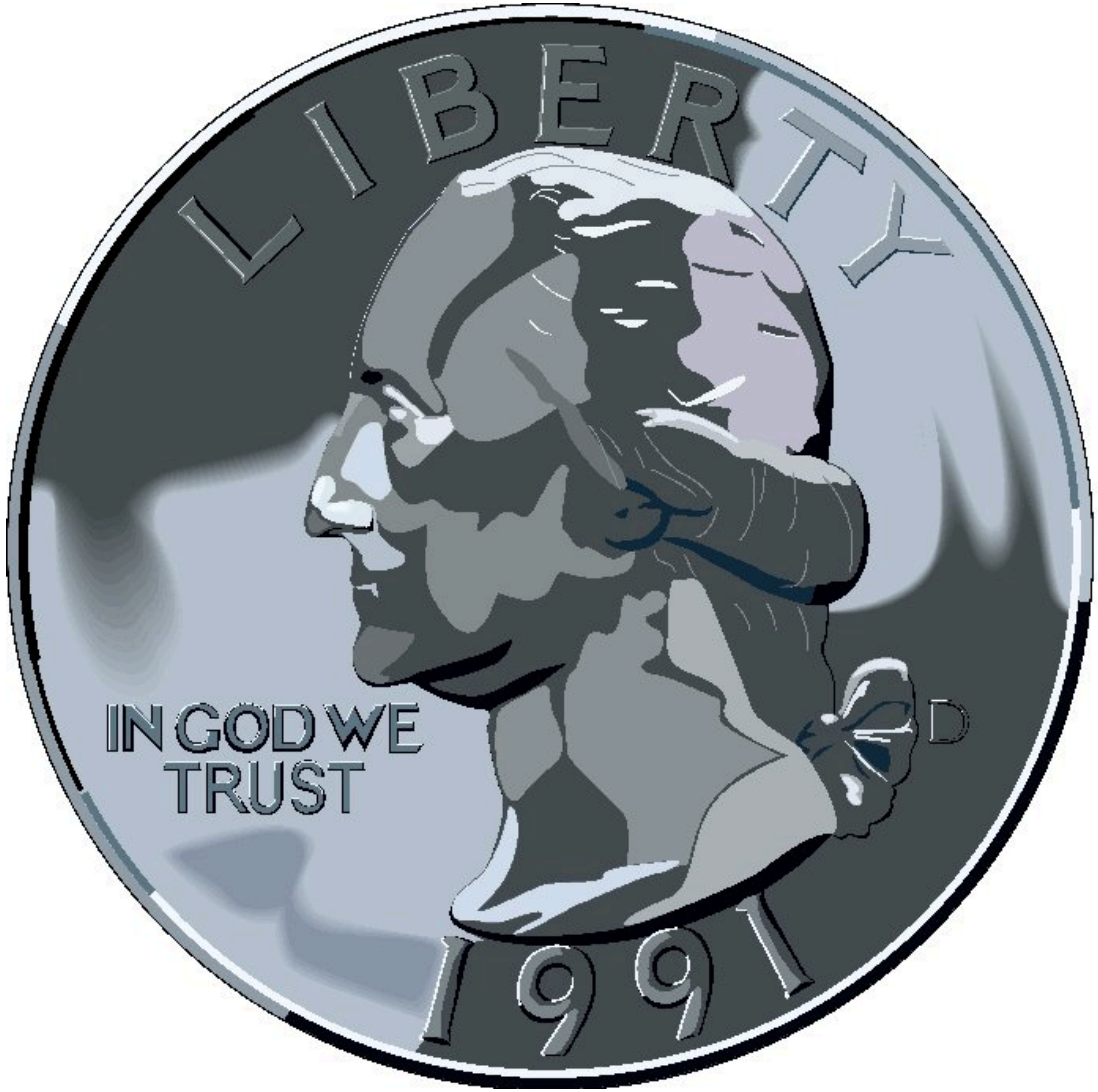
* choosing the right way to plot something!
* colormaps!
  * sequential, diverging, and qualitative

WHAT IS DATA ANALYSIS?

