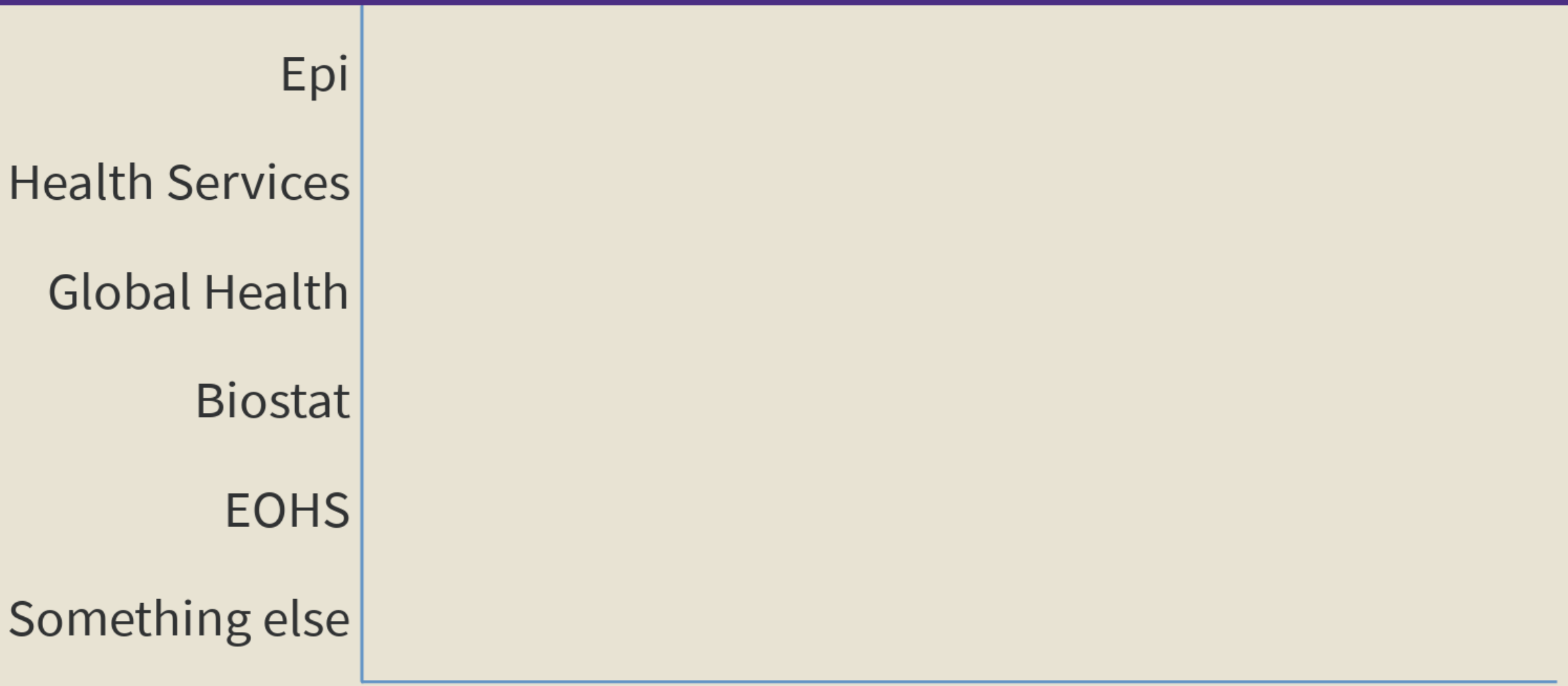
PROPORTIONS

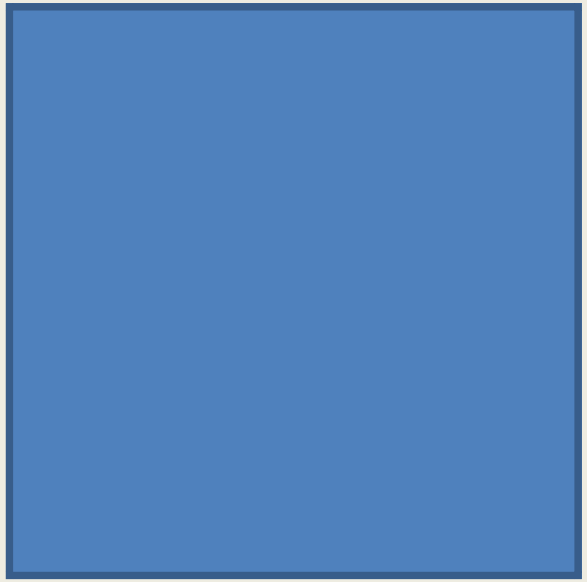
What department are you matriculated in?



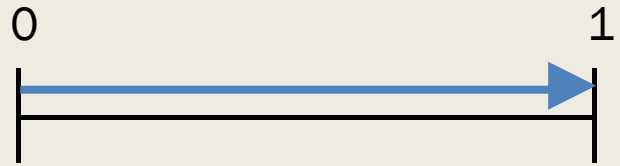
Where is she going with this?

- What is a proportion?
- Fractions
- Other ways we represent and manipulate proportions
- Proportions and other mathematical constructs in epidemiology

What is a proportion?

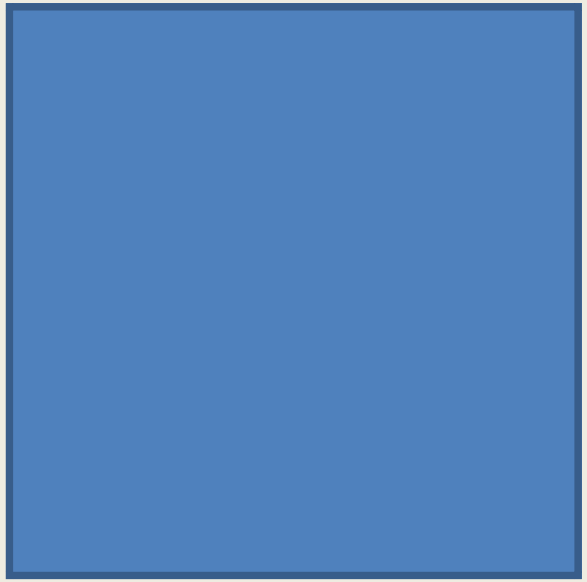


1



What is a proportion?

a part, share, or number considered in comparative relation to a whole



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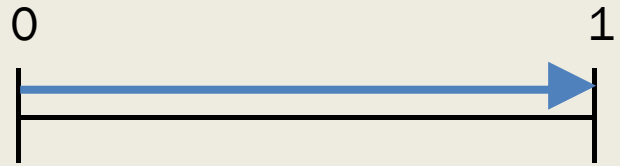

