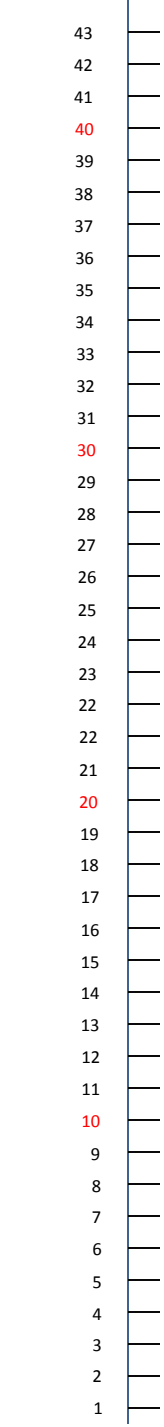
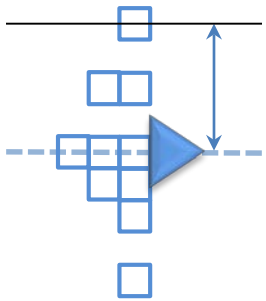
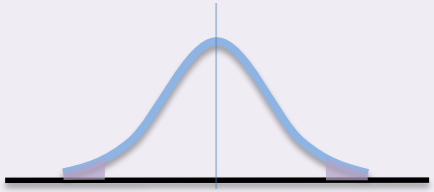




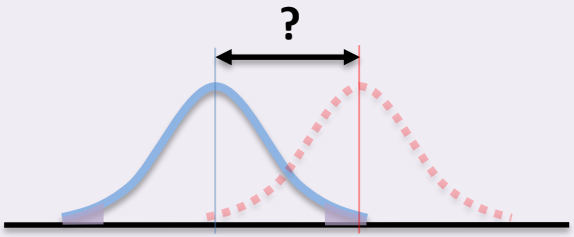
THE SCALE OF THE GUIDE

H_0 :



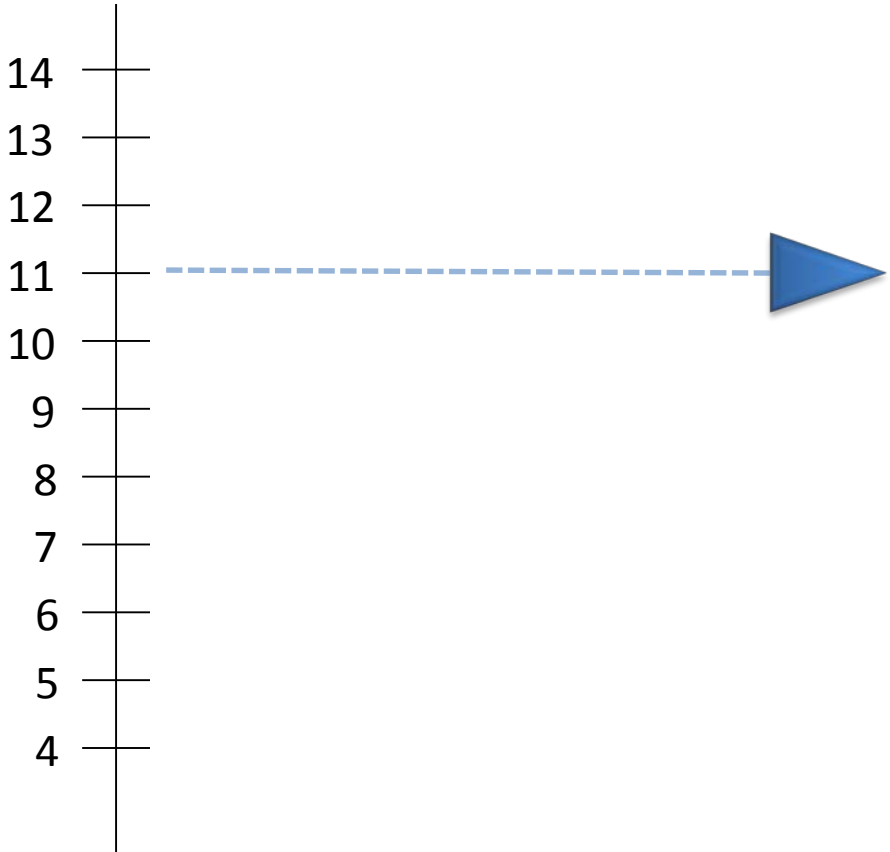
$\mu = 11$
$\sigma = ?$

H_1 :



$\mu = 11$ $\mu = ?$
$\sigma = ?$ $\sigma = ?$

How long do boxer dogs live?



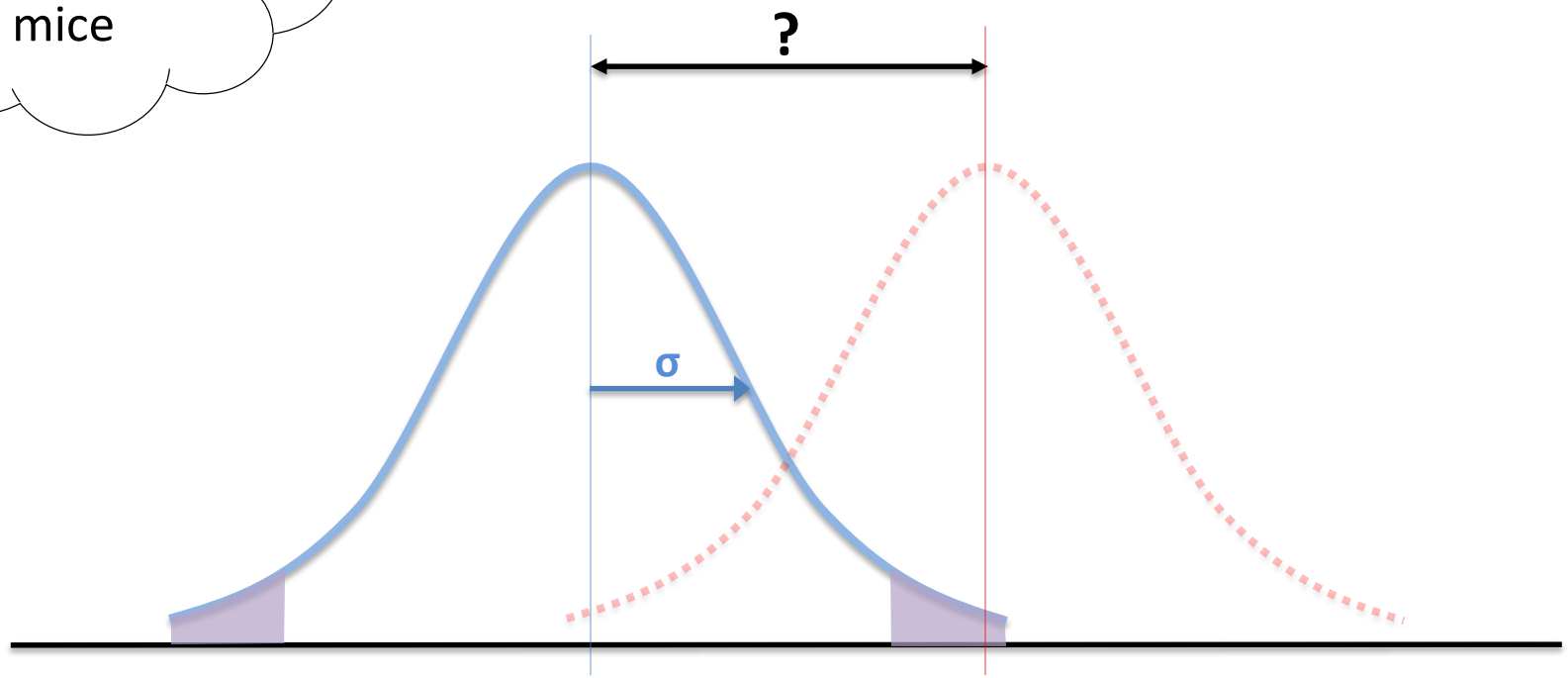
We would like to find out whether boxers differ from the other breeds in longevity. You've heard that dogs live 11 years on average. You ask around and meet 10 people who owned a boxer in the past. Each of them tell you how old was their dog when it died.