* Moving data around (*munging*)

* Visualizing data

* **Statistics**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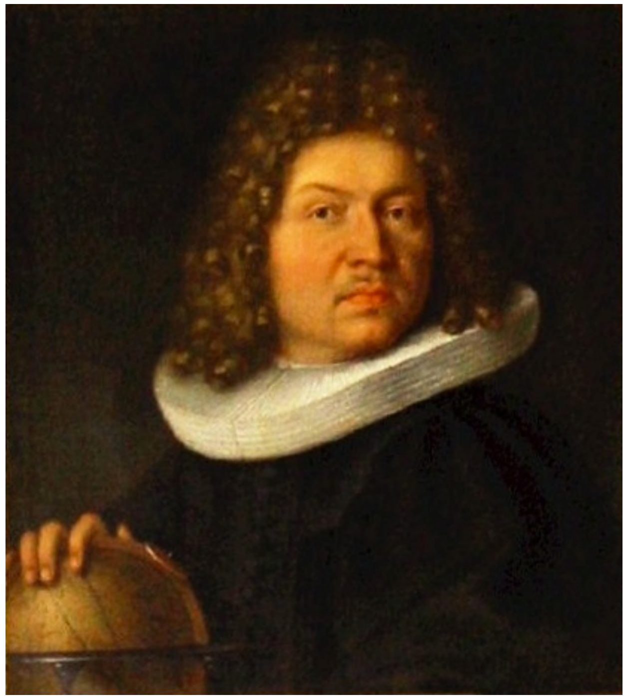
BERNOULLI



* The Bernoulli distribution is like flipping a coin: the outcome is either heads (1) or tails (0)

  * (but it doesn’t have to be a fair coin)

* It has one parameter: q = the probability that the outcome is 1

* X ~ Bernoulli(q) # means that X is a bernoulli random variable with parameter q

BERNOULLI

* To simulate a Bernoulli random variable (RV) we can use **np.random.rand()** and **>**

* For example, to get a random True or False with 50% probability:

* **np.random.rand() > 0.5**

BERNOULLI

* The **expected value (EV)** is (more or less) what the average value should be for an infinitely large sample

* It's defined as a sum of the possible values an RV could take, weighted by the probabilities of those values

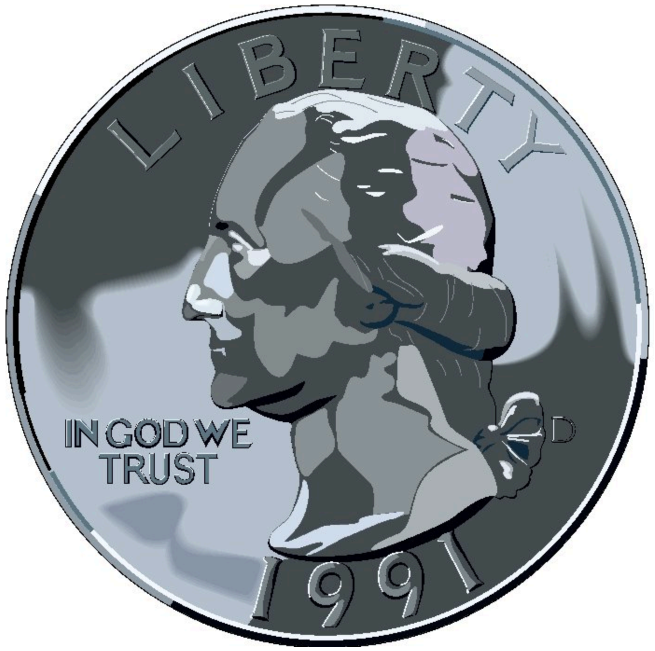
* If X ~ Bernoulli(q), then its expected value E[X] = q

WEIGHTED COIN?

* suppose we have a coin and we want to know if it's fair or not (i.e. does $q=0.5$?)

* we flip it 100 times, and it lands on heads 63 times

* is it fair? how do we know?