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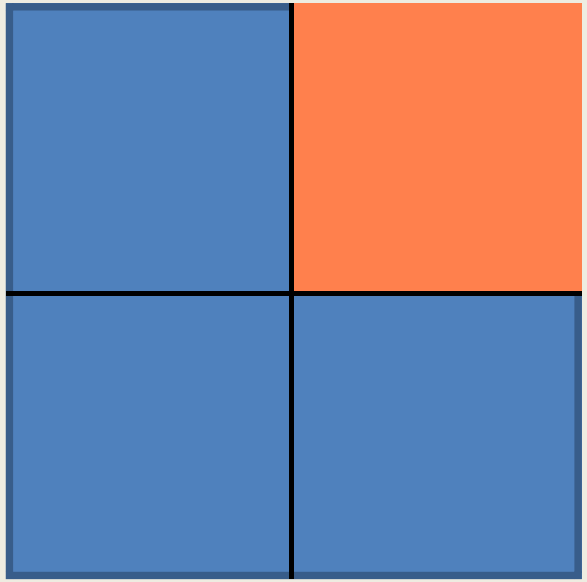
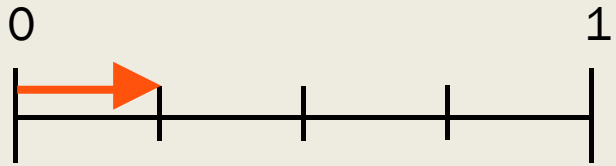
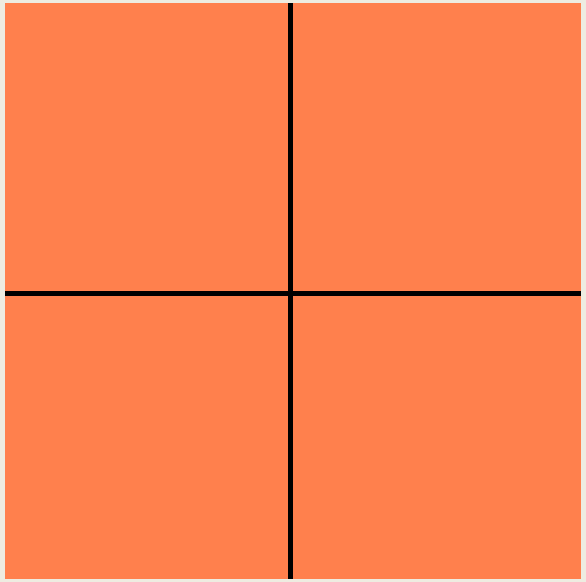


$\frac{1}{4}$



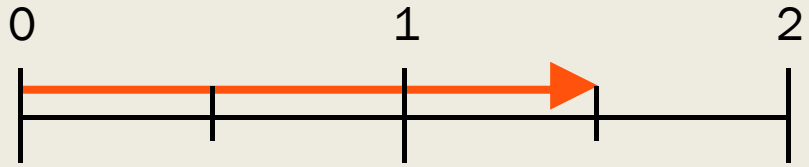
Fractions



$$\frac{4}{4} = 1$$

Fractions

$$2 = \frac{\mathbf{3}}{2}$$



Fraction Terminology

$$\frac{1}{4} = \frac{numerator}{denominator}$$

Manipulating fractions

- Comparing

  [PRO-TIP] Matching denominators will make this easier

- Addition & subtraction

  [RULE] Denominators must match, perform operation on numerators

- Multiplication & division

  [RULE] Numerator and denominator operate separately

Adding & subtracting fractions

- Same denominator? **YES!**
  - *Ignore the denominator, work through the numerator*

$$\frac{2}{8} + \frac{5}{8}$$

Adding & subtracting fractions

- Same denominator? **YES!**
  - *Ignore the denominator, work through the numerator*

$$\frac{2}{8}+\frac{5}{8}=\frac{7}{8}$$

Adding & subtracting fractions

- Same denominator? **YES!**
  - *Ignore the denominator, work through the numerator*

$$\frac{2}{8}+\frac{5}{8}=\frac{7}{8}$$

$$\frac{3}{5}+\frac{4}{5}=\frac{7}{5}=1\frac{2}{5}$$

Adding & subtracting fractions

- Same denominator? **YES!**
  - *Ignore the denominator, work through the numerator*

$$\frac{2}{8}+\frac{5}{8}=\frac{7}{8}$$

$$\frac{3}{5}+\frac{4}{5}=\frac{7}{5}=1\frac{2}{5}$$

$$\frac{10}{12}-\frac{4}{12}=\frac{6}{12}=\frac{1}{2}$$

Adding & subtracting fractions

- Same denominator? NO!

$$\frac{3}{4}+\frac{5}{6}$$

Adding & subtracting fractions

- Same denominator? **NO!**
  1. *Find the least common denominator*

$$\frac{3}{4}+\frac{5}{6}$$

Adding & subtracting fractions

- Same denominator? NO!
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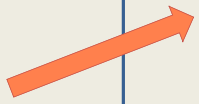


Least Common Multiple

$$\frac{3}{4}+\frac{5}{6}$$

Adding & subtracting fractions

- Same denominator? **NO!**
  1. *Find the least common denominator*

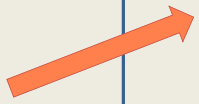
Least Common Multiple

4: 4, 8, 12, 16, 20…
6: 6, 12, 18, 24, 30…

$$\frac{3}{4}+\frac{5}{6}$$

Adding & subtracting fractions

- Same denominator? **NO!**
  1. *Find the least common denominator*



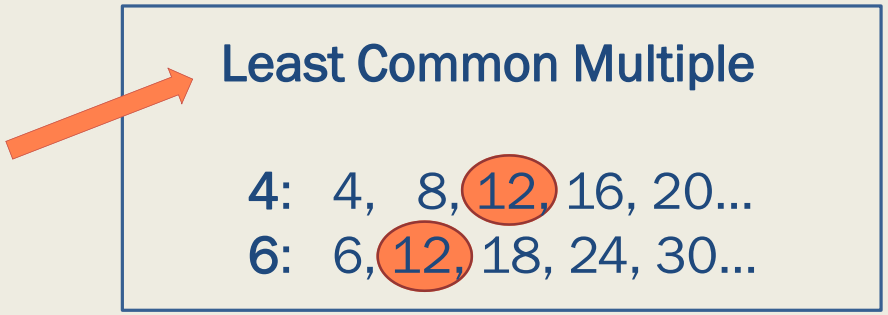
Least Common Multiple

4: 4, 8, 12, 16, 20…
6: 6, 12, 18, 24, 30…

$$\frac{3}{4}+\frac{5}{6}$$

Adding & subtracting fractions

- Same denominator? **NO!**
  1. *Find the least common denominator*
  2. *Convert fractions*



