Normal Approximation
for the Box Model

Review

Box Model

… *is like* drawing ____ times from the box _____ with replacement and summing the draws.

Example #1

Rolling a die 40 times and summing the numbers shown

…is like…

drawing ____ times from the box _____ with replacement and summing the draws.

Example #1

Rolling a die 40 times and summing the numbers shown

…is like…

drawing 40 times from the box 1, 2, 3, 4, 5, 6 with replacement and summing the draws.

the expected value

the standard error

The sum will be about _____ give or take _____ or so.

Equations

expected value for sum $=$ (**number of draws**) $\times$ (**average of box**)

SE for sum $= \sqrt{\textbf{number of draws}} \times$ (**SD of box**)

Helpful Hints

Suppose the box is a "big-small box" that only has big numbers B and small numbers S (e.g., the box 2, 2, 2, 2, 14, 14), then

SD of big-small box $=$ (**B** $-$ **S**) $\times \sqrt{}$(**fraction that are B**) $\times$ (**fraction that are S**)

Suppose the box is a "0-1 box" that only has 0s and 1s (e.g., the box 0, 0, 0, 1), then

SD of 0-1 box $= \sqrt{}$(**fraction that are 0**) $\times$ (**fraction that are 1**)

Example #1

Rolling a die 40 times and summing the numbers shown

…is like…

drawing 40 times from the box 1, 2, 3, 4, 5, 6 with replacement and summing the draws.

the expected value

the standard error

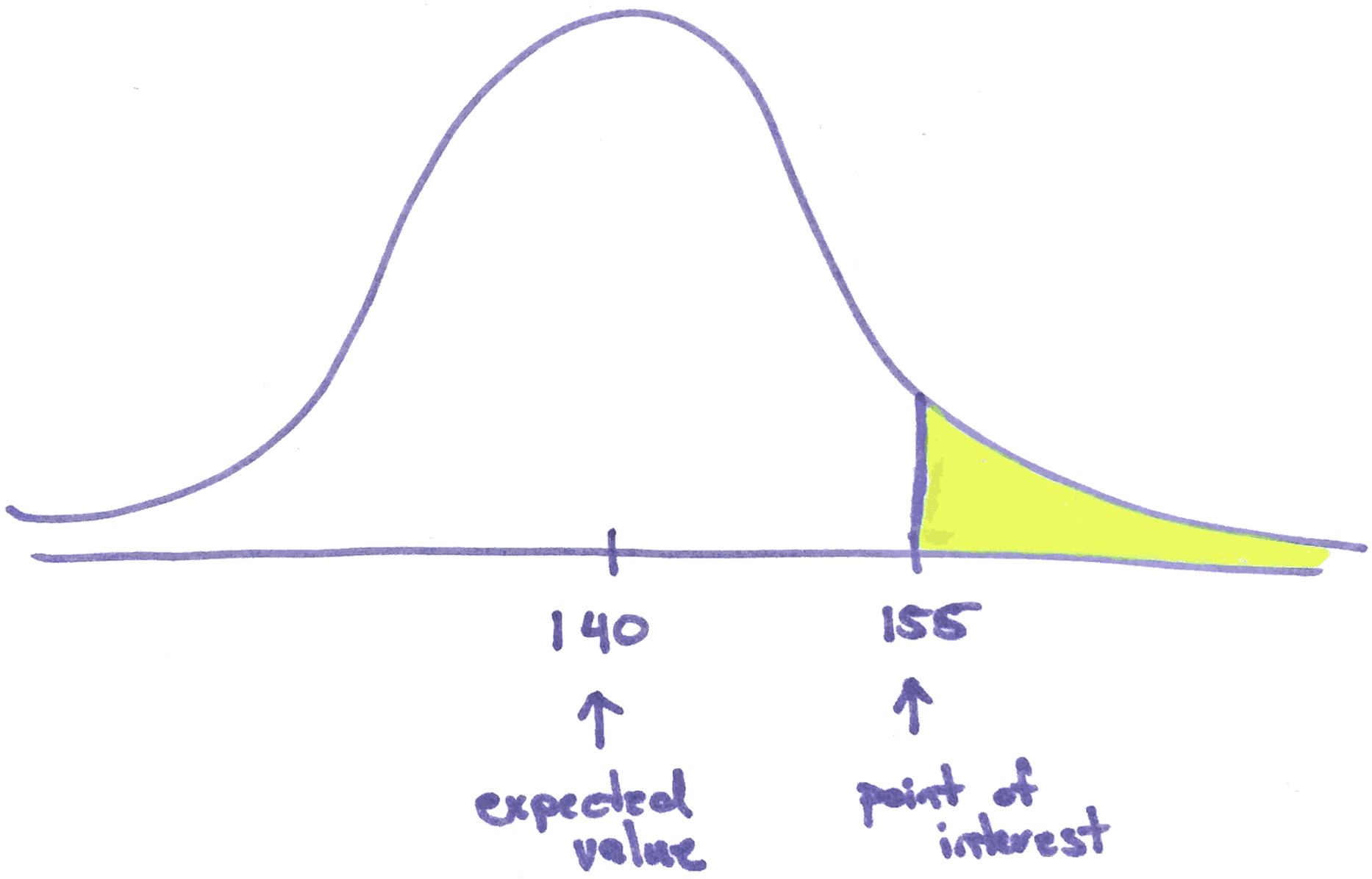
The sum will be about 140 give or take 11 or so.