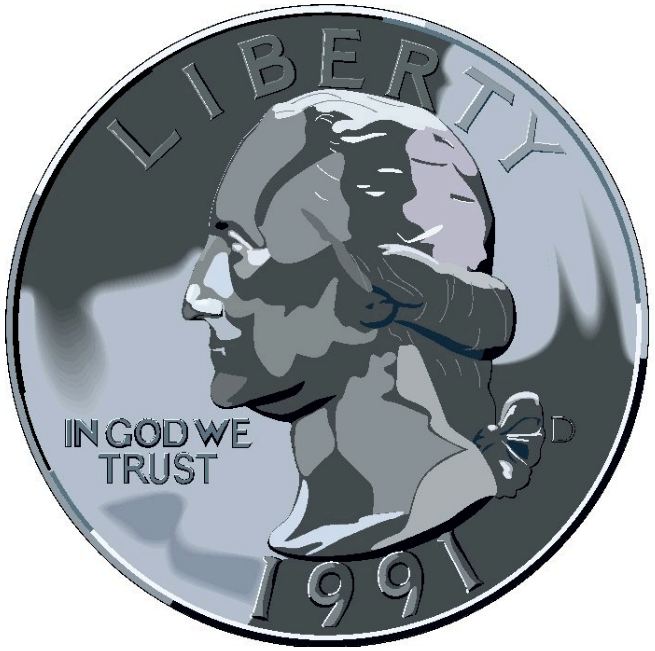
WEIGHTED COIN?

* we can test this by simulation!

* simulate 10,000 experiments where a fair coin (q=0.5) is flipped 100 times

* we know most values should be around 50

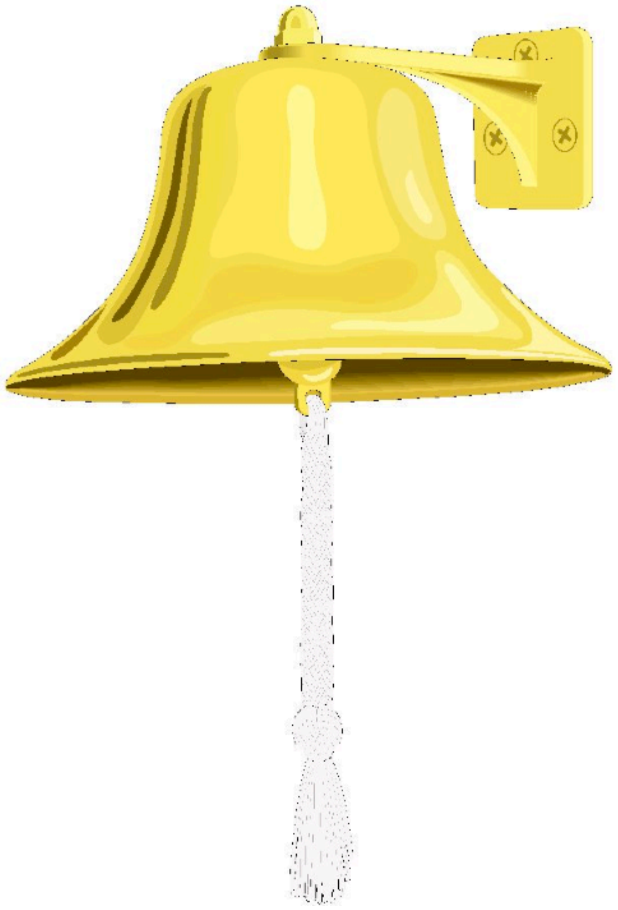
* but how often does a value as extreme as 63 come up?



P-VALUE

* the **p-value** is the probability of seeing an outcome *at least this extreme* if the “null hypothesis” (i.e. the coin is fair) is true