Group Comparison with T-tests

Visual Guide

Population of UNTREATED mice

Population is known



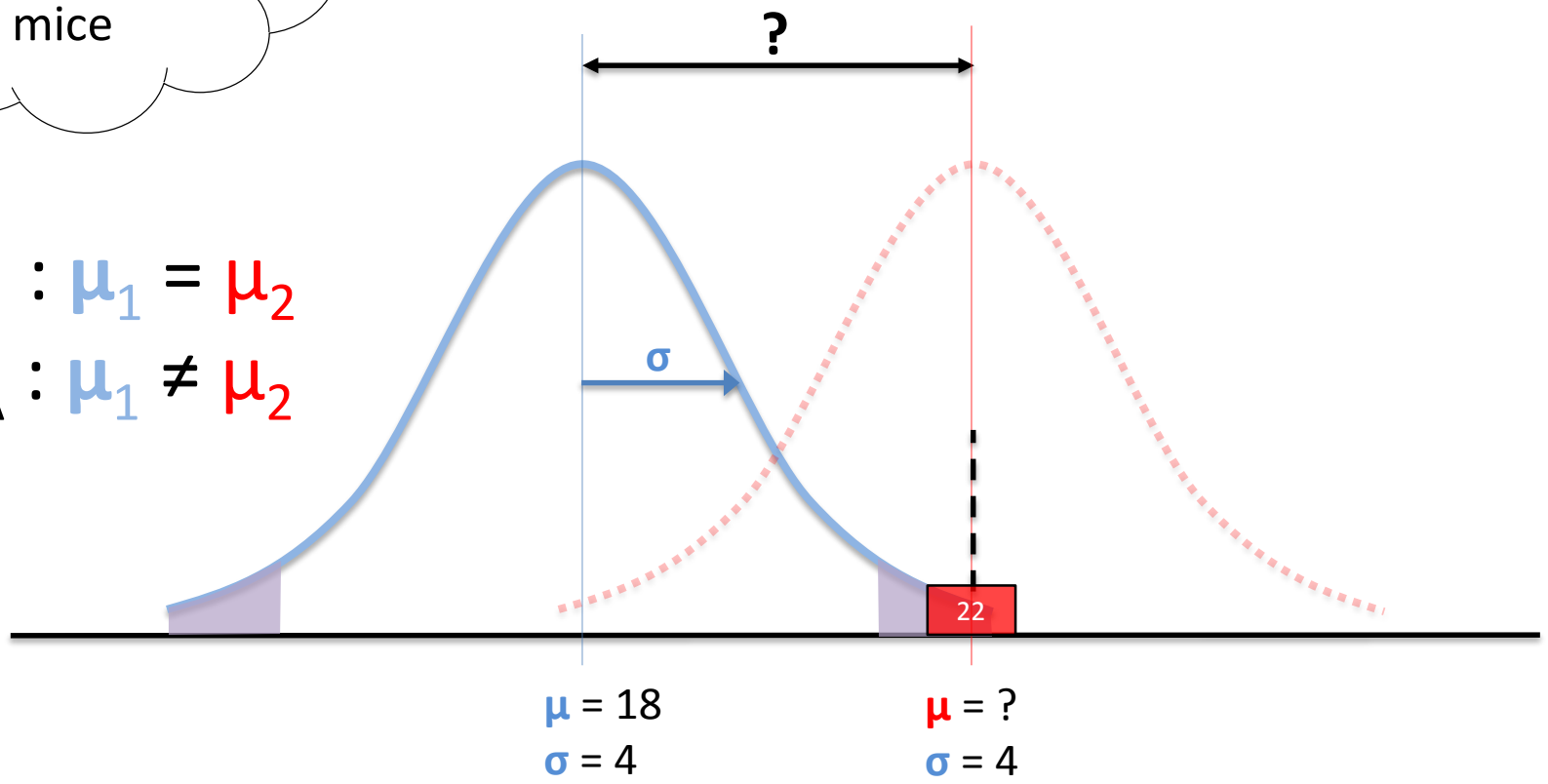
Population of TREATED mice

Population is known

Population of UNTREATED mice

$H_0 : \mu_1 = \mu_2$

$H_A : \mu_1 \neq \mu_2$



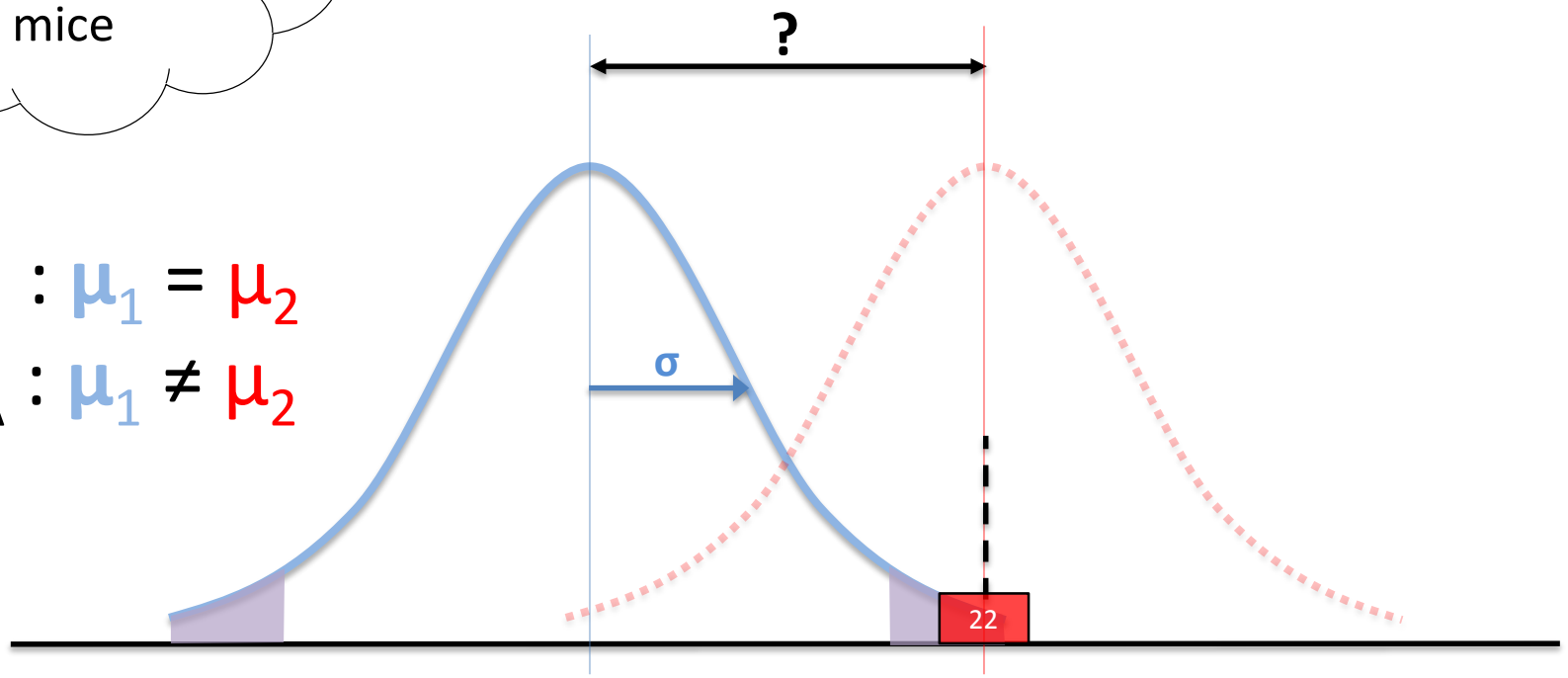
Population of TREATED mice

Population is known

Population of UNTREATED mice

$H_0 : \mu_1 = \mu_2$

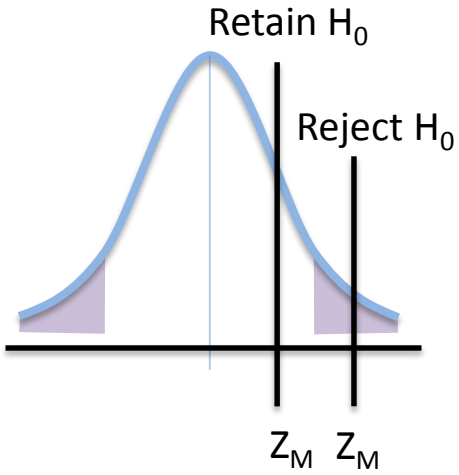
$H_A : \mu_1 \neq \mu_2$



Z-test :

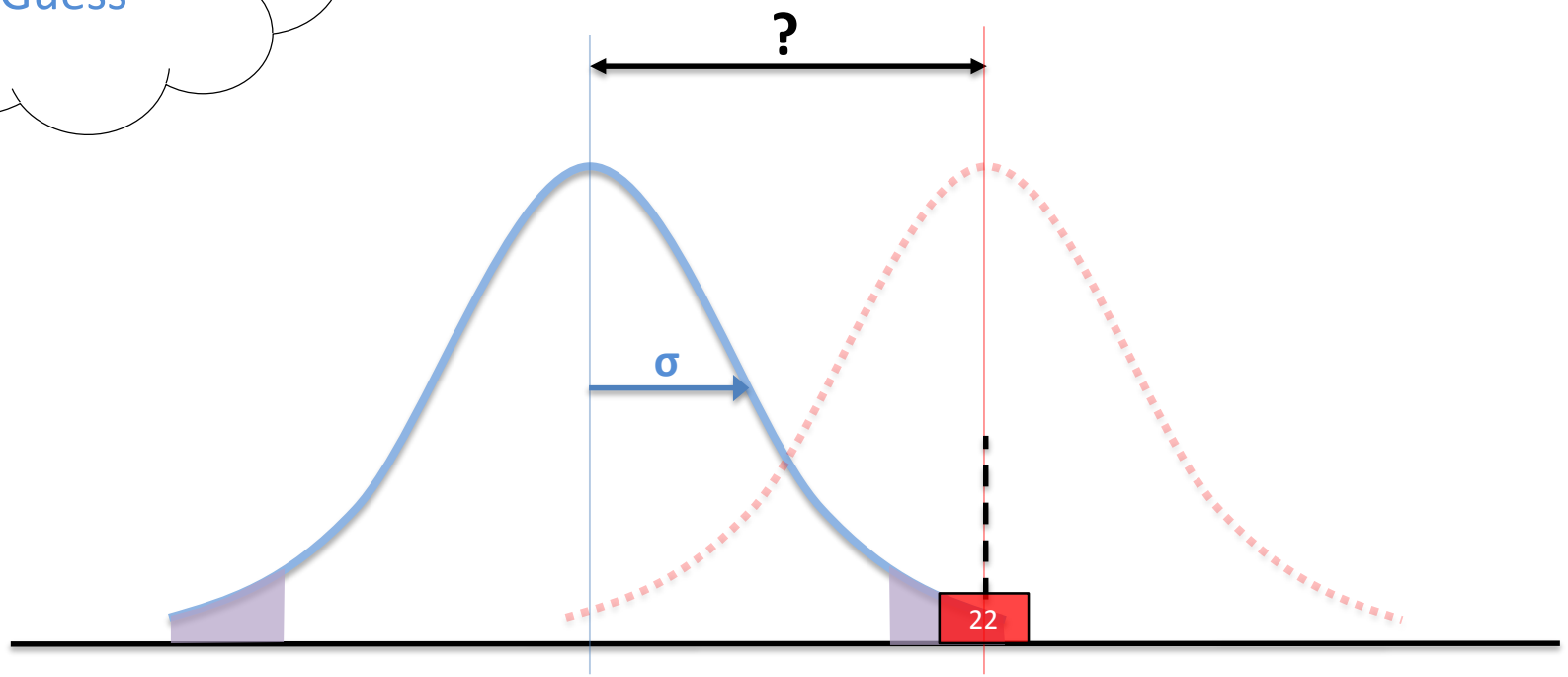
$$Z_M = \frac{M - \mu}{\sigma_M}$$

Population of TREATED mice



Population is **NOT** known

Your best Guess



μ = 18
σ = ?

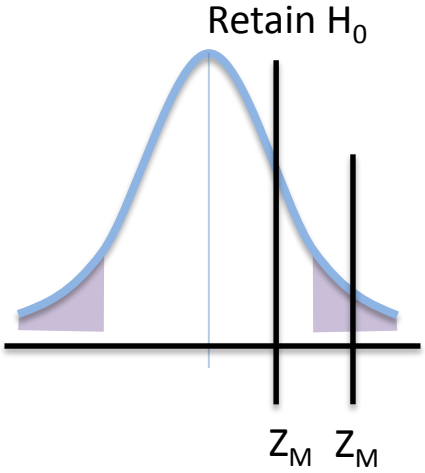
μ = ?
σ = ?

Z-test :

T-test :

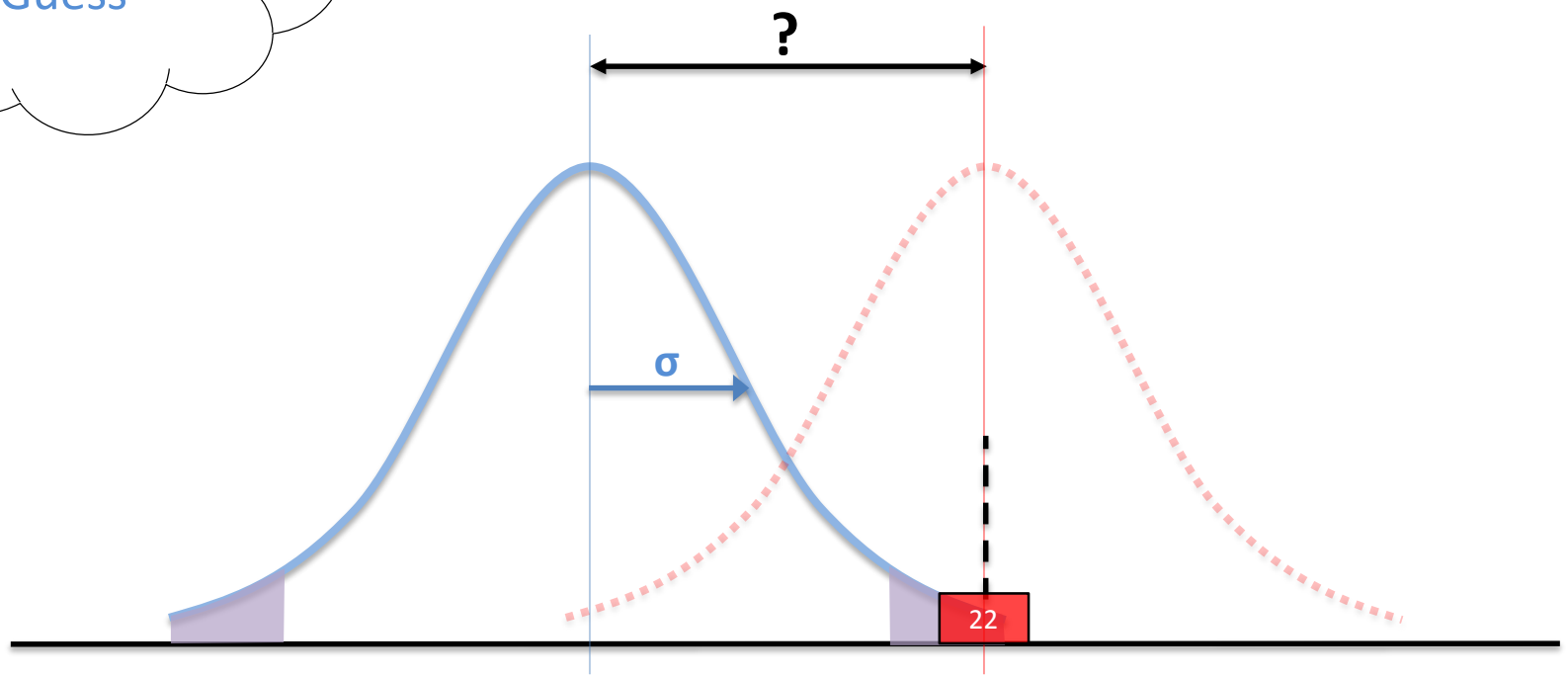
Estimated using sample

$$Z_M = \frac{M - \mu}{\sigma_M} \qquad t = \frac{M - \mu}{s_M}$$



Population is **NOT** known

Your best Guess



μ = 18
σ = ?

μ = ?
σ = ?

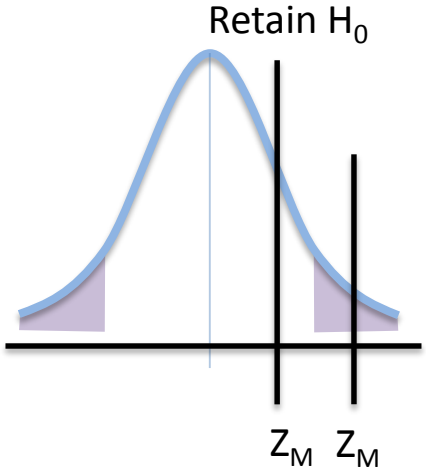
Estimated using sample

Z-test :

$$Z_M = \frac{M - \mu}{\sqrt{\frac{\sigma^2}{n}}}$$

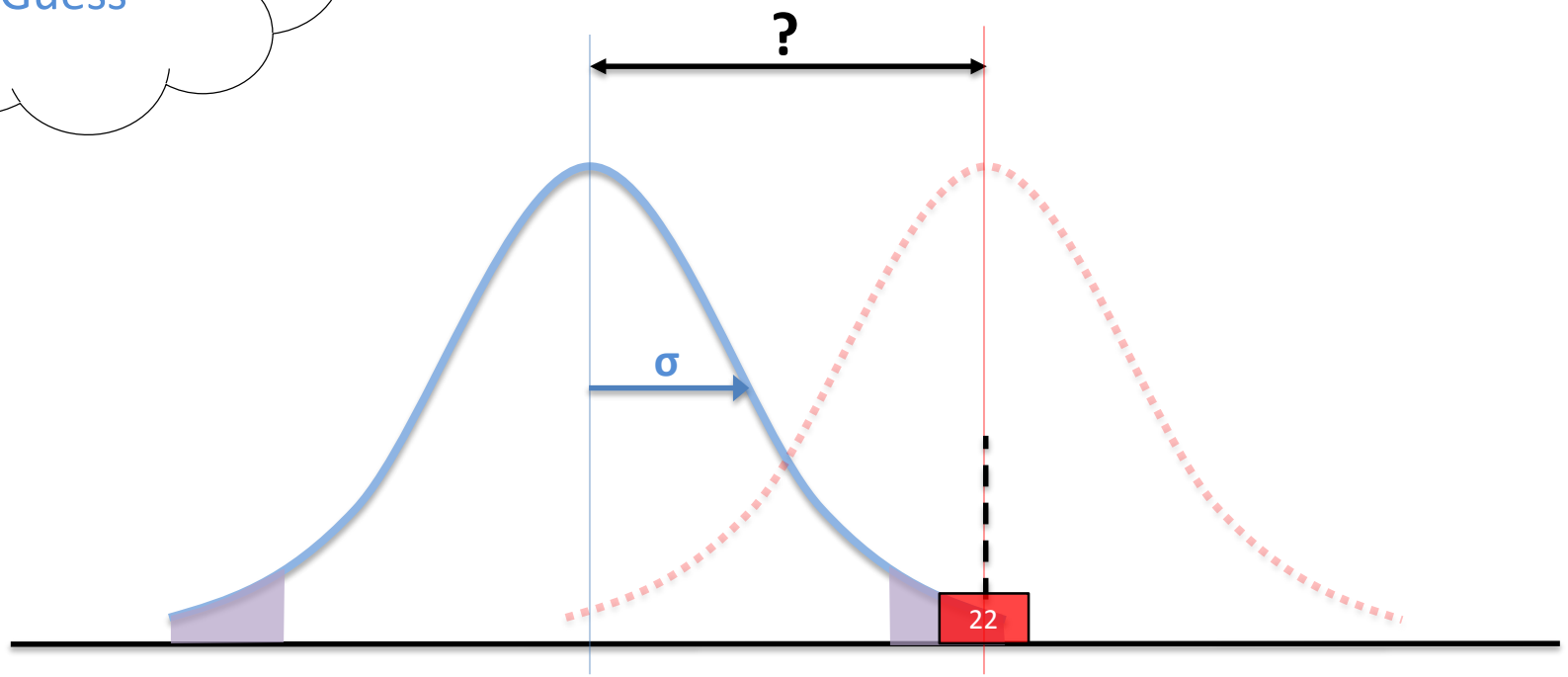
T-test :

$$t = \frac{M - \mu}{\sqrt{\frac{s^2}{n}}}$$



Population is **NOT** known

Your best Guess



μ = 18
σ = ?