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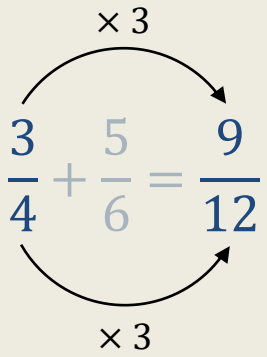


Adding & subtracting fractions

- Same denominator? **NO!**
  1. *Find the least common denominator*
  2. *Convert fractions*

Least Common Multiple

4: 4, 8, 12, 16, 20…
6: 6, 12, 18, 24, 30…

$$\frac{3}{4} + \frac{5}{6} = \frac{9}{12} + \frac{10}{12} =$$

$\times 2$ $\times 2$

Adding & subtracting fractions

- Same denominator? **NO!**
  1. *Find the least common denominator*
  2. *Convert fractions*
  3. *Add (or subtract or compare) as usual*

Least Common Multiple

4: 4, 8, 12, 16, 20…
6: 6, 12, 18, 24, 30…

$$\frac{3}{4}+\frac{5}{6}=\frac{9}{12}+\frac{10}{12}=\frac{19}{12}$$

Adding & subtracting fractions

- Same denominator? **NO!**
  1. *Find the least common denominator*
  2. *Convert fractions*
  3. *Add (or subtract or compare) as usual*

Least Common Multiple

4: 4, 8, 12, 16, 20…
6: 6, 12, 18, 24, 30…

$$\frac{3}{4}+\frac{5}{6}=\frac{9}{12}+\frac{10}{12}=\frac{19}{12}=1\frac{7}{12}$$

Adding & subtracting fractions

- Same denominator?

$$\frac{3}{7}+\frac{2}{3}$$

Adding & subtracting fractions

- Same denominator? NO!

$$\frac{3}{7}+\frac{2}{3}$$

Adding & subtracting fractions

- Same denominator? NO!
  1. *Find the least common denominator*

Least Common Multiple

7: 7, 14, 21, 28, 35…
3: 3, 6, 9, 12, 15, 18, 21…

$$\frac{3}{7}+\frac{2}{3}$$

Adding & subtracting fractions

- Same denominator? NO!
  1. *Find the least common denominator*

Least Common Multiple

7: 7, 14, 21, 28, 35…
3: 3, 6, 9, 12, 15, 18, 21…

$$\frac{3}{7}+\frac{2}{3}$$

Adding & subtracting fractions

- Same denominator? NO!
  1. *Find the least common denominator*
  2. *Convert fractions*

Least Common Multiple

7: 7, 14, 21, 28, 35…
3: 3, 6, 9, 12, 15, 18, 21…

$$\frac{3}{7}+\frac{2}{3}=\frac{9}{21}+\frac{14}{21}$$

Adding & subtracting fractions

- Same denominator? NO!
  1. *Find the least common denominator*
  2. *Convert fractions*
  3. *Add (or subtract or compare) as usual*

Least Common Multiple

7: 7, 14, 21, 28, 35…
3: 3, 6, 9, 12, 15, 18, 21…

$$\frac{3}{7}+\frac{2}{3}=\frac{9}{21}+\frac{14}{21}=\frac{23}{21}=1\frac{2}{21}$$

Adding & subtracting fractions

- Same denominator?

$$-\frac{3}{7}-\left(-\frac{4}{4}\right)$$

Adding & subtracting fractions

- Same denominator? NO!
  1. *Find the least common denominator*

Least Common Multiple

7: 7, 14, 21, 28, 35…
4: 4, 8, 12, 16, 20, 24, 28…

$$-\frac{3}{7}-\left(-\frac{4}{4}\right)$$

Adding & subtracting fractions

- Same denominator? NO!
  1. *Find the least common denominator*
  2. *Convert fractions*

Least Common Multiple

7: 7, 14, 21, 28, 35…
4: 4, 8, 12, 16, 20, 24, 28…

$$-\frac{3}{7}-\left(-\frac{4}{4}\right)=-\frac{12}{28}-\left(-\frac{7}{28}\right)$$

Adding & subtracting fractions

- Same denominator? NO!
  1. *Find the least common denominator*
  2. *Convert fractions*
  3. *Add (or subtract or compare) as usual*

Least Common Multiple

7: 7, 14, 21, 28, 35…
4: 4, 8, 12, 16, 20, 24, 28…

$$-\frac{3}{7}-\left(-\frac{4}{4}\right)=-\frac{12}{28}-\left(-\frac{7}{28}\right)=-\frac{12}{28}+\frac{7}{28}=-\frac{5}{28}=\frac{23}{21}=1\frac{2}{21}$$

YOUR TURN

1. $1\frac{1}{3} - \frac{2}{3}$

2. $\frac{1}{6} \; ? \; \frac{2}{9}$

3. $\frac{3}{4} - \frac{1}{3}$

SOLUTION

1. $1\frac{1}{3} - \frac{2}{3} = \frac{4}{3} - \frac{2}{3} = \frac{2}{3}$

2. $\frac{1}{6} \; ? \; \frac{2}{9}$

3. $\frac{3}{4} - \frac{1}{3}$

SOLUTION

1. $1\frac{1}{3} - \frac{2}{3} = \frac{4}{3} - \frac{2}{3} = \frac{2}{3}$

2. $\frac{1}{6} \; ? \; \frac{2}{9} \rightarrow \frac{3}{18} \; ? \; \frac{4}{18} \rightarrow \frac{3}{18} < \frac{4}{18}$