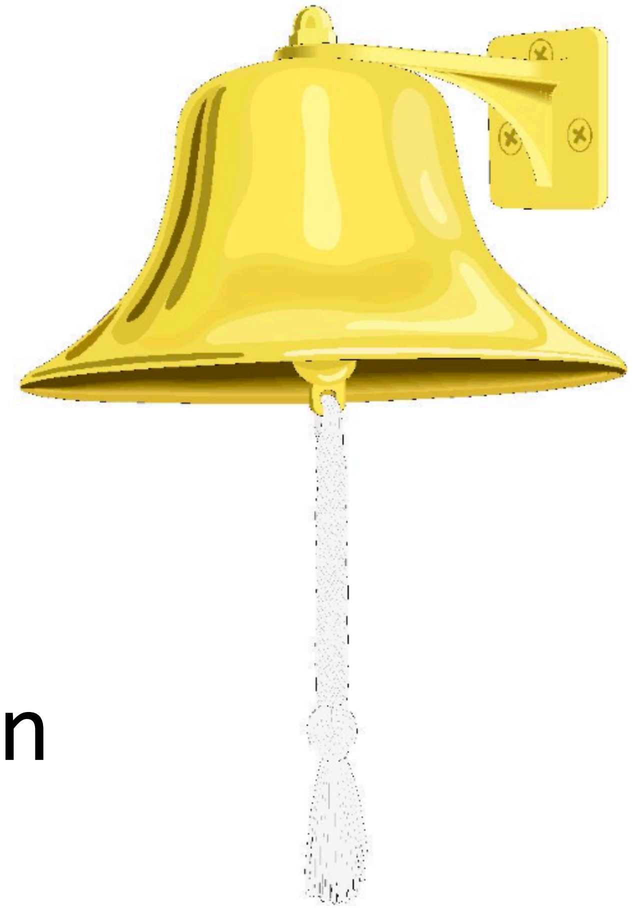
BINOMIAL DISTRIBUTION



* it turns out you don’t need to simulate lots of experiments to test things about bernoulli RVs

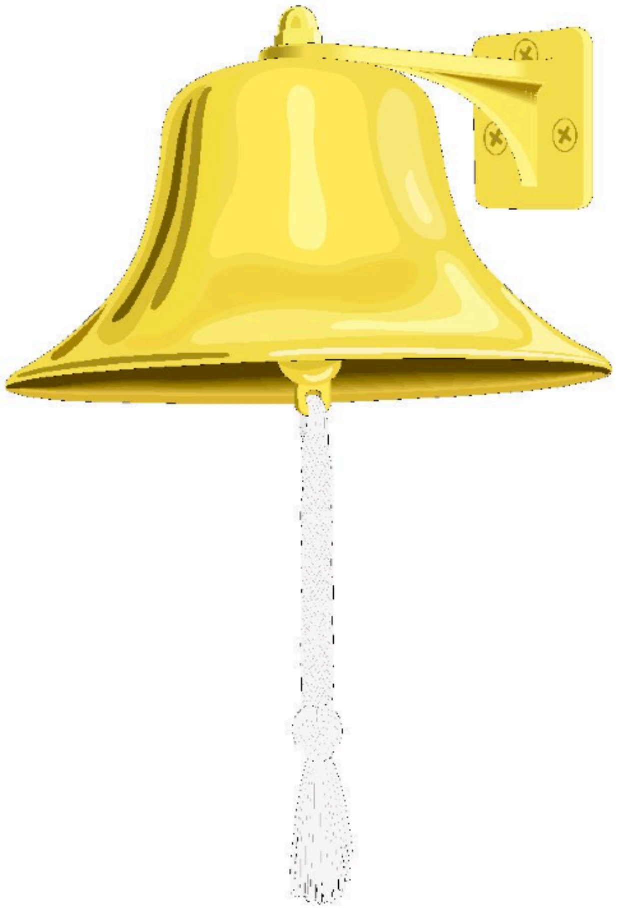
* because you can compute it exactly using the **binomial distribution**!

BINOMIAL DISTRIBUTION



* **Y ~ Binomial(n, q)** # Y is a Binomial RV with n trials and probability q on each trial
* Y is number of 1's that came up in *n* samples from a bernoulli distribution with parameter *q*
* (this is exactly what we've been doing–generating binomial RVs!)