μ = ?
σ = ?

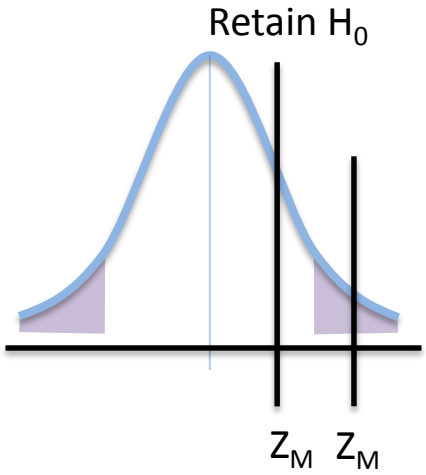
Estimated using sample

Z-test :

$$Z_M = \frac{M - \mu}{\sqrt{\frac{SS}{n}}}$$

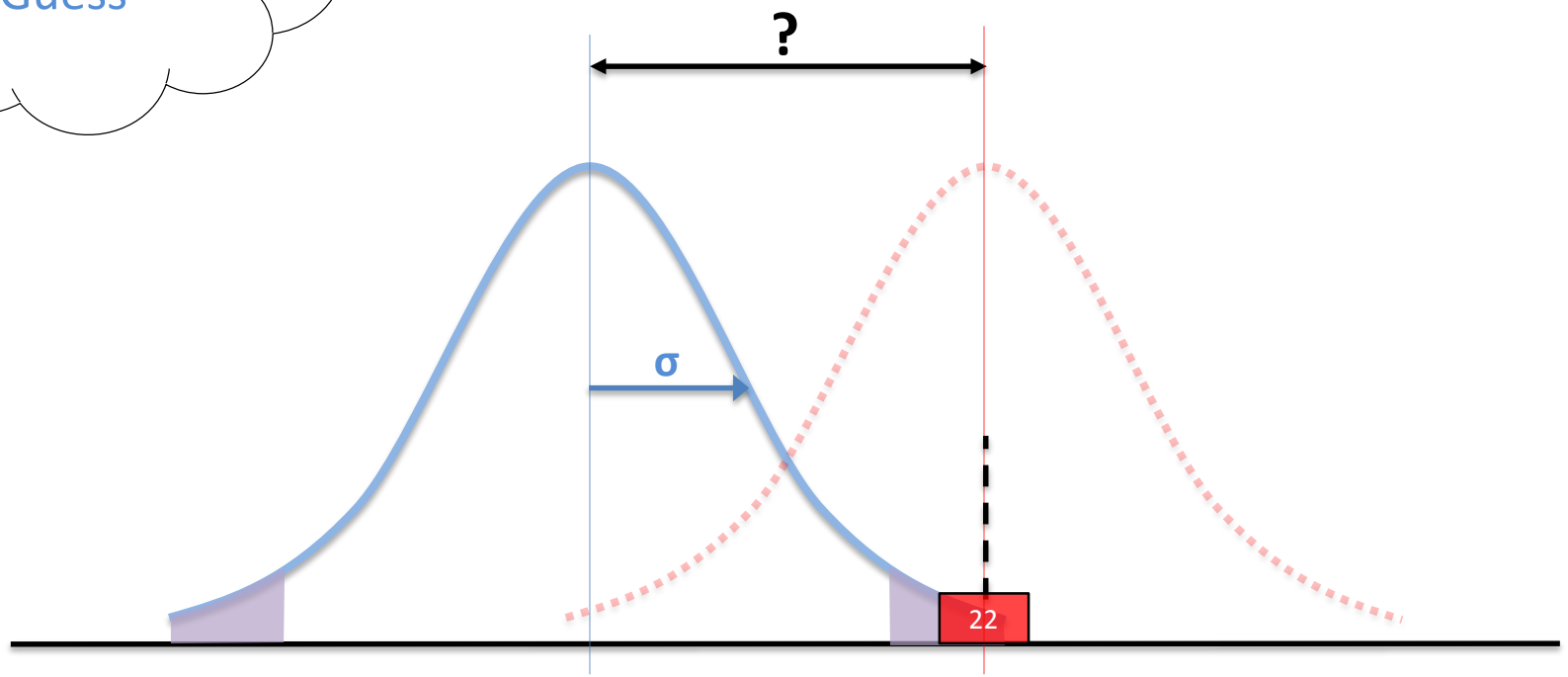
T-test :

$$t = \frac{M - \mu}{\sqrt{\frac{SS}{n-1}}}$$



Population is **NOT** known

Your best Guess

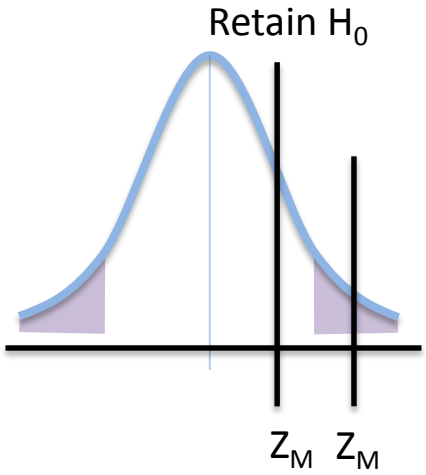


$\mu = 18$
$\sigma = ?$

$\mu = ?$
$\sigma = ?$

Z-test :

T-test :



Estimated using sample

$$\frac{\text{Observed Difference}}{\text{Difference due to chance}}$$

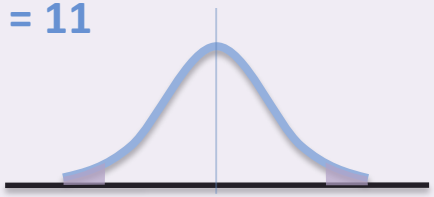
So what exactly is this Difference due to chance thing?