3. $\frac{3}{4} - \frac{1}{3}$

SOLUTION

1. $1\frac{1}{3} - \frac{2}{3} = \frac{4}{3} - \frac{2}{3} = \frac{2}{3}$

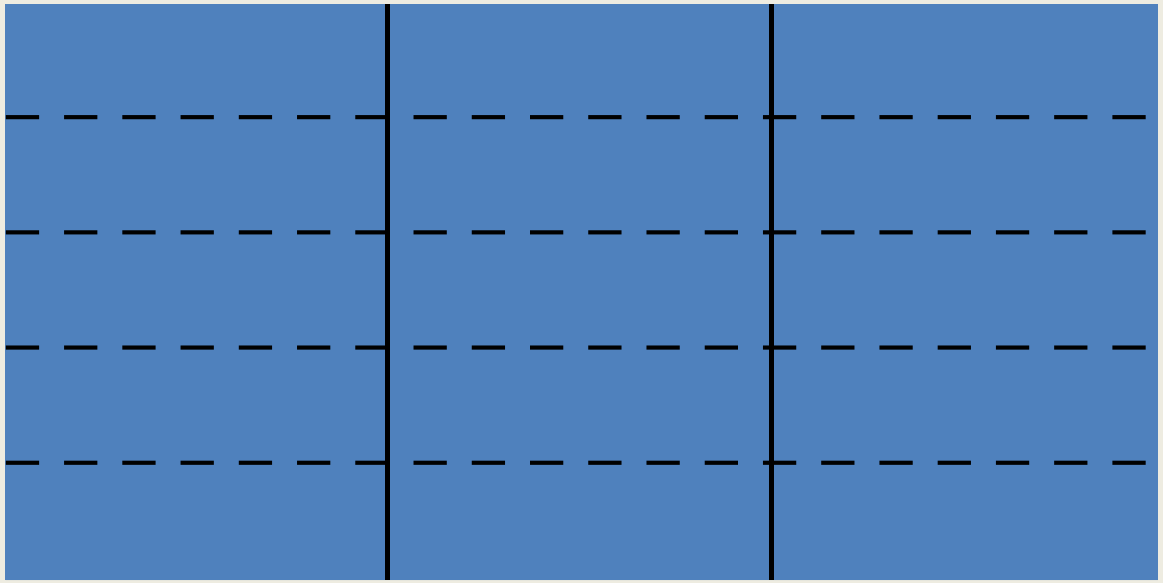
2. $\frac{1}{6} \; ? \; \frac{2}{9} \rightarrow \frac{3}{18} \; ? \; \frac{4}{18} \rightarrow \frac{3}{18} < \frac{4}{18}$

