# Two-way Bounding

Ian Ludden

# Learning Objective

By the end of this lesson, you will be able to:

# Learning Objective

By the end of this lesson, you will be able to:

- Understand the difference between an exact result, an upper bound, and a lower bound.

# What is two-way bounding?

# What is two-way bounding?

- Example: How many prime numbers are there between 100 and 1000?

# What is two-way bounding?

- Example: How many prime numbers are there between 100 and 1000?
- Could check all of them and find 143 primes (***exact result***)

# What is two-way bounding?

- Example: How many prime numbers are there between 100 and 1000?
- Could check all of them and find 143 primes (***exact result***)
- Easy ***lower bound***: 1, since we know 173 is prime

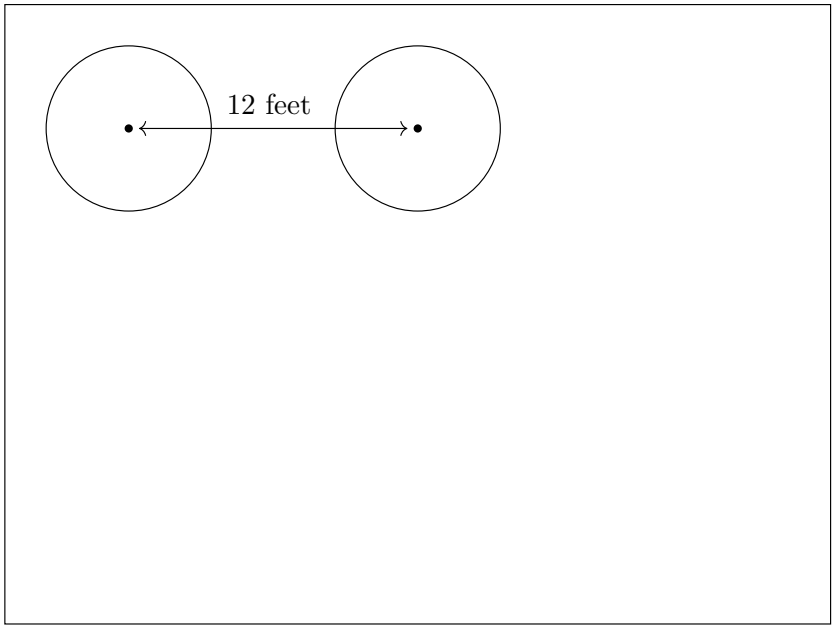
# What is two-way bounding?

- Example: How many prime numbers are there between 100 and 1000?
- Could check all of them and find 143 primes (***exact result***)
- Easy ***lower bound***: 1, since we know 173 is prime
- Easy ***upper bound***: $(1000 - 100)/2 = 450$ (none of the even integers in that range can be prime)