One-Sample T-test

Example

H_0 : Boxers live 11 years

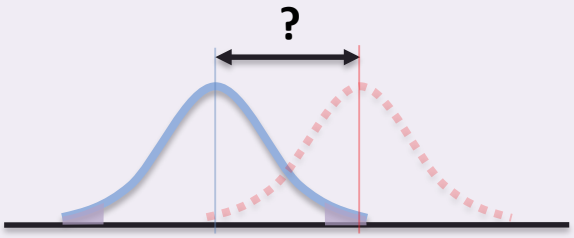
$H_0 : \mu = 11$



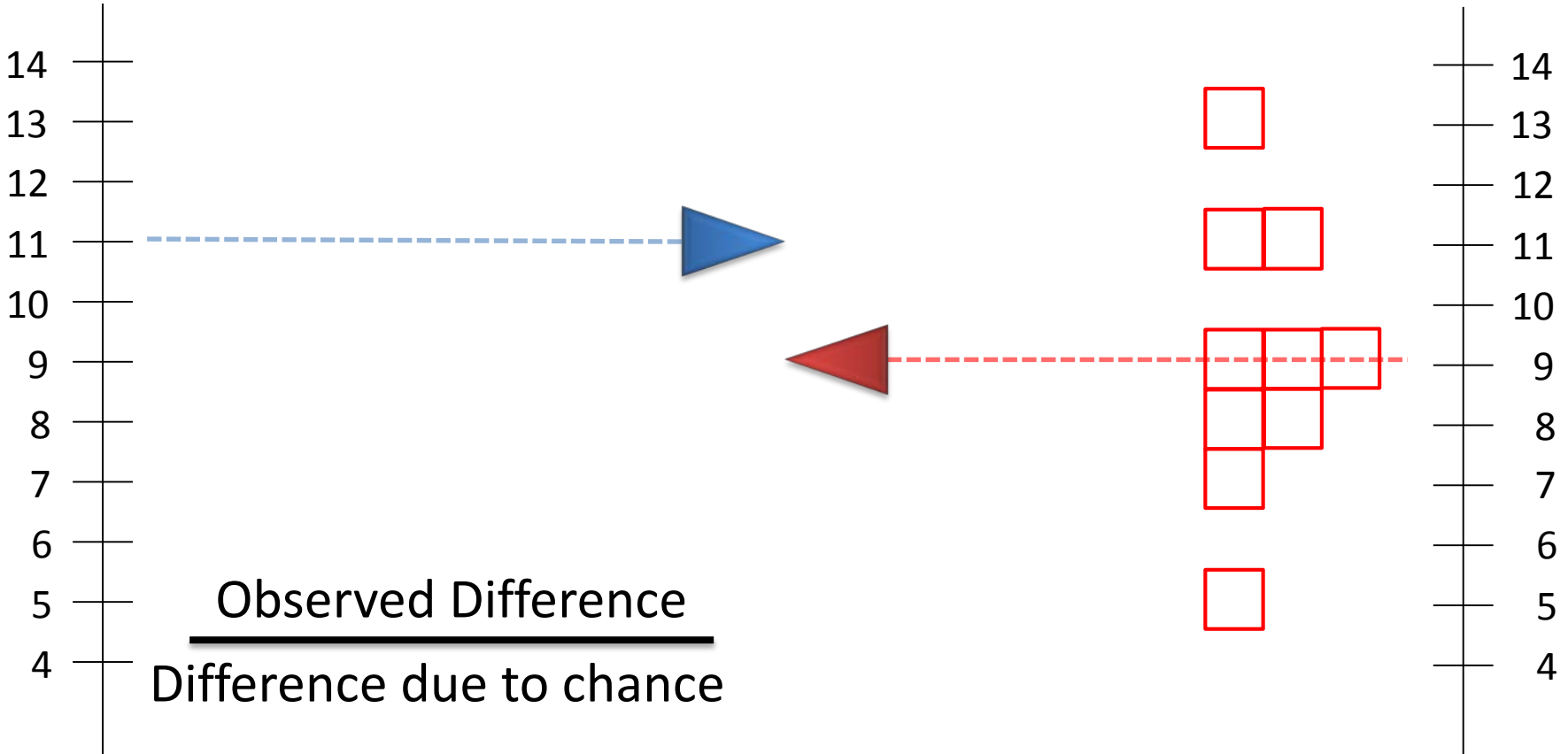
$\mu = 11$
$\sigma = 2.3$

H_1 : No, something else

$H_1 : \mu \neq 11$

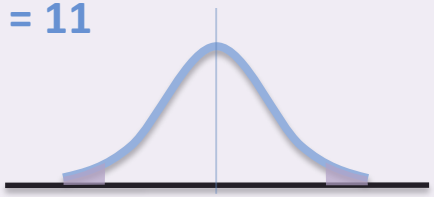


$\mu = 11$ $\bar{X} = 9$
$\sigma = 2.3$ $s = 2.3$



H_0 : Boxers live 11 years

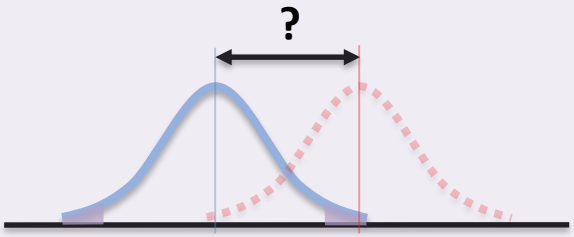
$H_0 : \mu = 11$



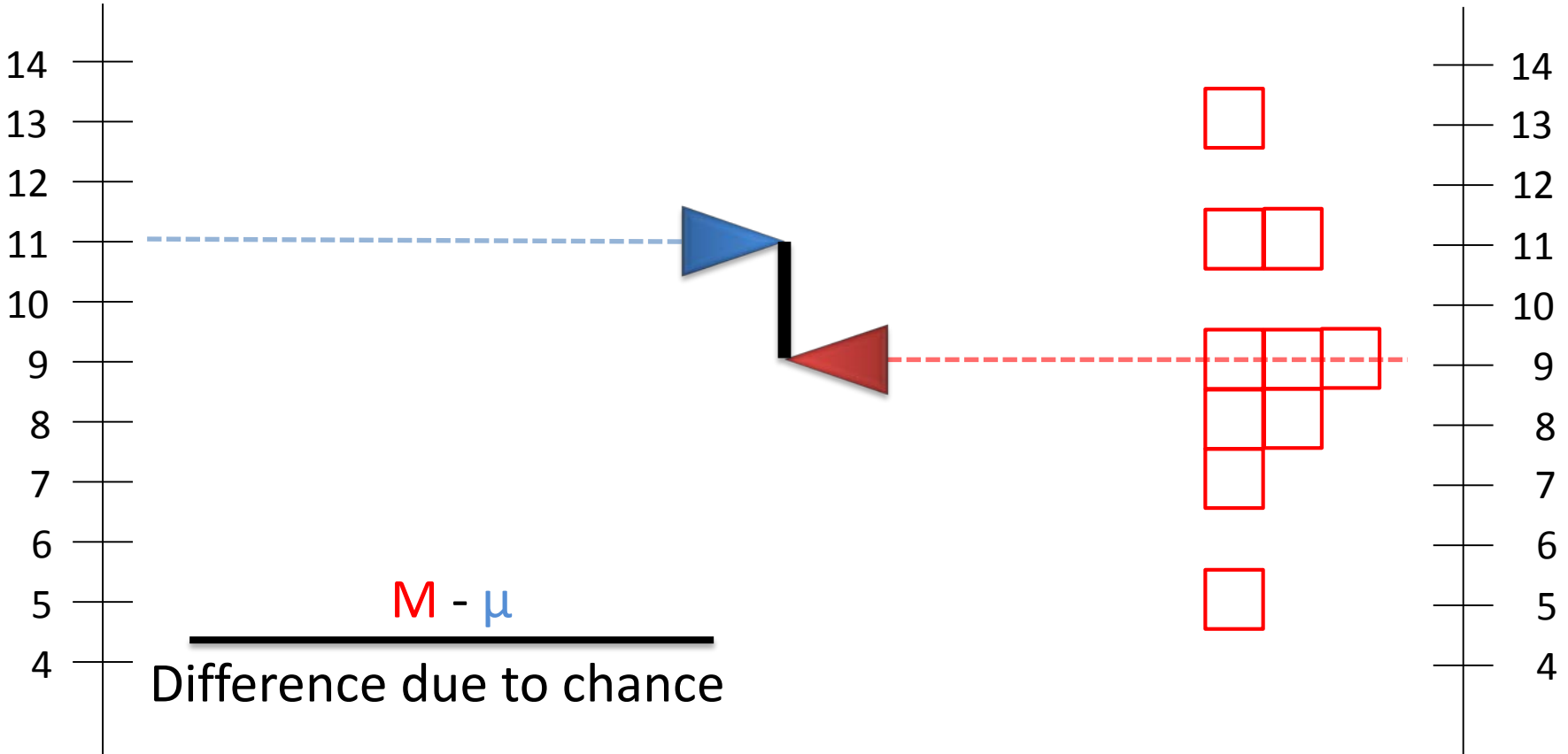
$\mu = 11$
$\sigma = 2.3$

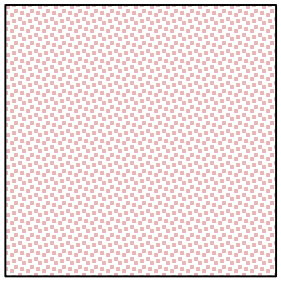
H_1 : No, something else

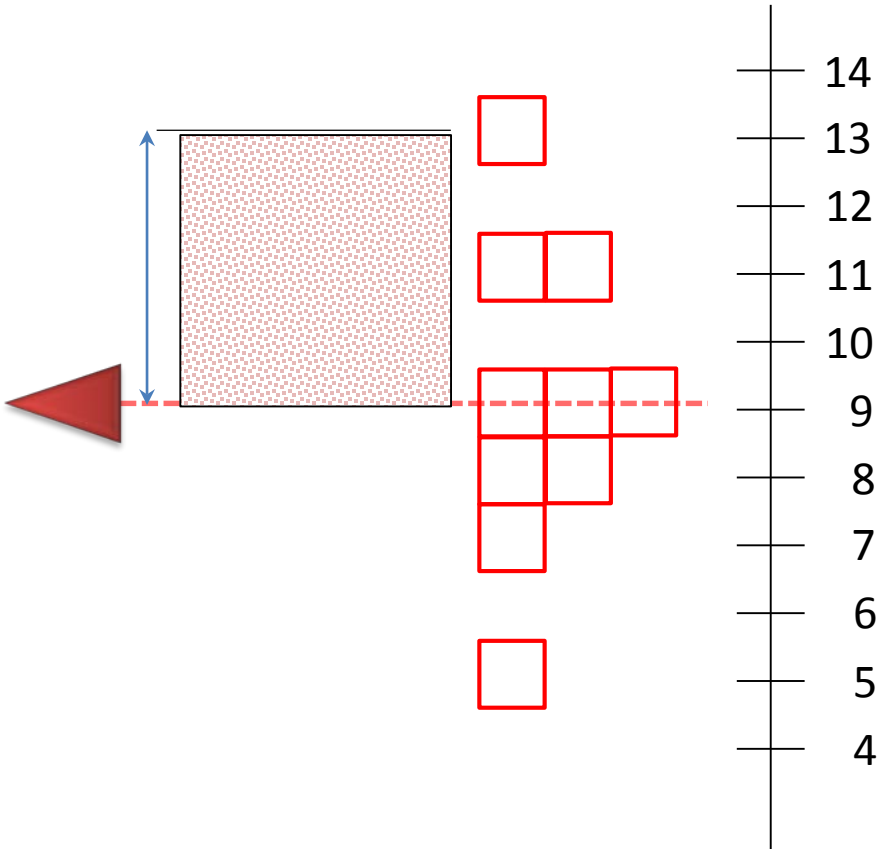
$H_1 : \mu \neq 11$



$\mu = 11$ $\bar{X} = 9$
$\sigma = 2.3$ $s = 2.3$



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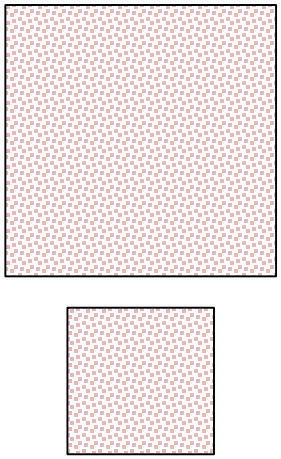