3. $\frac{3}{4} - \frac{1}{3} = \frac{9}{12} - \frac{4}{12} = \frac{5}{12}$

Multiplying Fractions

- Numerator by numerator, denominator by denominator

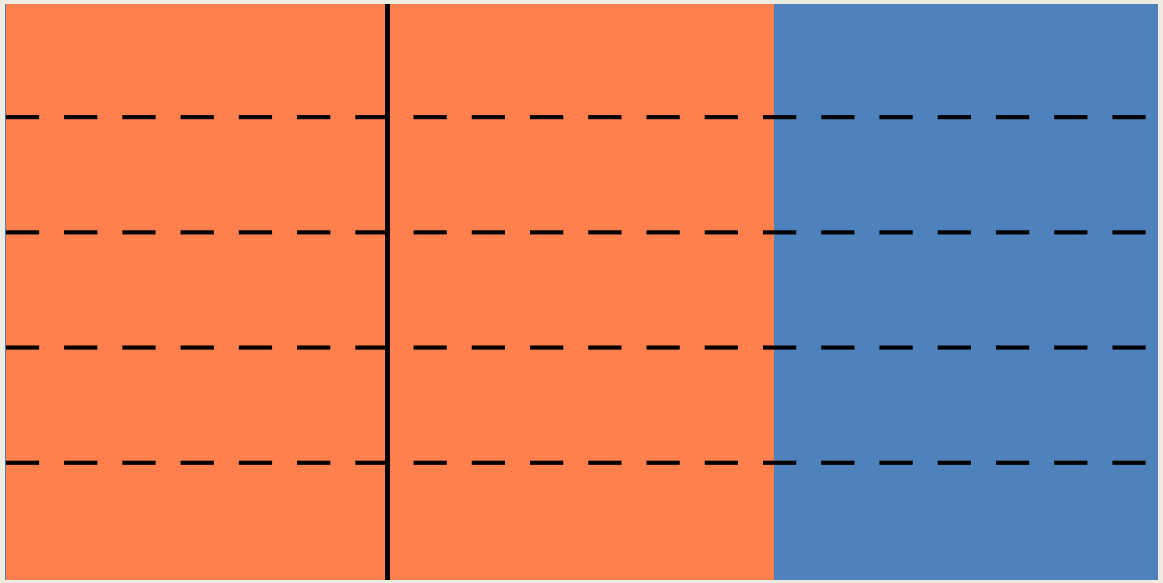
$$\frac{2}{3} \times \frac{2}{5} = ?$$



Multiplying Fractions

- Numerator by numerator, denominator by denominator

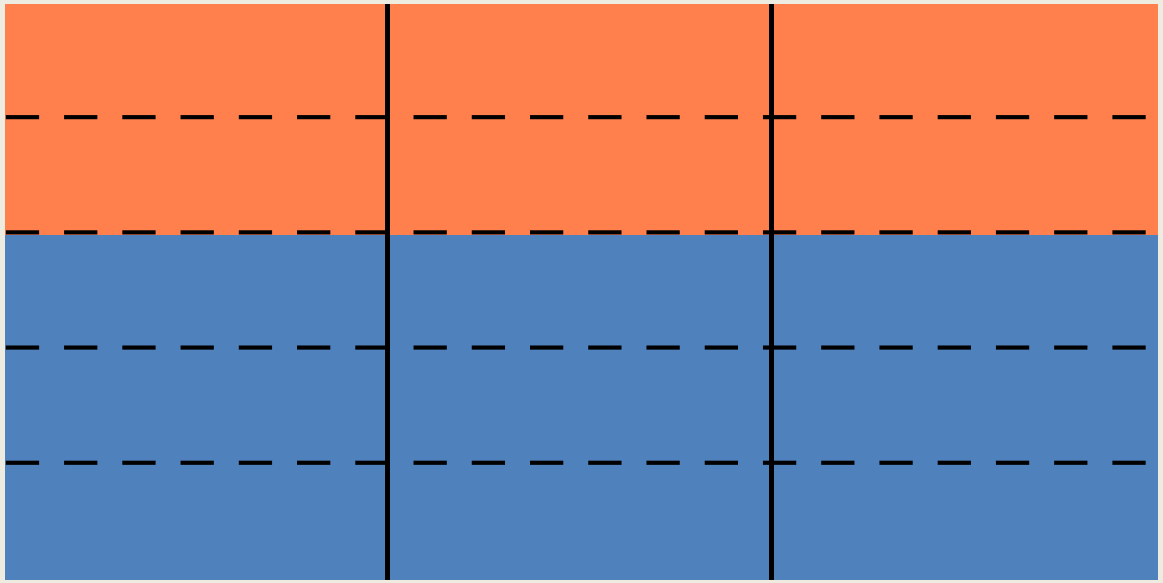
$$\frac{2}{3} \times \frac{2}{5} = ?$$



Multiplying Fractions

- Numerator by numerator, denominator by denominator

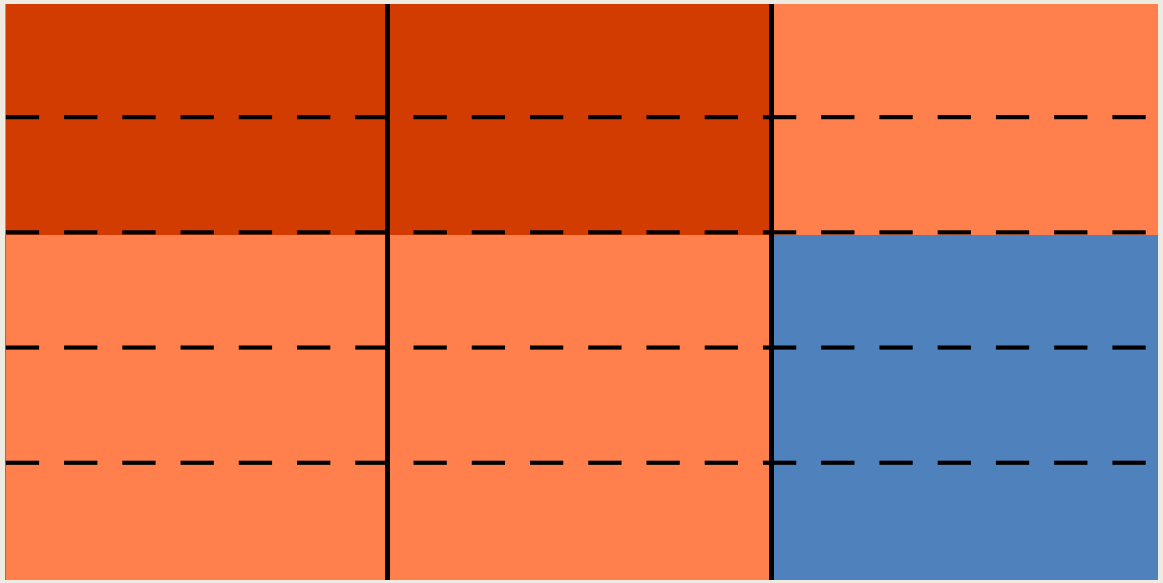
$\frac{2}{3} \times \frac{\mathbf{2}}{\mathbf{5}} = ?$



Multiplying Fractions

- Numerator by numerator, denominator by denominator

$$\frac{2}{3} \times \frac{2}{5} = \frac{4}{15}$$



Multiplying Fractions

- Numerator by numerator, denominator by denominator

$$\frac{2}{3} \times \frac{2}{5} = \frac{2 \times 2}{3 \times 5} = \frac{4}{15}$$

YOUR TURN

$\frac{3}{4} \times \frac{4}{5} =$

$\frac{7}{8} \times \frac{5}{6} =$

Multiplying fractions

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SOLUTION

$$\frac{3}{4} \times \frac{4}{5} = \frac{12}{20}$$

$$\frac{7}{8} \times \frac{5}{6} =$$

SOLUTION

$$\frac{3}{4} \times \frac{4}{5} = \frac{12}{20} = \frac{3}{5}$$

$$\frac{7}{8} \times \frac{5}{6} =$$

SOLUTION

$$\frac{3}{\cancel{4}} \times \frac{\cancel{4}}{5} = \frac{12}{20} = \frac{3}{5}$$ or cross-cancel!

$$\frac{7}{8} \times \frac{5}{6} =$$

SOLUTION

$$\frac{3}{4} \times \frac{4}{5} = \frac{12}{20} = \frac{3}{5}$$

$$\frac{7}{8} \times \frac{5}{6} = \frac{35}{48}$$

Dividing Fractions

- Multiply by the reciprocal

$$\frac{\frac{4}{5}}{\frac{2}{3}}$$

Dividing Fractions

- Multiply by the reciprocal

$$\frac{\frac{4}{5}}{\frac{2}{3}} = \frac{4}{5} \div \frac{2}{3}$$

Dividing Fractions

- Multiply by the reciprocal

$$\frac{\frac{4}{5}}{\frac{2}{3}} = \frac{4}{5} \div \frac{2}{3} = \frac{4}{5} \times \frac{3}{2}$$

Dividing Fractions

- Multiply by the reciprocal

$$\frac{\frac{4}{5}}{\frac{2}{3}} = \frac{4}{5} \div \frac{2}{3} = \frac{4}{5} \times \frac{3}{2} = \frac{12}{10}$$