BINOMIAL DISTRIBUTION

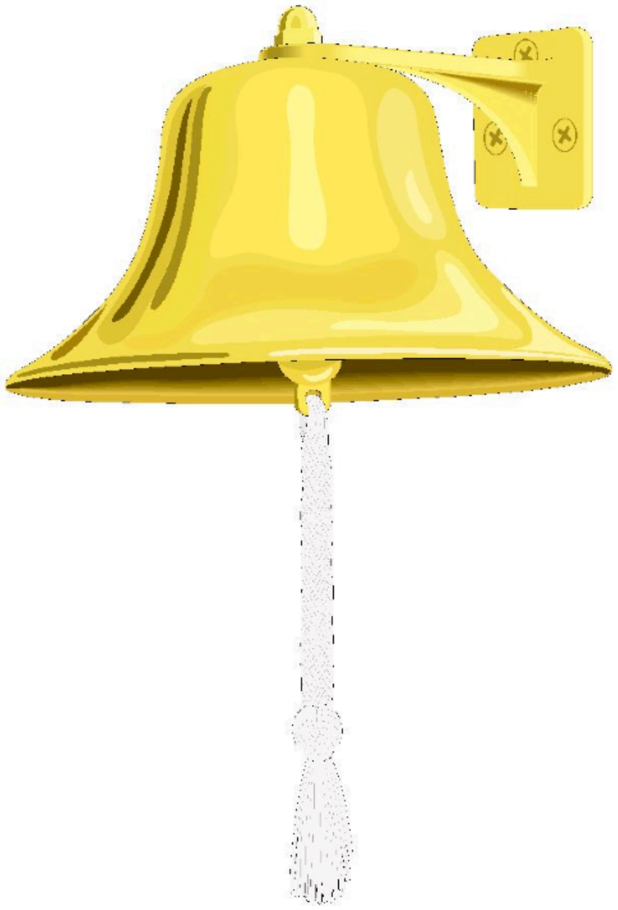


* the exact shape of a binomial distribution is given by this formula:

$$\binom{n}{k} q^k (1-q)^{n-k}$$

n-choose-k: the number of ways to pick k things out of n things

BINOMIAL DISTRIBUTION



* the exact shape of a binomial distribution is given by this formula:

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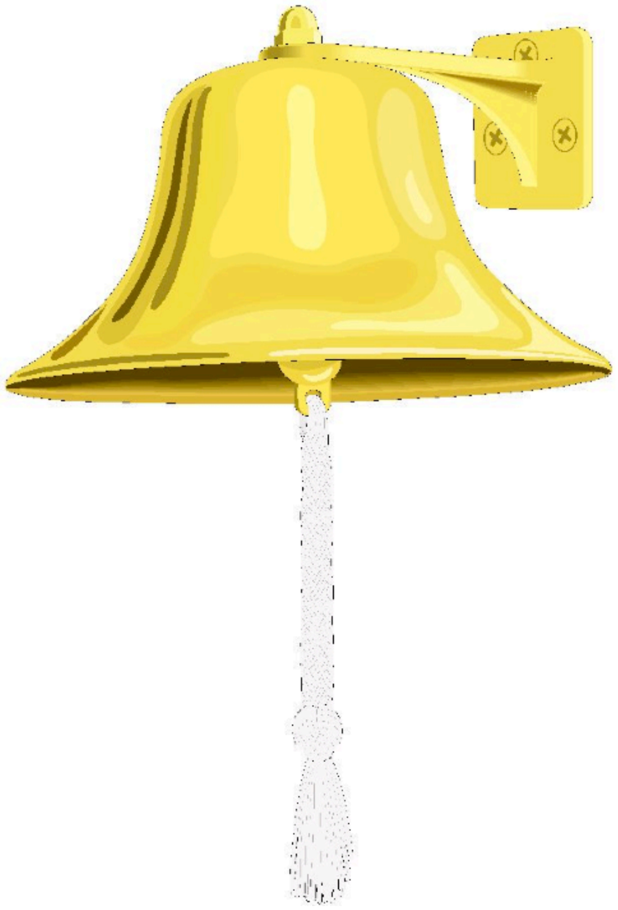
q^k: the probability of getting exactly k 1's

BINOMIAL DISTRIBUTION



* the exact shape of a binomial distribution is given by this formula:

$$\binom{n}{k} q^k (1-q)^{n-k}$$

(1-q)^(n-k): the probability of getting exactly (n-k) 0's

END