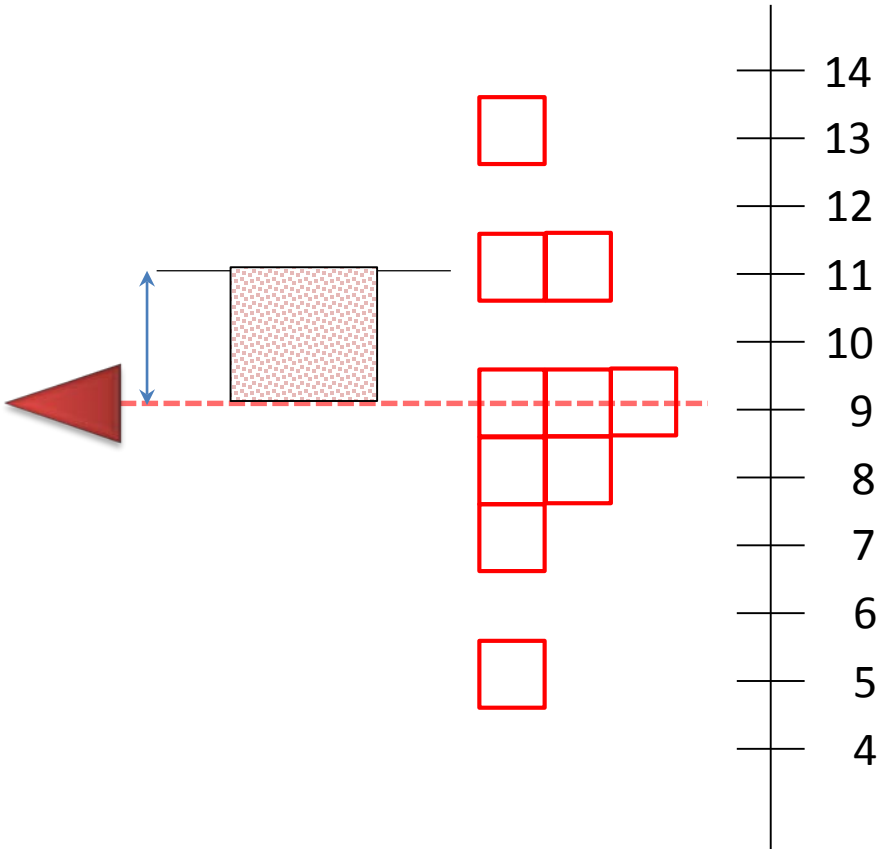
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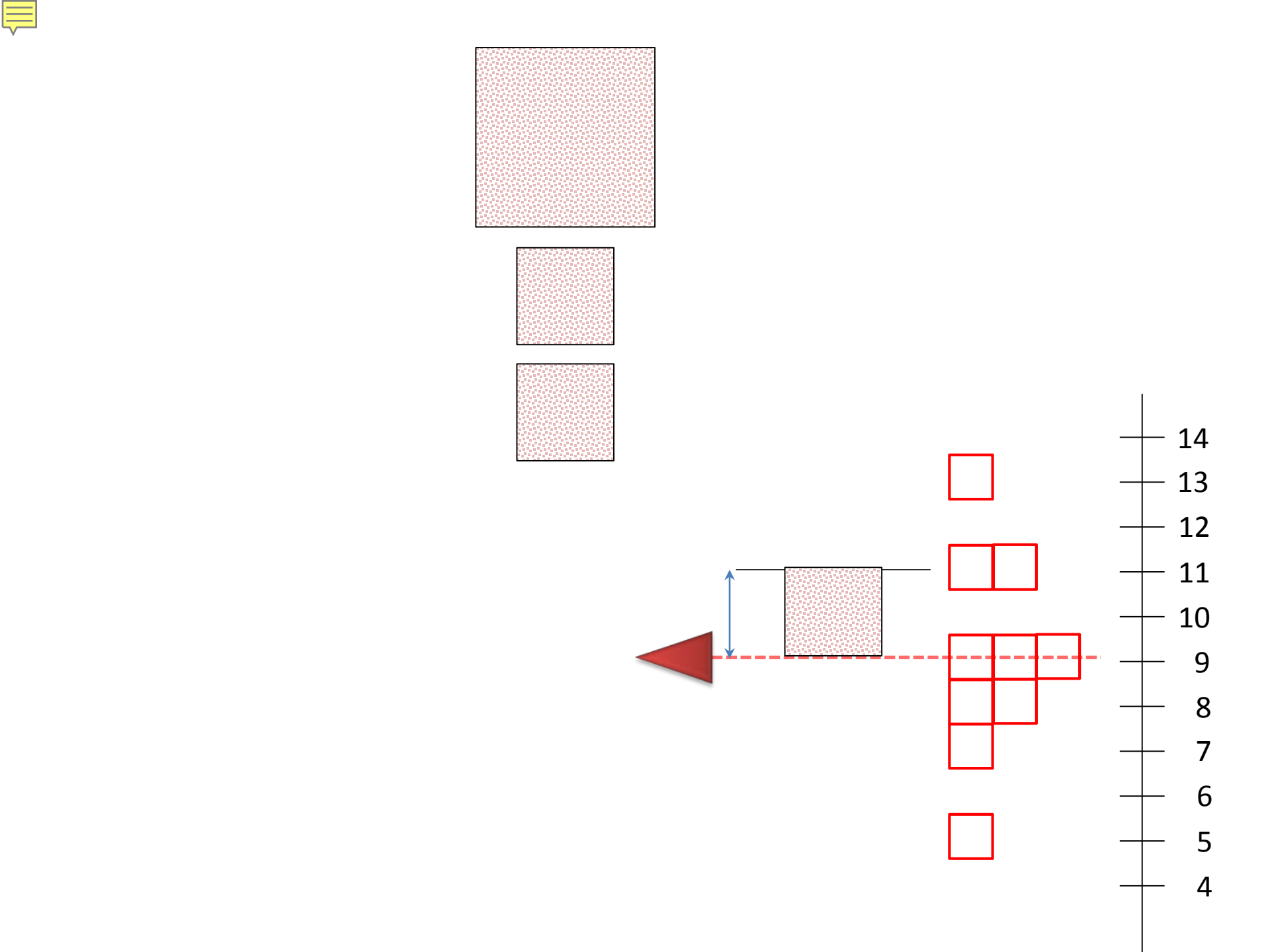
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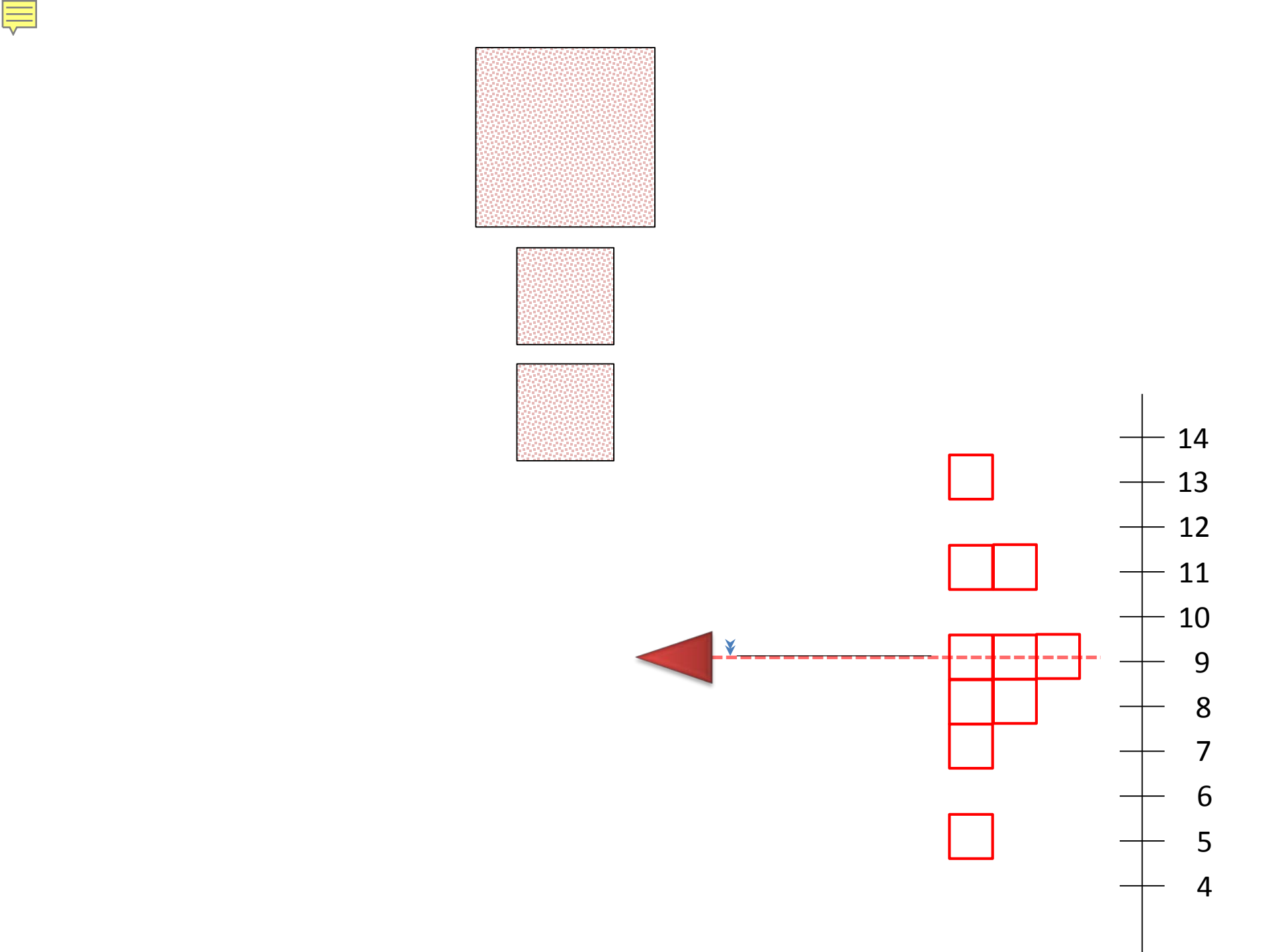
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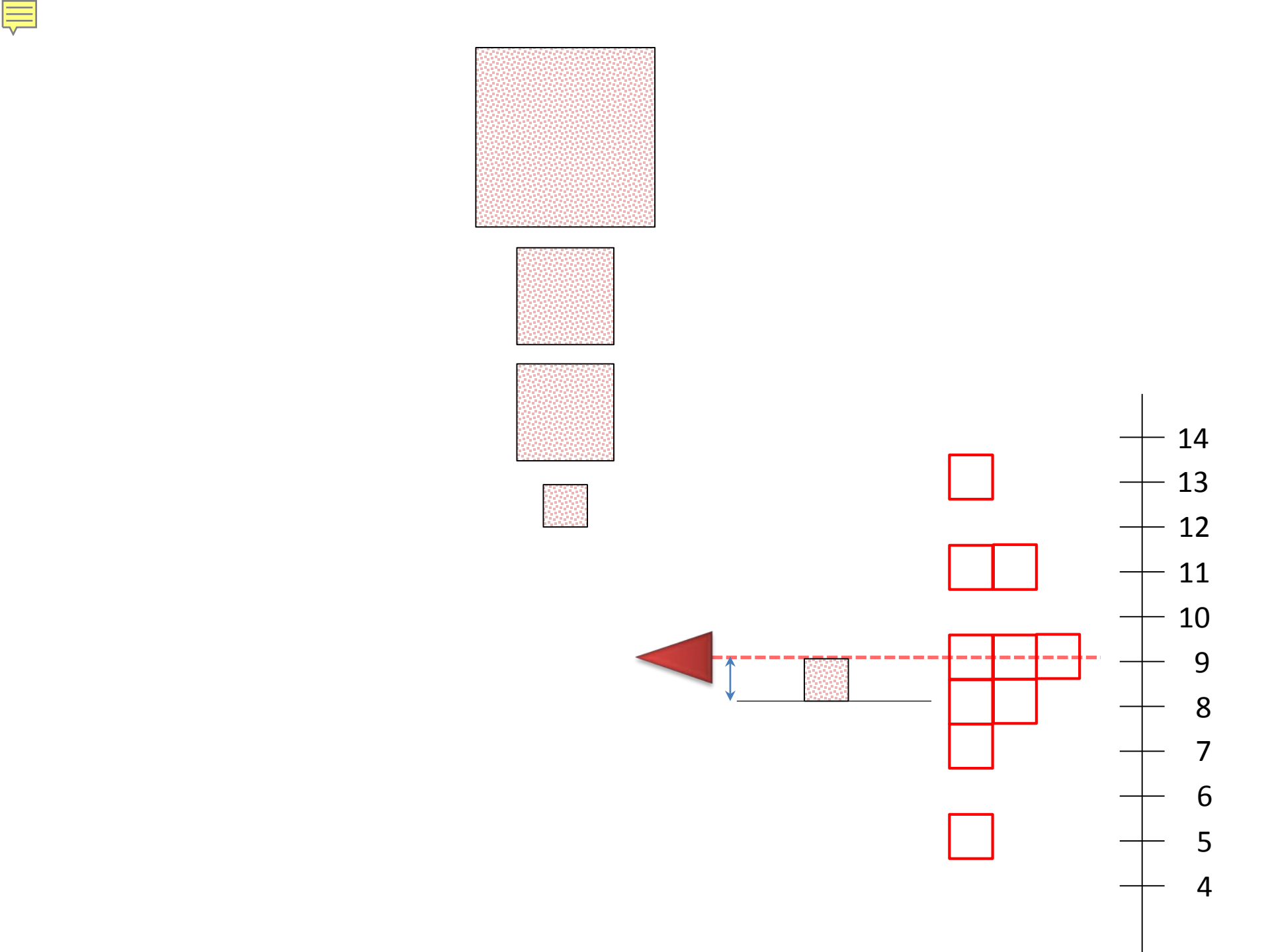