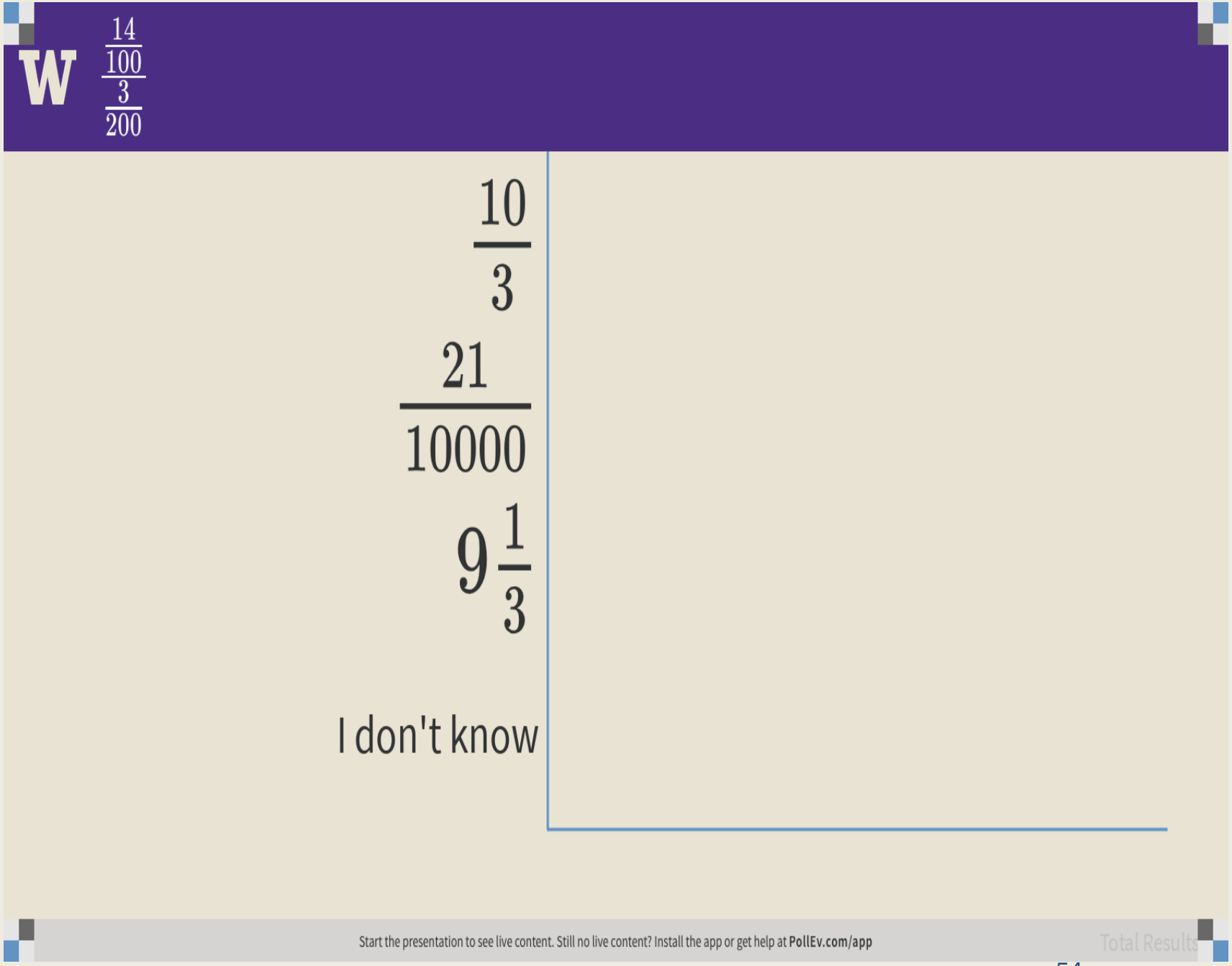
Dividing Fractions

- Multiply by the reciprocal

$$\frac{\frac{4}{5}}{\frac{2}{3}} = \frac{4}{5} \div \frac{2}{3} = \frac{4}{5} \times \frac{3}{2} = \frac{12}{10} = 1\frac{1}{5}$$

YOU TRY

$$\frac{\frac{14}{100}}{\frac{3}{200}}$$



SOLUTION

$$\frac{\frac{14}{100}}{\frac{3}{200}} = \frac{14}{100} \times \frac{200}{3} = \frac{2800}{300} = \frac{28}{3} = 9\frac{1}{3}$$

REMINDER: Don’t do this!

$$\frac{3}{4}+\frac{5}{6}\neq\frac{3+5}{4+6}$$

$$1\frac{7}{12}\neq\frac{8}{12}$$

$$\frac{3}{4a}+\frac{4}{5b}\neq\frac{7}{4a+5b}$$

$$\frac{X}{Y}+\frac{X}{Z}\neq\frac{X}{Y+Z}$$

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Where is she going with this?

- What is a proportion? ✓
- Fractions ✓
- Other ways represent and manipulate proportions
- Proportions and other mathematical constructs in epidemiology

Other ways to represent proportions

- Percentage
  - *Just a fraction with a denominator equal to 100*

$$\frac{1}{4} = \frac{25}{100} = 25\% \qquad \frac{3}{2} = \frac{150}{100} = 150\%$$

- Decimal
  - *Just a percentage rendered on the number line*

$$\frac{1}{4} = \frac{25}{100} = 0.25 \qquad \frac{3}{2} = \frac{150}{100} = 1.5$$

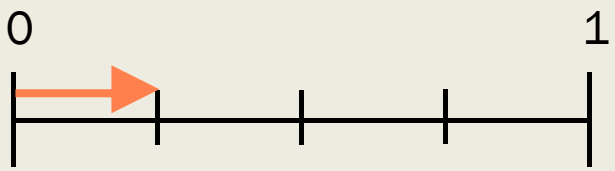
Other ways to represent proportions

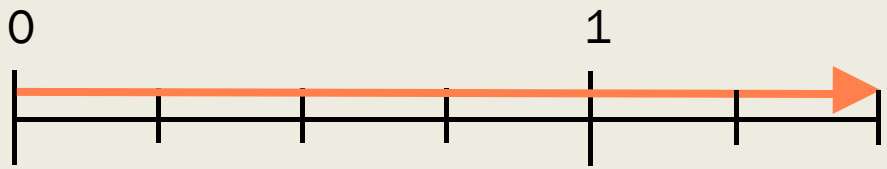
- Percentage
  - *Just a fraction with a denominator equal to 100*

$$\frac{1}{4} = \frac{25}{100} = 25\% \qquad \frac{3}{2} = \frac{150}{100} = 150\%$$

- Decimal
  - *Just 10-based representation for increments less than 1*

$$\frac{1}{4} = \frac{25}{100} = 0.25 \qquad \frac{3}{2} = \frac{150}{100} = 1.5$$





Percentage ←→ Decimal

- Percentage
  - *Just a fraction with a denominator equal to 100*

$$\frac{1}{4} = \frac{25}{100} = 25\% \qquad \frac{3}{2} = \frac{150}{100} = 150\%$$

- Decimal
  - *Just 10-based representation for increments less than 1*

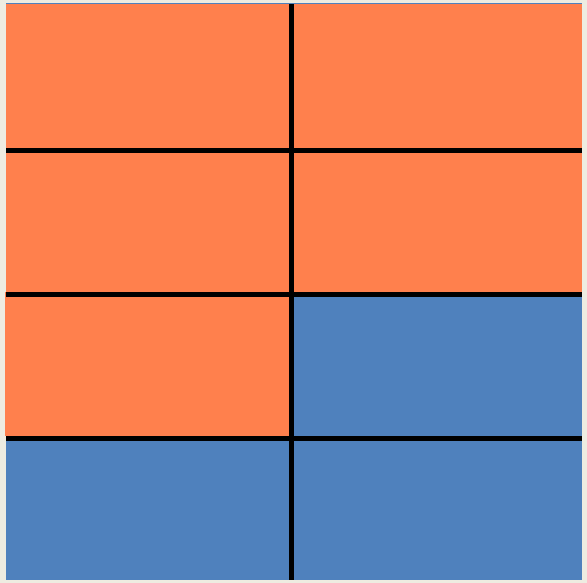
$$\frac{1}{4} = \frac{25}{100} = 0.25 \qquad \frac{3}{2} = \frac{150}{100} = 1.5$$