Question

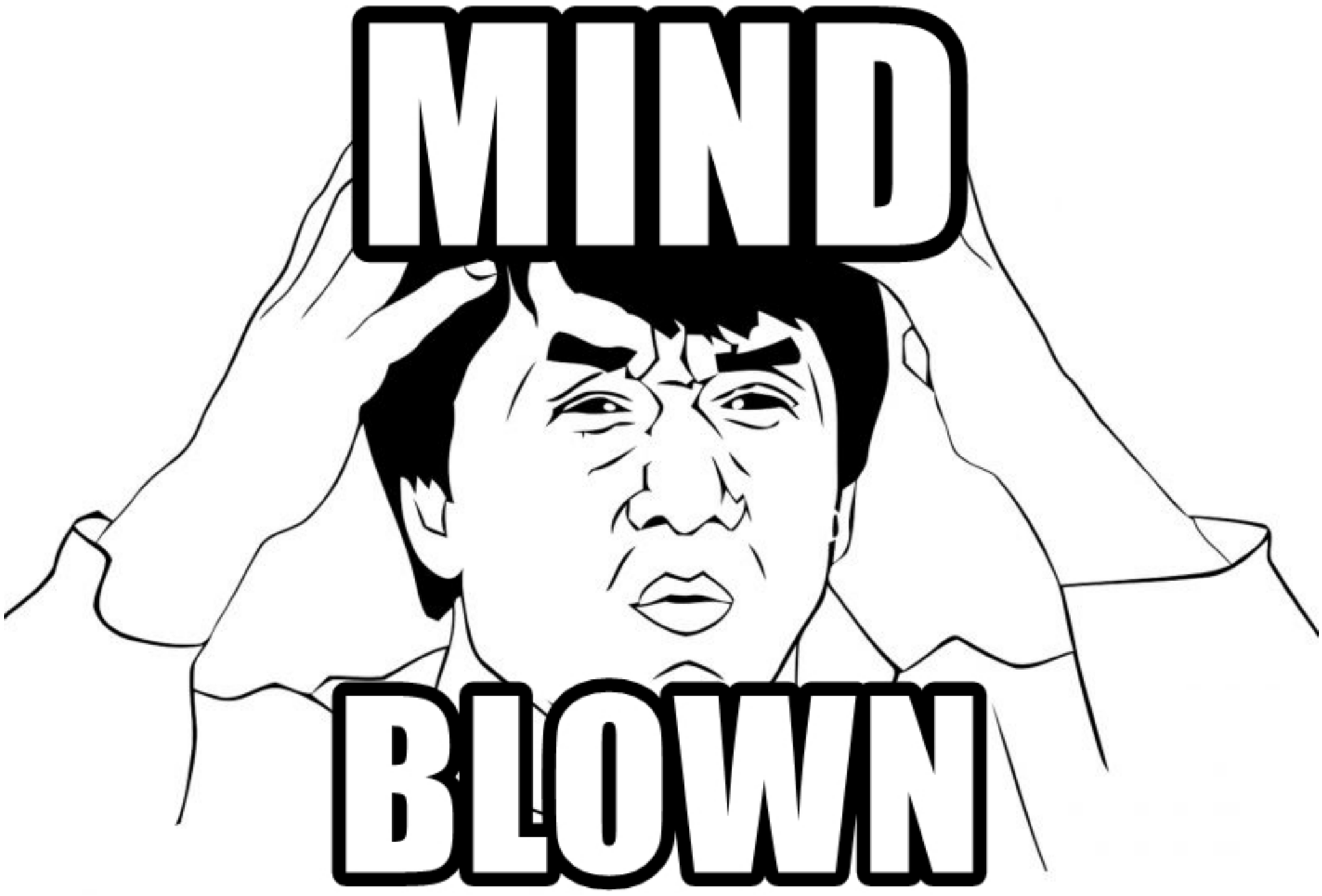
Whats the chance that the sum is more than 155?