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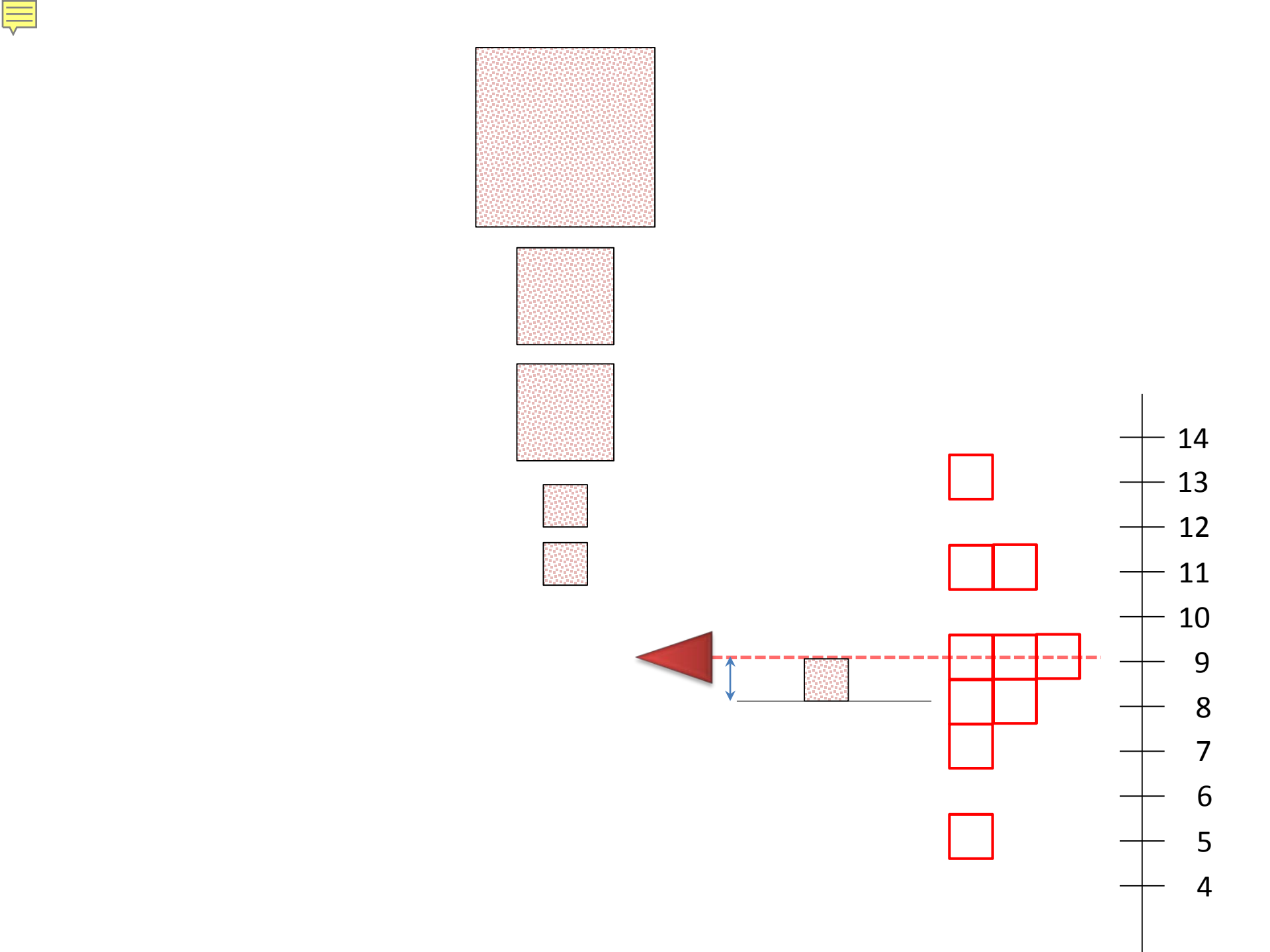
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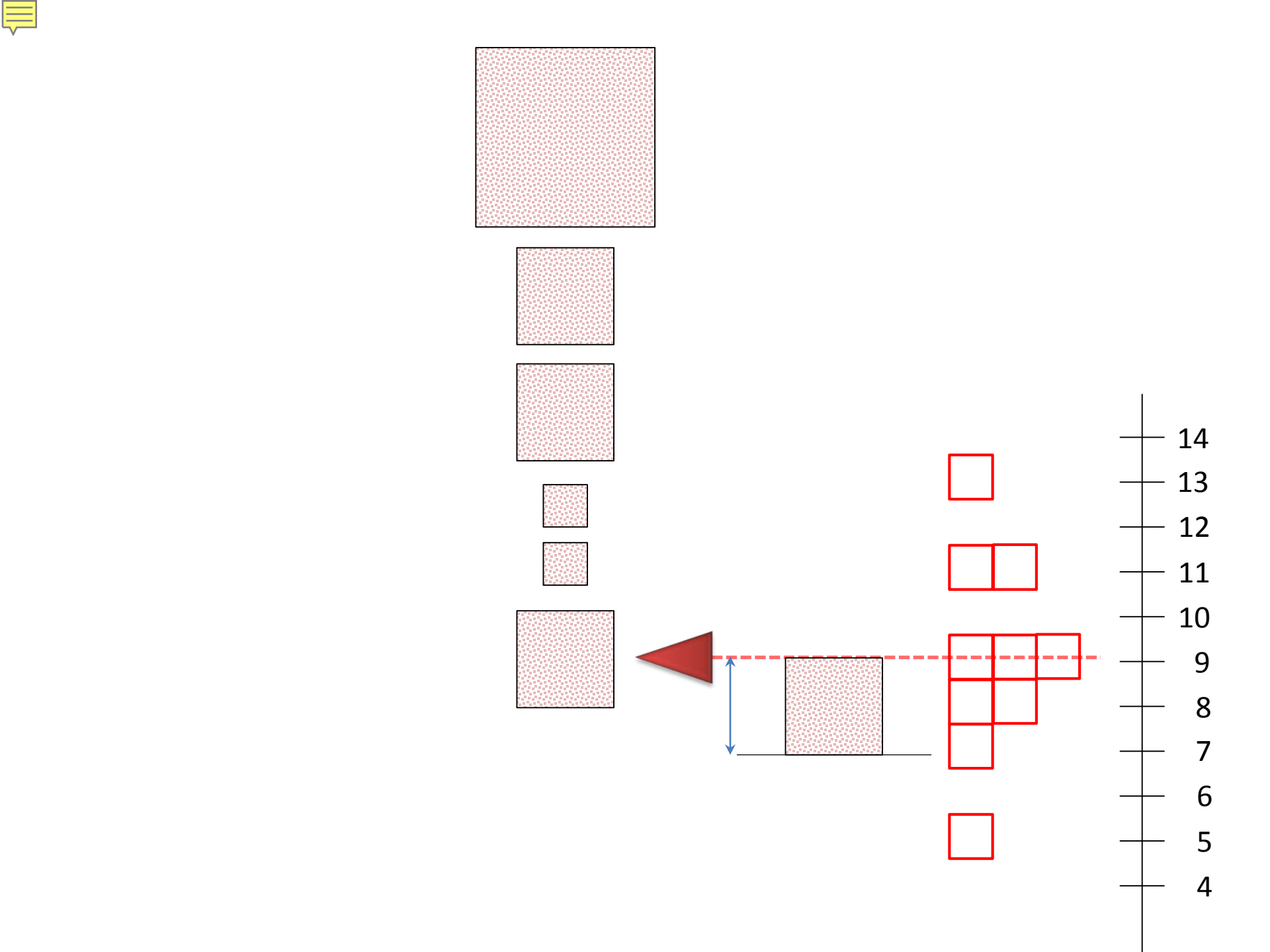
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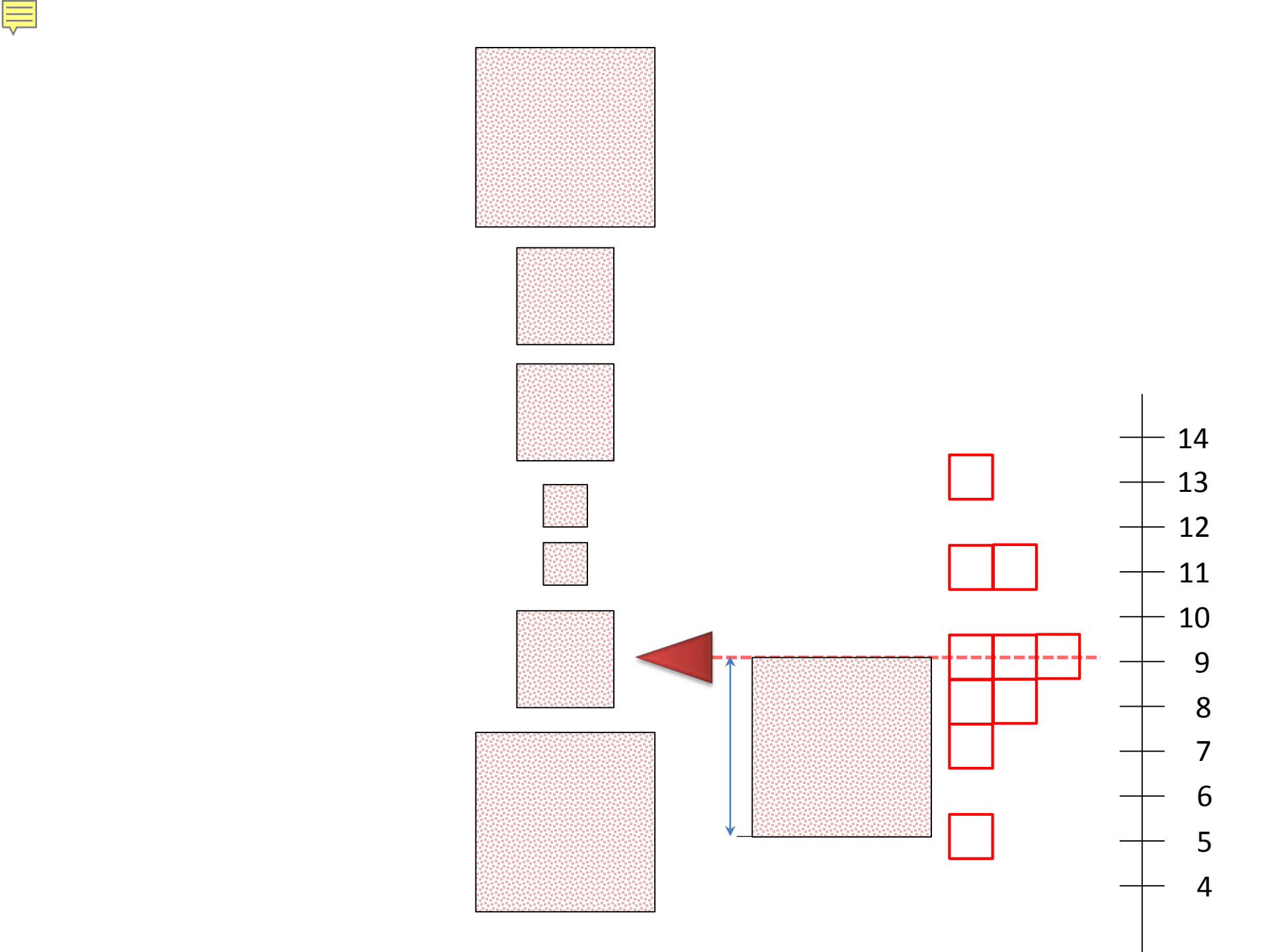
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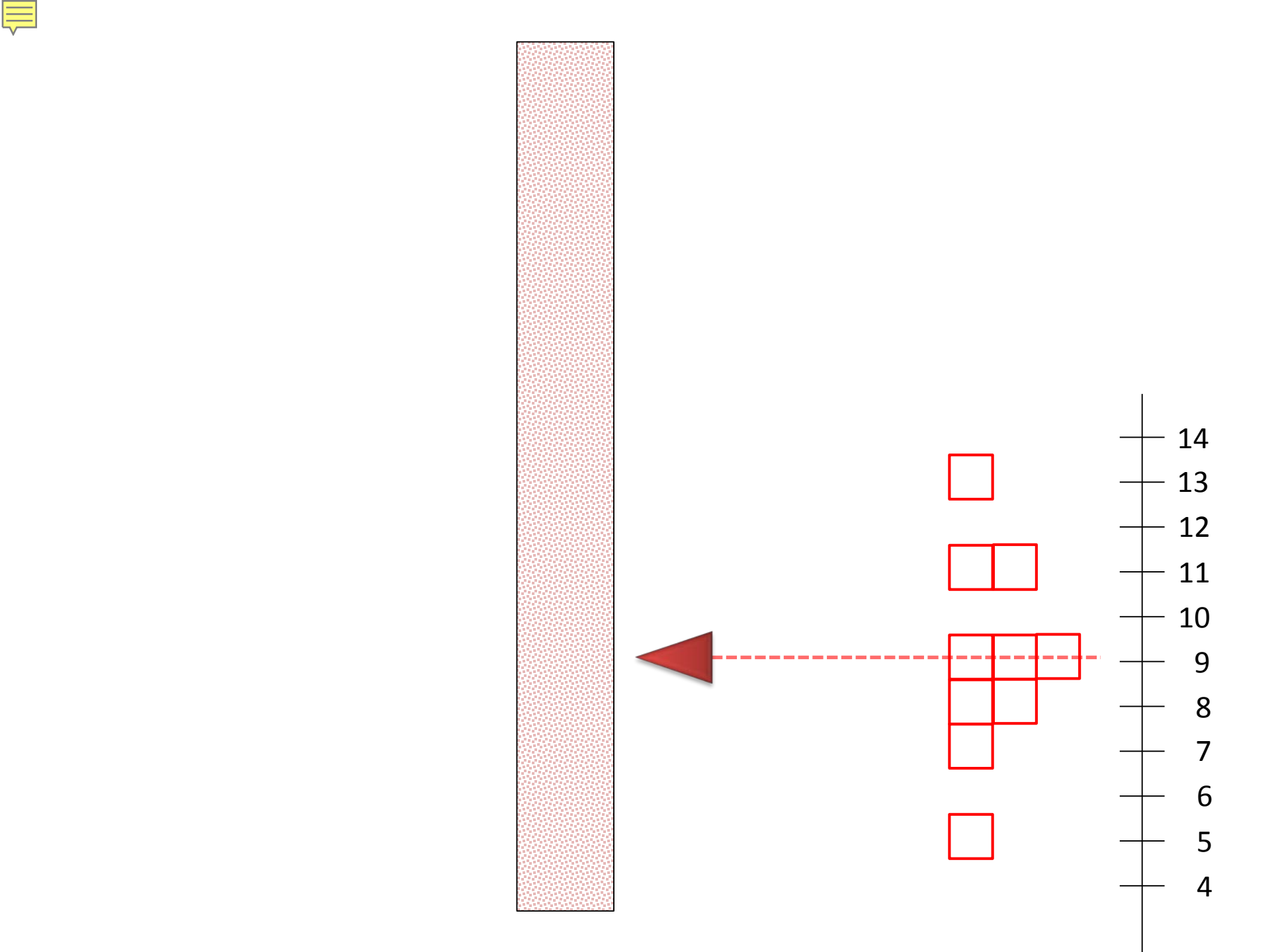