# Example: COVID-19 Restaurant Seating

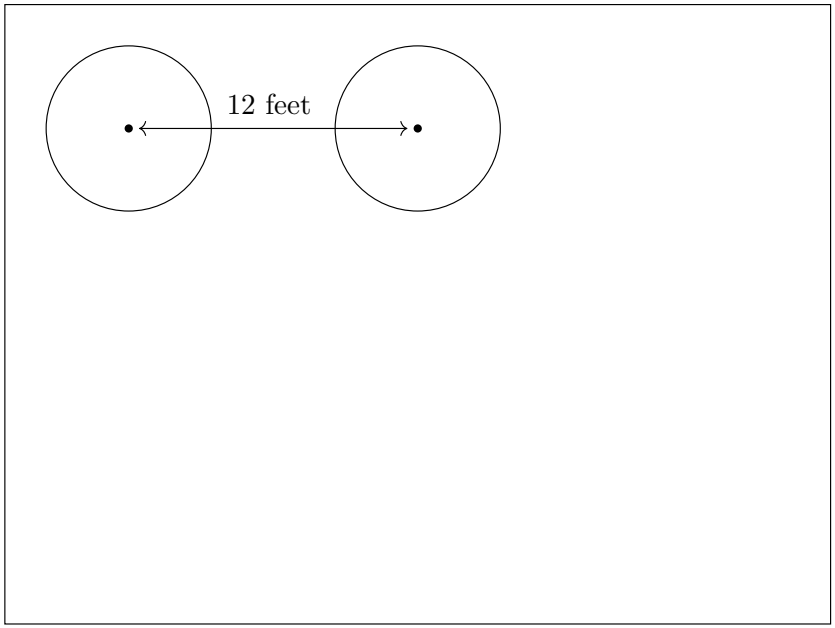
# Example: COVID-19 Restaurant Seating

- Given: rectangle representing restaurant seating area



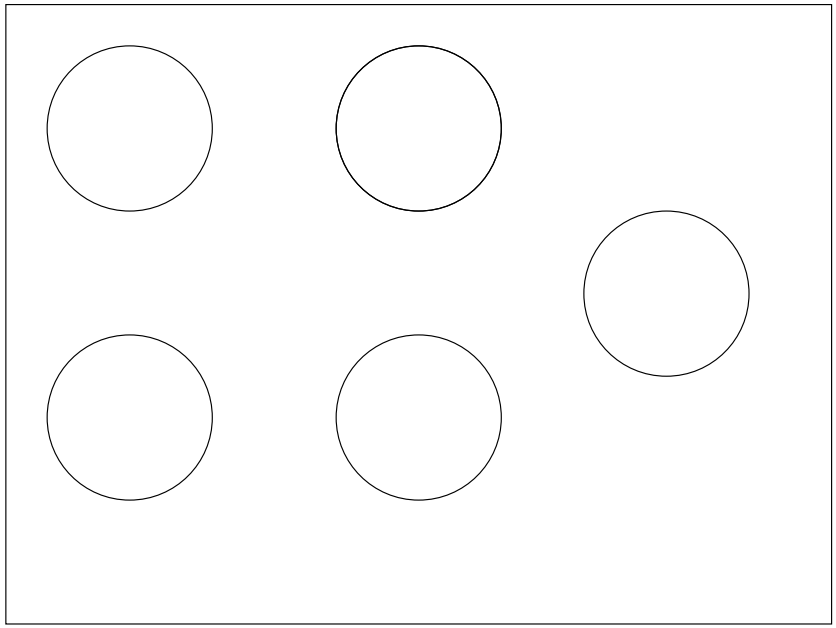
# Example: COVID-19 Restaurant Seating

- Given: rectangle representing restaurant seating area
- Find: $t$, the maximum number of tables possible while complying with CDC physical distancing guidelines



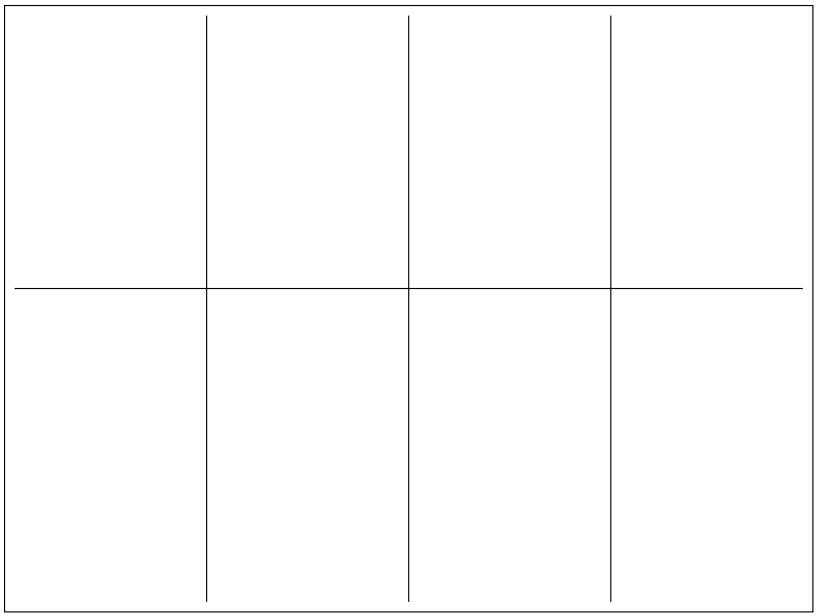
# Example: COVID-19 Restaurant Seating

- Given: rectangle representing restaurant seating area
- Find: $t$, the maximum number of tables possible while complying with CDC physical distancing guidelines



# Example: COVID-19 Restaurant Seating

- Given: rectangle representing restaurant seating area
- Find: $t$, the maximum number of tables possible while complying with CDC physical distancing guidelines



# Example: Moving Boxes

# Example: Moving Boxes

- Given: SUV trunk with dimensions 4.5 ft $\times$ 4 ft $\times$ 3 ft, and 12 identical 20 in. $\times$ 12 in. $\times$ 3 ft moving boxes

# Example: Moving Boxes

- Given: SUV trunk with dimensions 4.5 ft $\times$ 4 ft $\times$ 3 ft, and 12 identical 20 in. $\times$ 12 in. $\times$ 3 ft moving boxes
- Find: $b$, the maximum number of boxes you can move in one trip

# Example: Moving Boxes

- Given: SUV trunk with dimensions 4.5 ft $\times$ 4 ft $\times$ 3 ft, and 12 identical 20 in. $\times$ 12 in. $\times$ 3 ft moving boxes
- Find: $b$, the maximum number of boxes you can move in one trip
- Bound #1: volumes

# Example: Moving Boxes

- Given: SUV trunk with dimensions 4.5 ft $\times$ 4 ft $\times$ 3 ft, and 12 identical 20 in. $\times$ 12 in. $\times$ 3 ft moving boxes
- Find: $b$, the maximum number of boxes you can move in one trip
- Bound #1: volumes
- Bound #2: first attempt at packing

# Recap: Learning Objective

By the end of this lesson, you will be able to:

- Understand the difference between an exact result, an upper bound, and a lower bound.