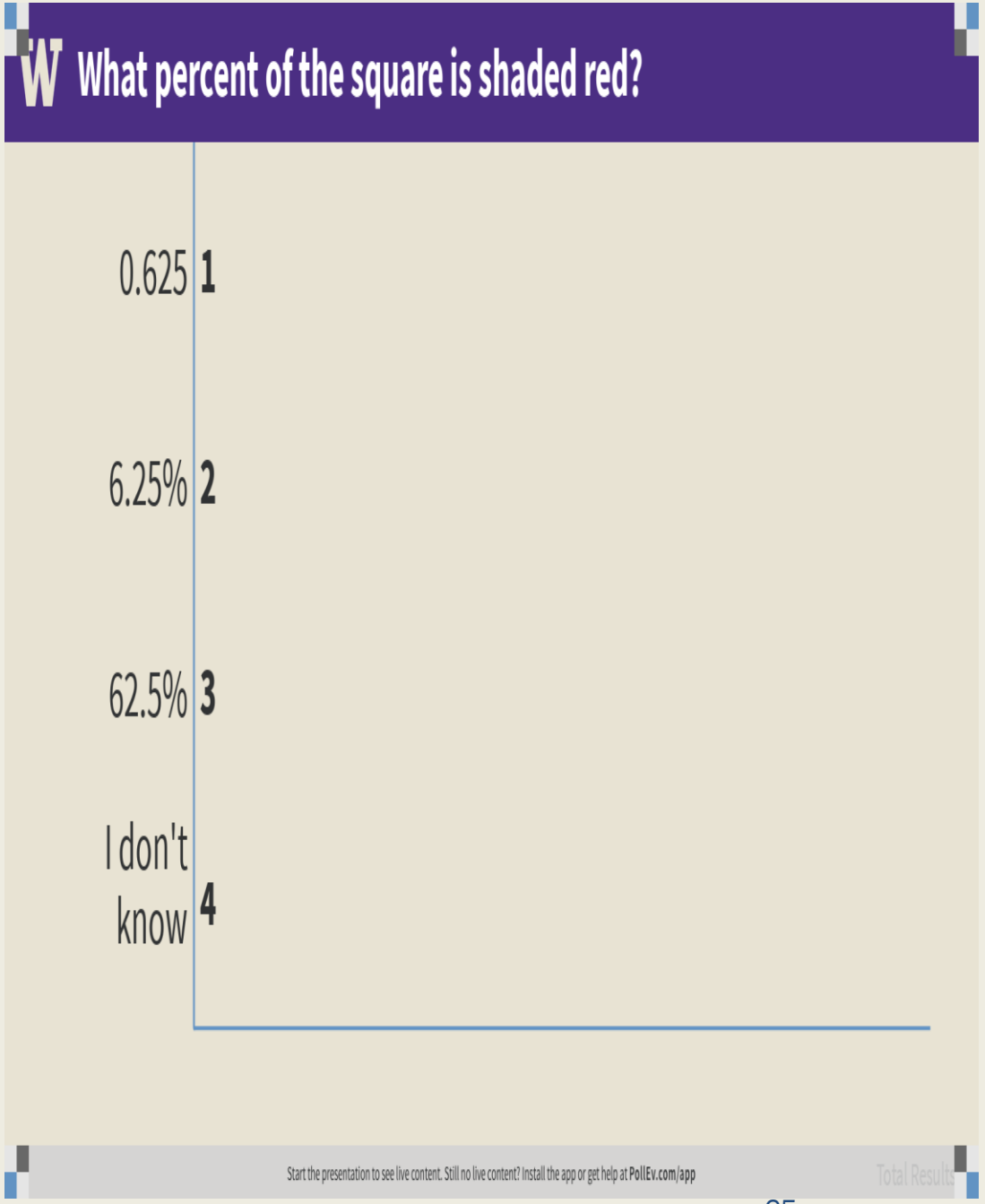
$$0.25 \times \mathbf{100} = 25\%$$

$$1.5 \times \mathbf{100} = 150\%$$

YOUR TURN

- What percent of the square is shaded red?





YOUR TURN

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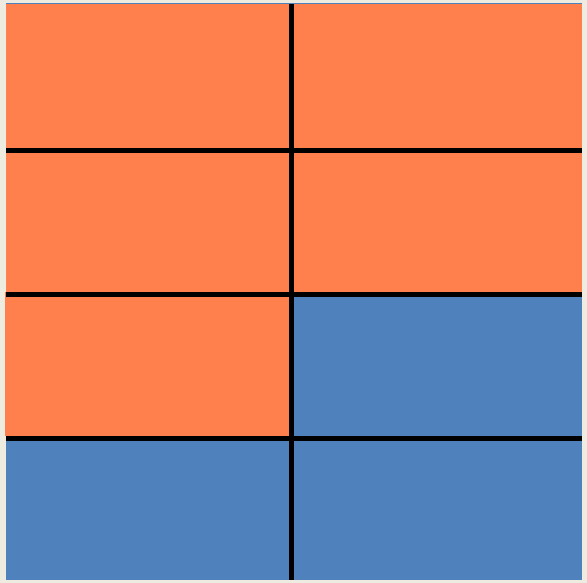
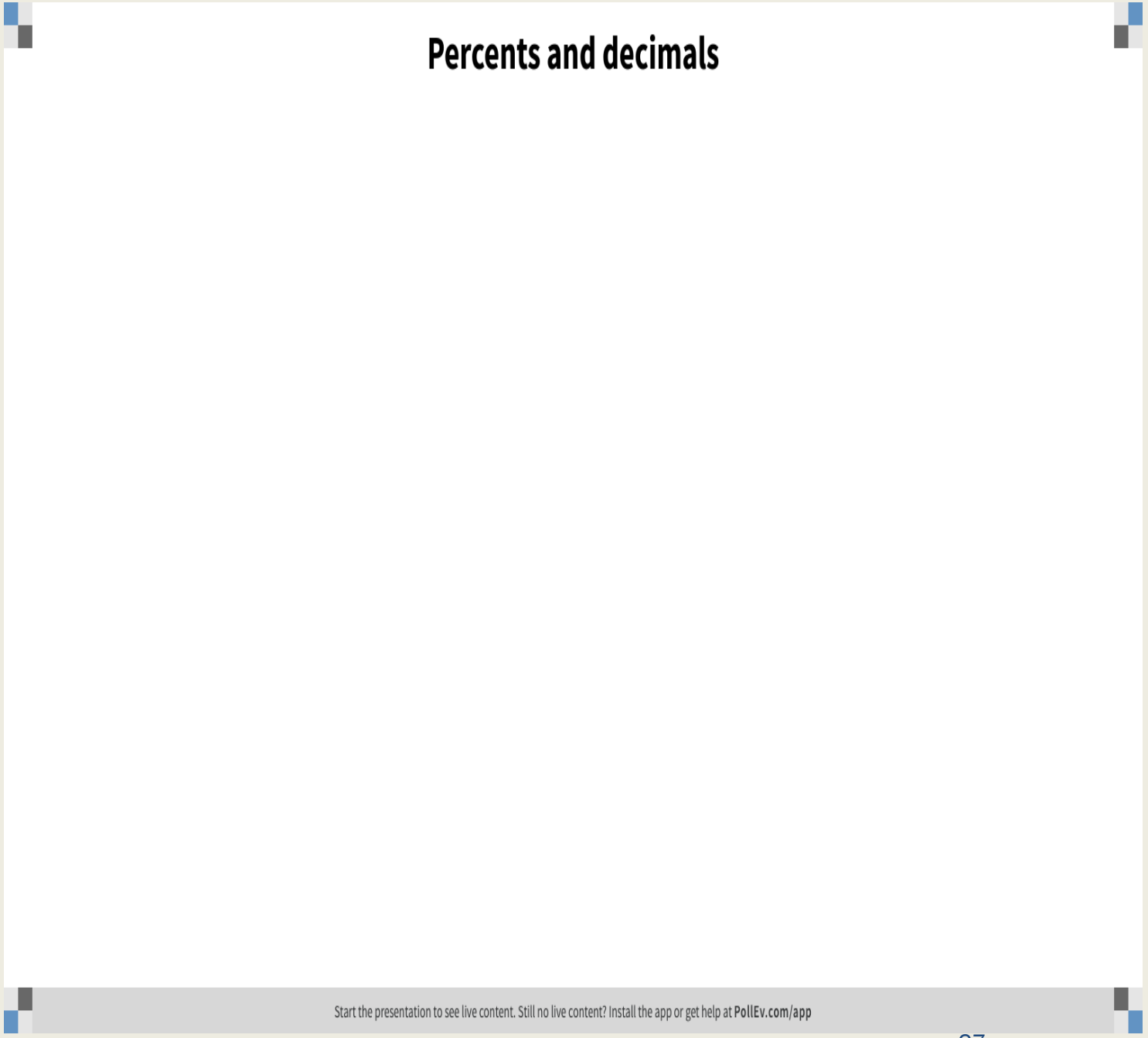