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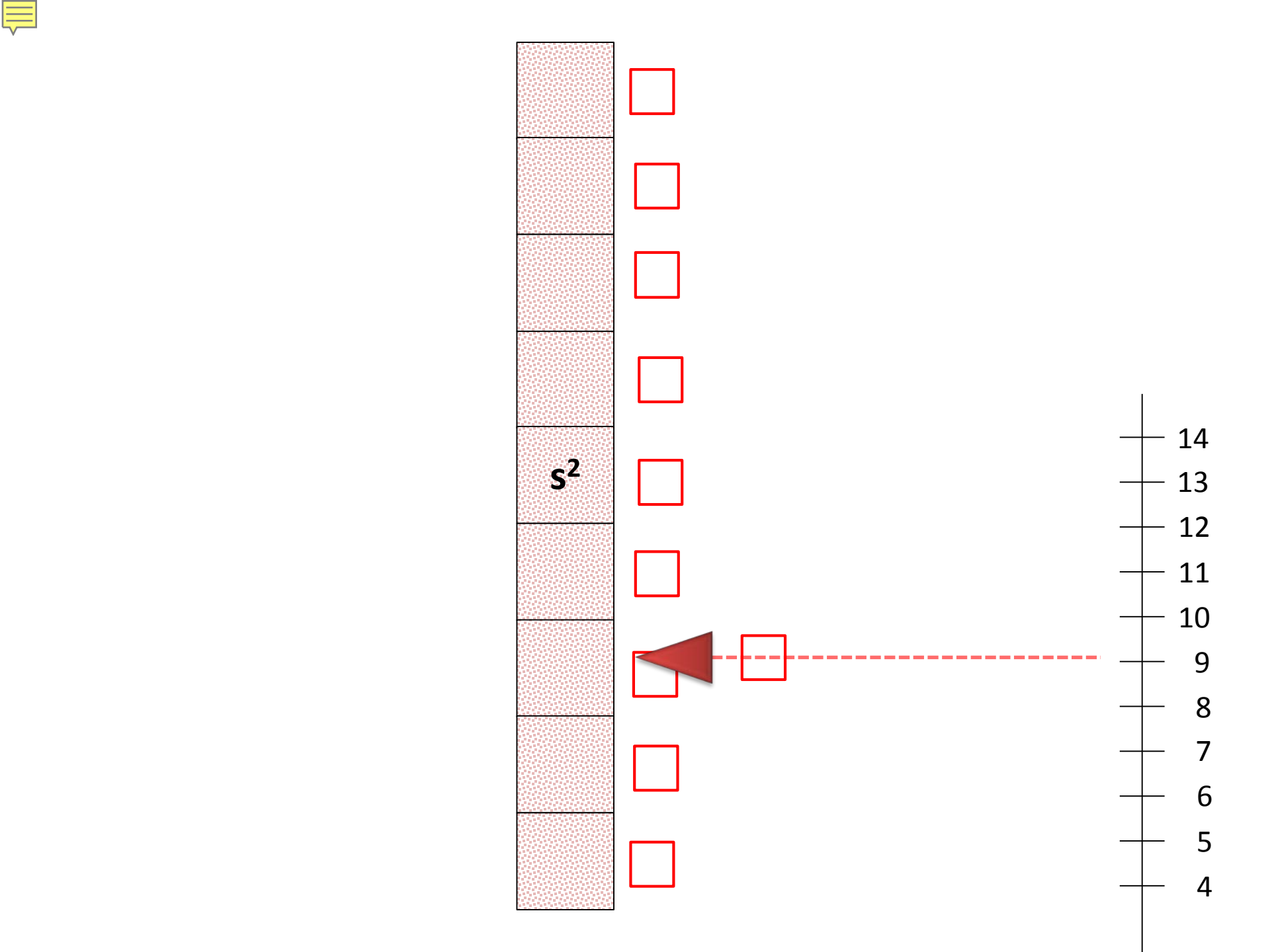
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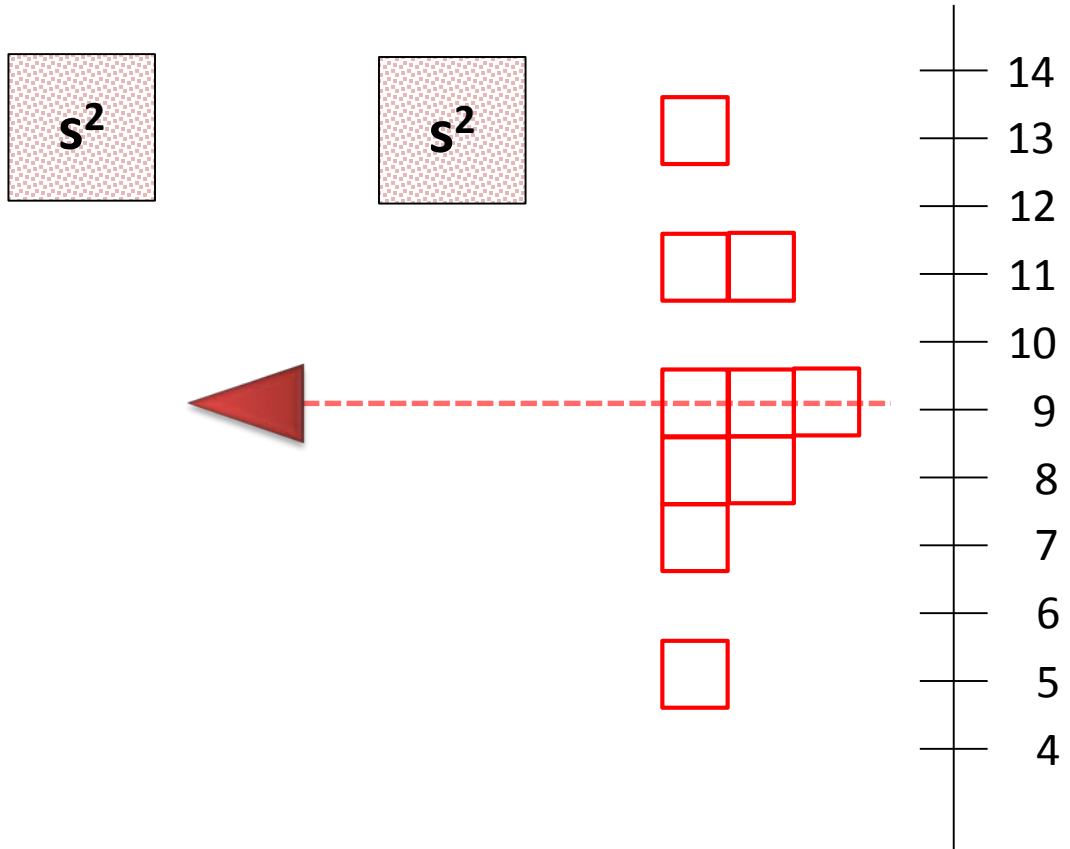
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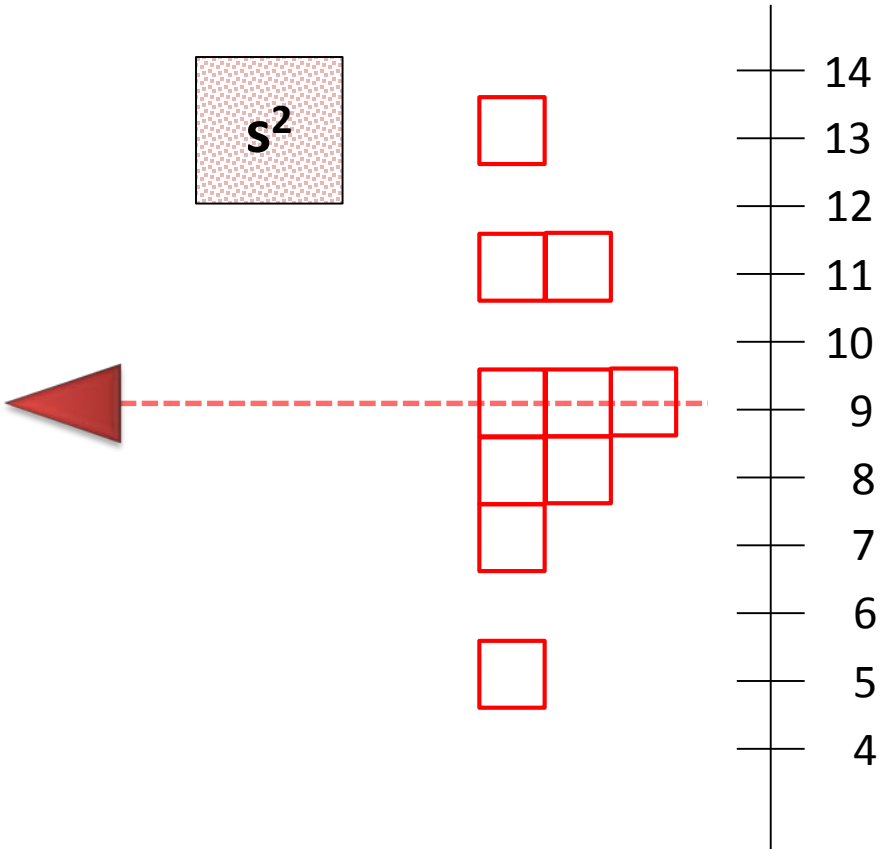
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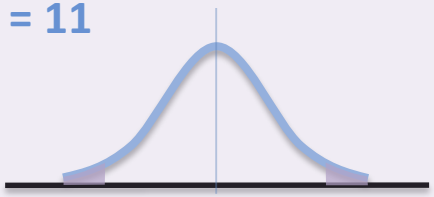
H_0 : Boxers live 11 years