Normal Approximation

1. **Draw a picture!**
    i. **bell curve**
    ii. **label values**
    iii. **shade area of interest**
2. **Convert to standard units (use expected value instead of average and standard error instead of SD).**
3. **Use rules.**
    i. **normal table (p. A-104)**
    ii. **100%**
    iii. **symmetric**


140
155
expected value
point of interest

As long as the number of draws is sufficiently large,
the sum follows the normal curve.



proof by example

https://carlislerainey.shinyapps.io/box-model/

An App to Repeatedly Execute the Box Model

Box Model: Draw _____ times from the box _____ with replacement and sum the draws.

Number of Draws

10

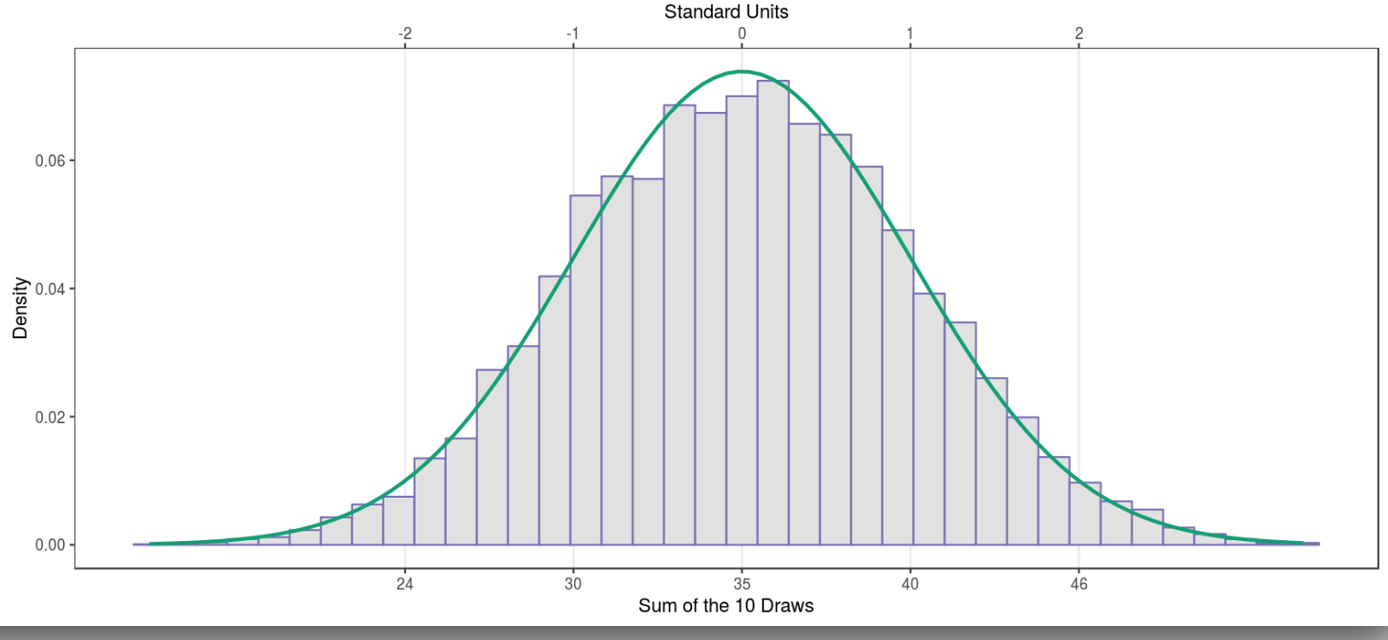
Box (e.g., 1, 2, 2, -14):

1, 2, 3, 4, 5, 6

Quantity	Value
Number of Draws	10
Box	1, 2, 3, 4, 5, 6
Average of Box	3.5
SD of Box	1.71
Expected Value for Sum	35
Standard Error for Sum	5.4

A Histograms of Sums

...if we execute the box model 10,000 times.



Practice Problem I

If I toss a coin 50 times, what's the chance I get more than 30 heads?

Initial guess?

What's the box model?

What's the expected value and standard error?

What's the normal approximation?

draw picture

convert to standard units

use rules

Practice Problem II

Suppose I give an exam with 9 true-false questions. A student isn't well-prepared, so they decide to guess on each.

What's the chance they pass?

Initial guess?

How many correct answer do you need to pass (more than 70%)?

What's the box model?

What's the expected value and standard error?

What's the normal approximation?

draw picture

convert to standard units

use rules