$$\frac{5}{8} = 0.625 = 62.5\%$$

YOUR TURN

1. 12 is what percent of 40?
2. $\frac{0.012}{0.4}$
3. Compare: $0.05 \ ? \ 0.011$
4. Compare: $-0.078 \ ? \ -0.035$



SOLUTION

1. 12 is what percent of 40?

$$\frac{12}{40} = 0.3 = 30\%$$

2. $\frac{0.012}{0.4}$

3. Compare: $0.05 \ ? \ 0.011$

4. Compare: $-0.078 \ ? \ -0.035$

SOLUTION

1. 12 is what percent of 40?

$$\frac{12}{40} = 0.3 = 30\%$$

2. $\frac{0.012}{0.4} = \frac{12}{400} = \frac{3}{100} = 0.03$

3. Compare: 0.05 ? 0.011

4. Compare: -0.078 ? -0.035

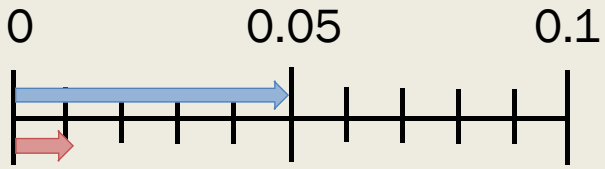
SOLUTION

1. 12 is what percent of 40?

$$\frac{12}{40} = 0.3 = 30\%$$

2. $\frac{0.012}{0.4} = \frac{12}{400} = \frac{3}{100} = 0.03$

3. Compare: 0.05 ? 0.011



4. Compare: -0.078 ? -0.035

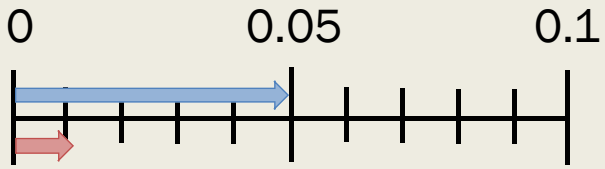
SOLUTION

1. 12 is what percent of 40?

$$\frac{12}{40} = 0.3 = 30\%$$

2. $\frac{0.012}{0.4} = \frac{12}{400} = \frac{3}{100} = 0.03$

3. Compare: $0.05 > 0.011$



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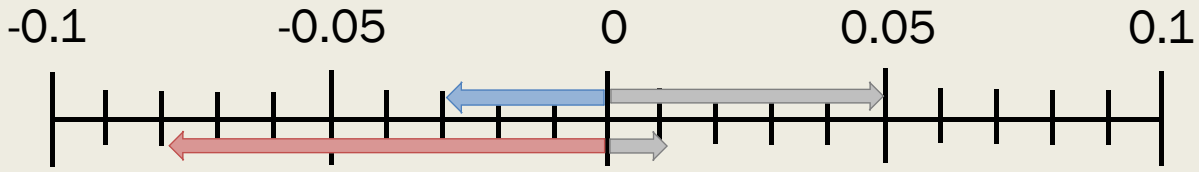

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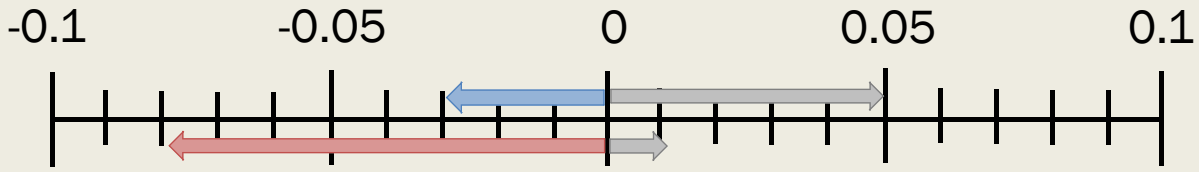

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Mathematical constructs in epi

- Proportion: a part, share, or number considered in comparative relation to a whole
  - *Represented by fraction, percentage or decimal*
  - *These have units!*

  Example: Proportion of deaths due to heart disease, 23.5%
- Rate: a measure, quantity, or frequency measured against some other quantity or measure
  - *Represented by fraction, percentage or decimal*
  - *Usually measuring something in relation to time*

  Example: mortality rate of heart disease, 193 deaths per 100,000 person-years
- Ratio: the relationship of two comparable amounts
  - *Often represented in the form,* number:number (e.g. 3:1)
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  Example: Sex ratio at age 60 is 81 males:100 females

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Extra practice

- Fractions

  https://www.khanacademy.org/math/arithmetic/fraction-arithmetic

- Decimals

  https://www.khanacademy.org/math/arithmetic/arith-decimals

- Relationship of fractions, decimals and percentages

  https://www.khanacademy.org/math/cc-seventh-grade-math/cc-7th-fractions-decimals