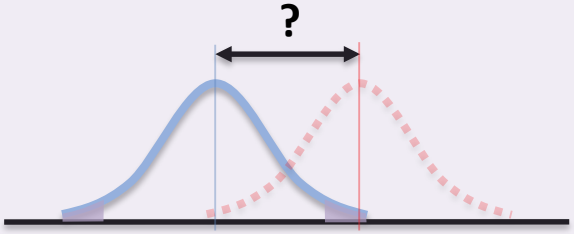
$H_0 : \mu = 11$



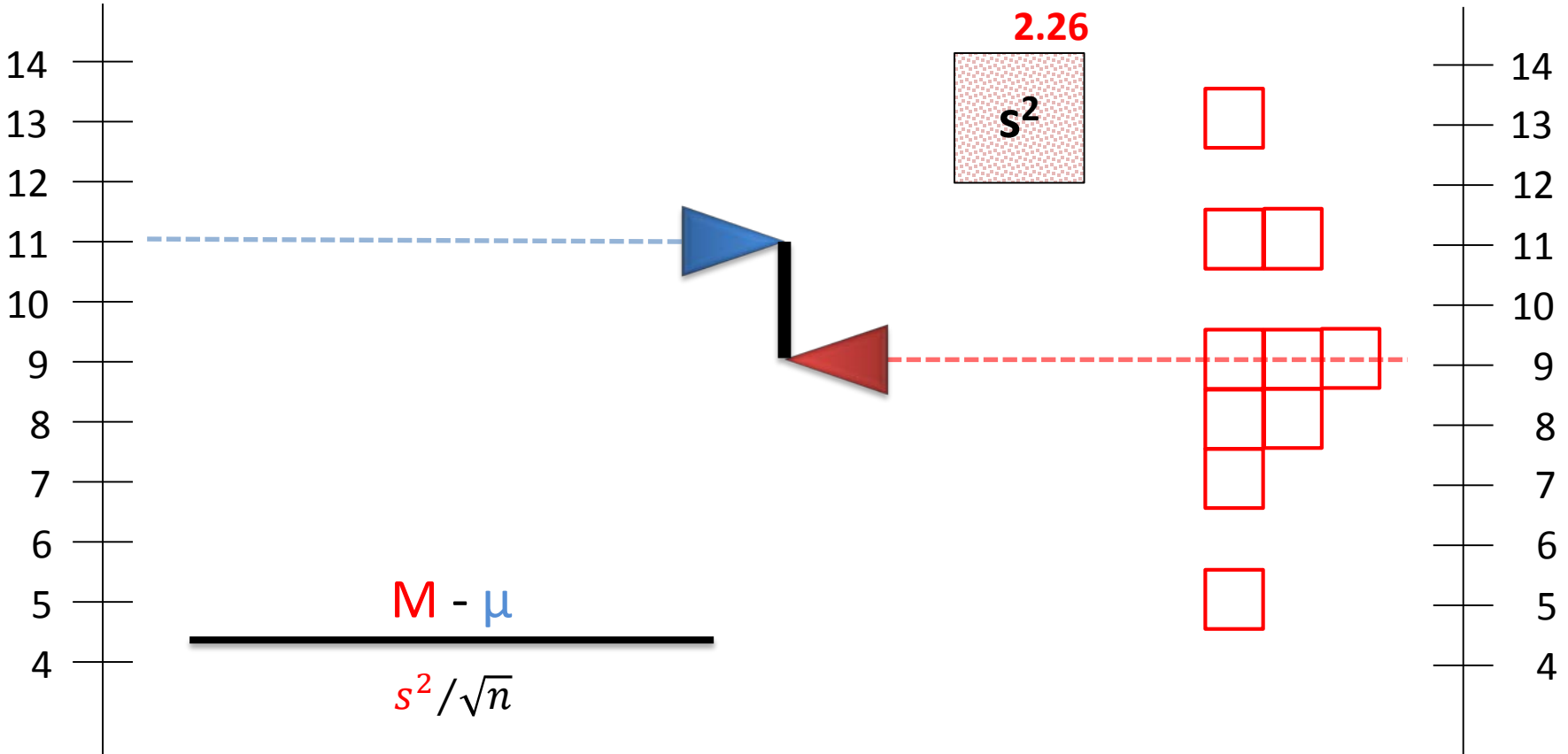
$\mu = 11$
$\sigma = 2.3$

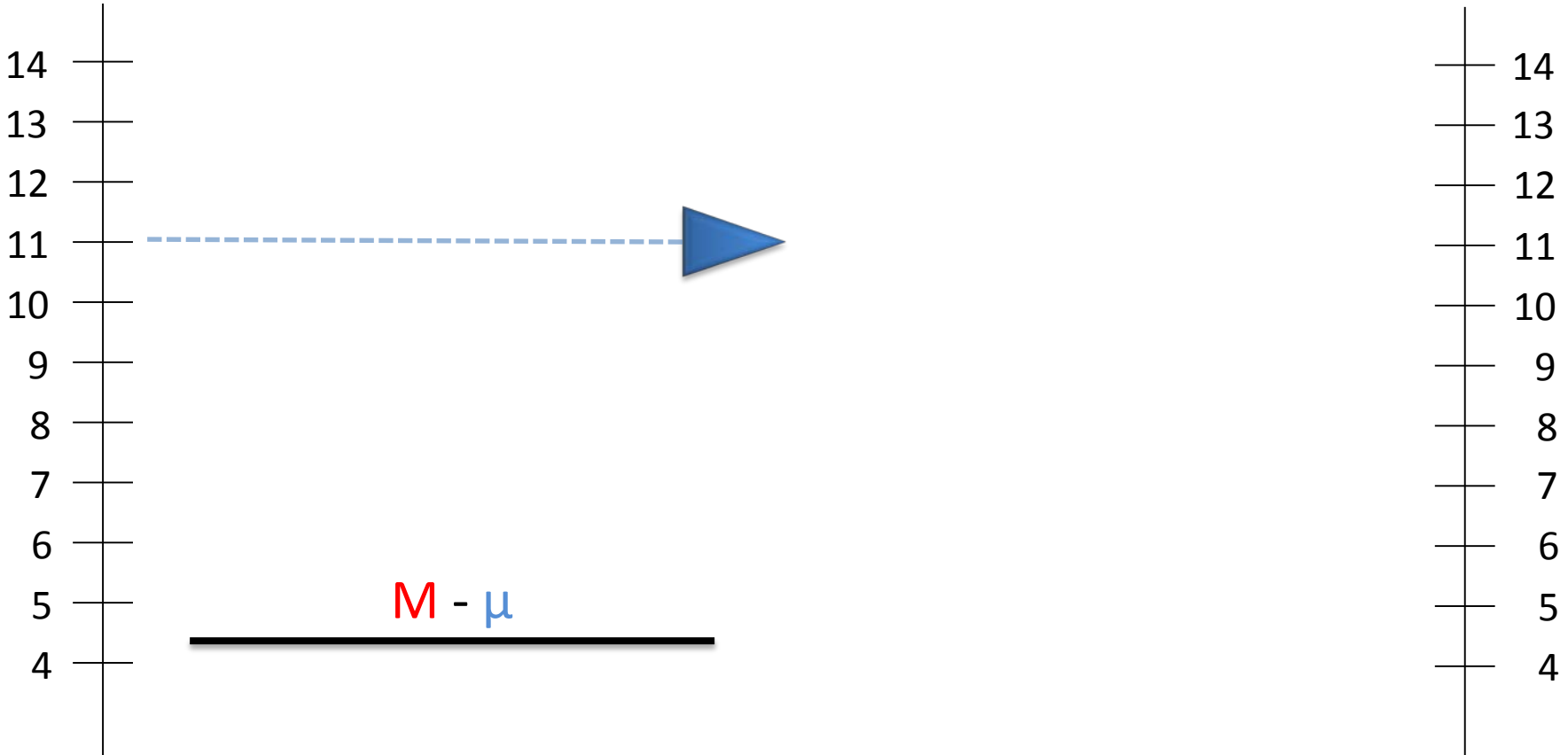
H_1 : No, something else

$H_1 : \mu \neq 11$



$\mu = 11$ $\bar{X} = 9$
$\sigma = 2.3$ $s = 2.3$

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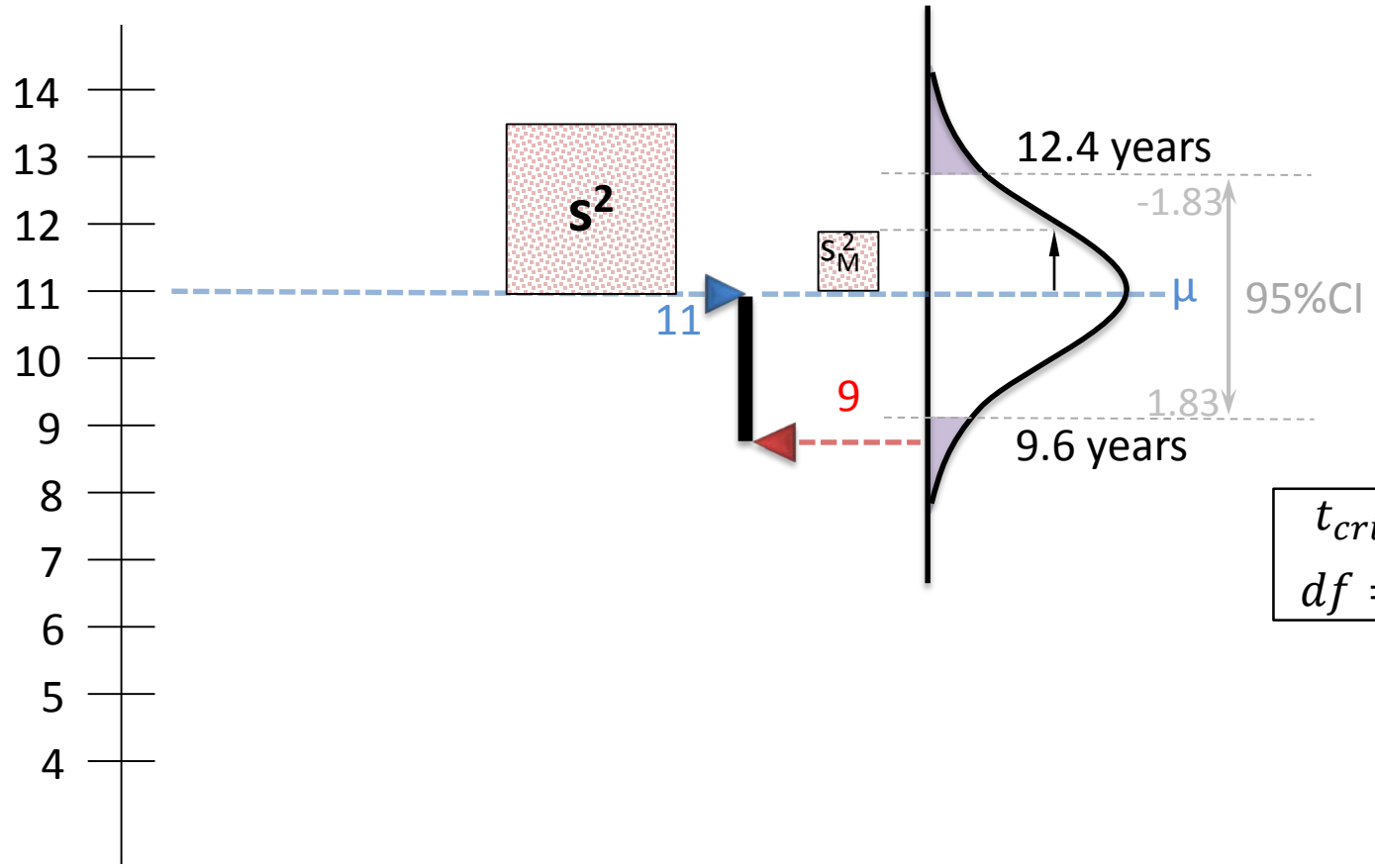
Sampling Distribution



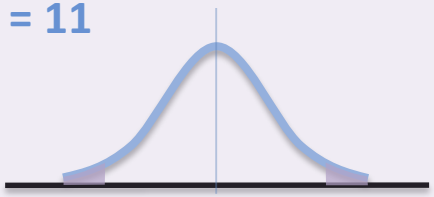
$t_{crit} = \pm 1.83$

$df = n - 1 = 9$

1.83

H_0 : Boxers live 11 years

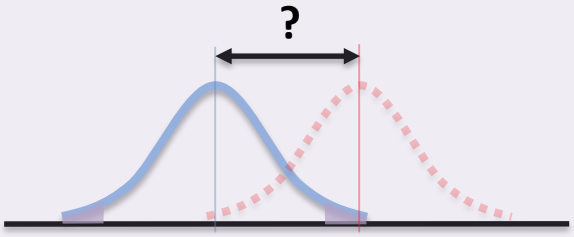
$H_0 : \mu = 11$



$\mu = 11$
$\sigma = 2.3$

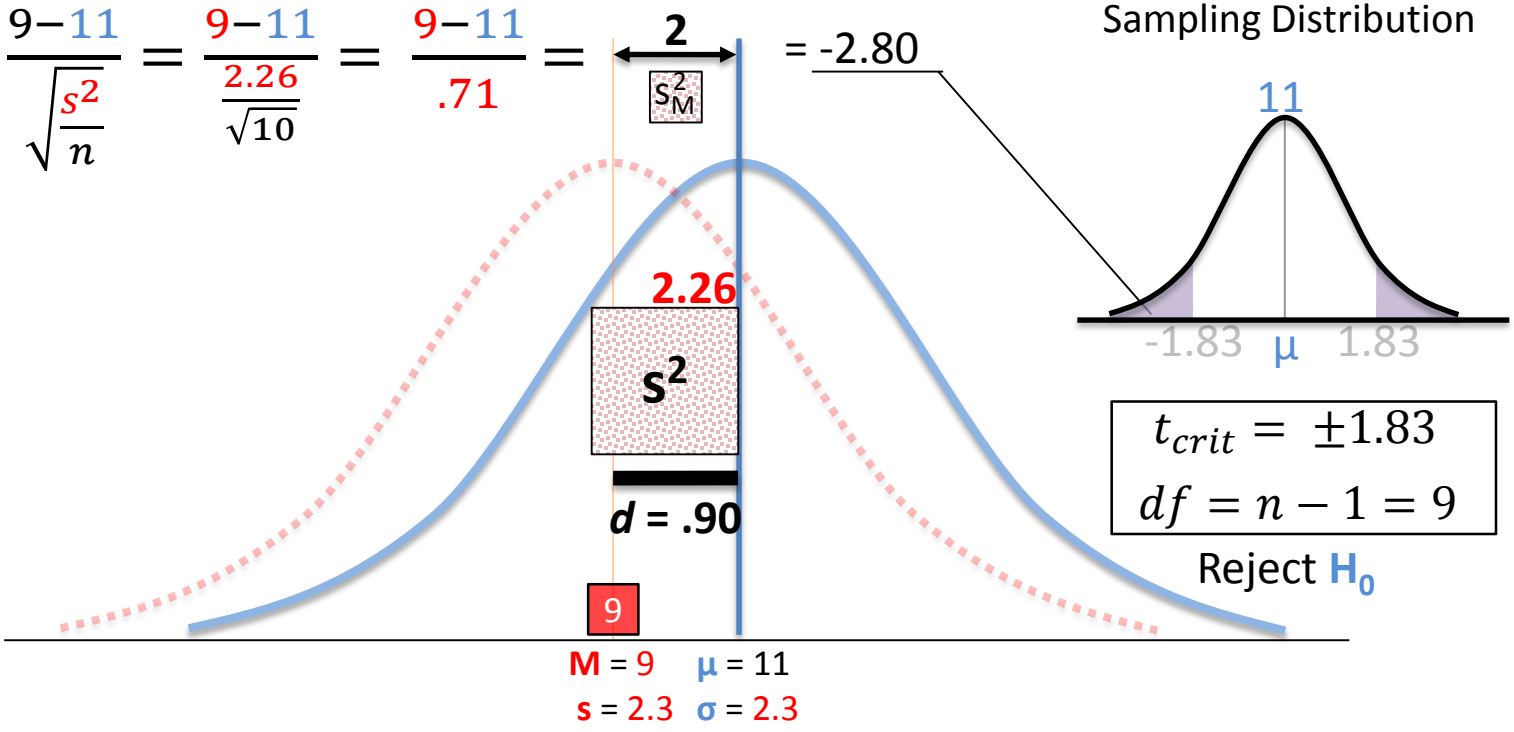
H_1 : No, something else

$H_1 : \mu \neq 11$



$\mu = 11$ $\bar{X} = 9$
$\sigma = 2.3$ $s = 2.3$

$$t = \frac{\bar{X} - \mu}{s_M} = \frac{9-11}{\sqrt{\frac{s^2}{n}}} = \frac{9-11}{\frac{2.26}{\sqrt{10}}} = \frac{9-11}{.71} = \frac{2}{s_M^2} = -2.80$$



$t_{crit} = \pm 1.83$

$df = n - 1 = 9$

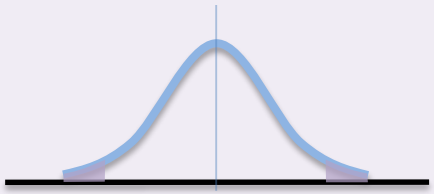
Reject H_0

One-sample t-test indicated that boxers (M = 9, s = 2.26, n = 10) live significantly less than 11 years, $t(9)$ = -2.80, p<.05, SEM=0.71, , Cohen's D =0.90.

One-Sample T-test

Scenario 3

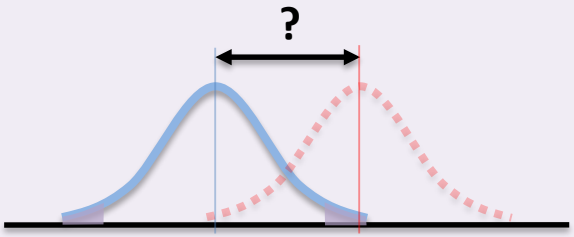
H_0 :



$\mu = 13.5$

$\sigma = ?$

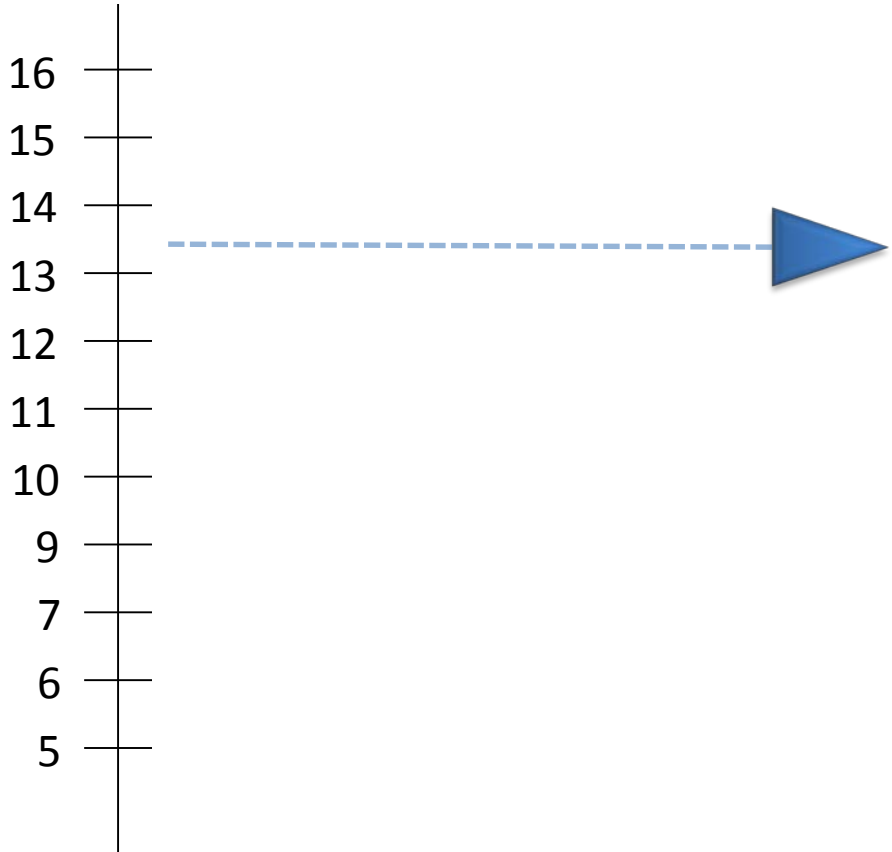
H_1 :



$\mu = 13.5$ $\mu = ?$

$\sigma = ?$ $\sigma = ?$

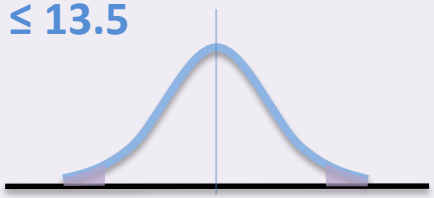
Do programmer have greater need for control?



A psychologist wanted to determine whether computer programmers have a greater need for control than the typical person. The typical person scores an average of 13.5 on the CONTROL personality inventory. The psychologist administered the CONTROL inventory to 36 computer programmers and found that the average need for control among them was 15 with a standard deviation of 4.9. Do programmers have a greater need for control than average population? Use an alpha of .05

H_0 : No, they don't

$H_0 : \mu \leq 13.5$

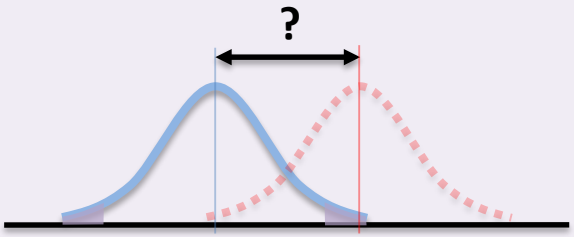


$\mu = 13.5$

$\sigma = 4.9$

H_1 : Programmers need more control

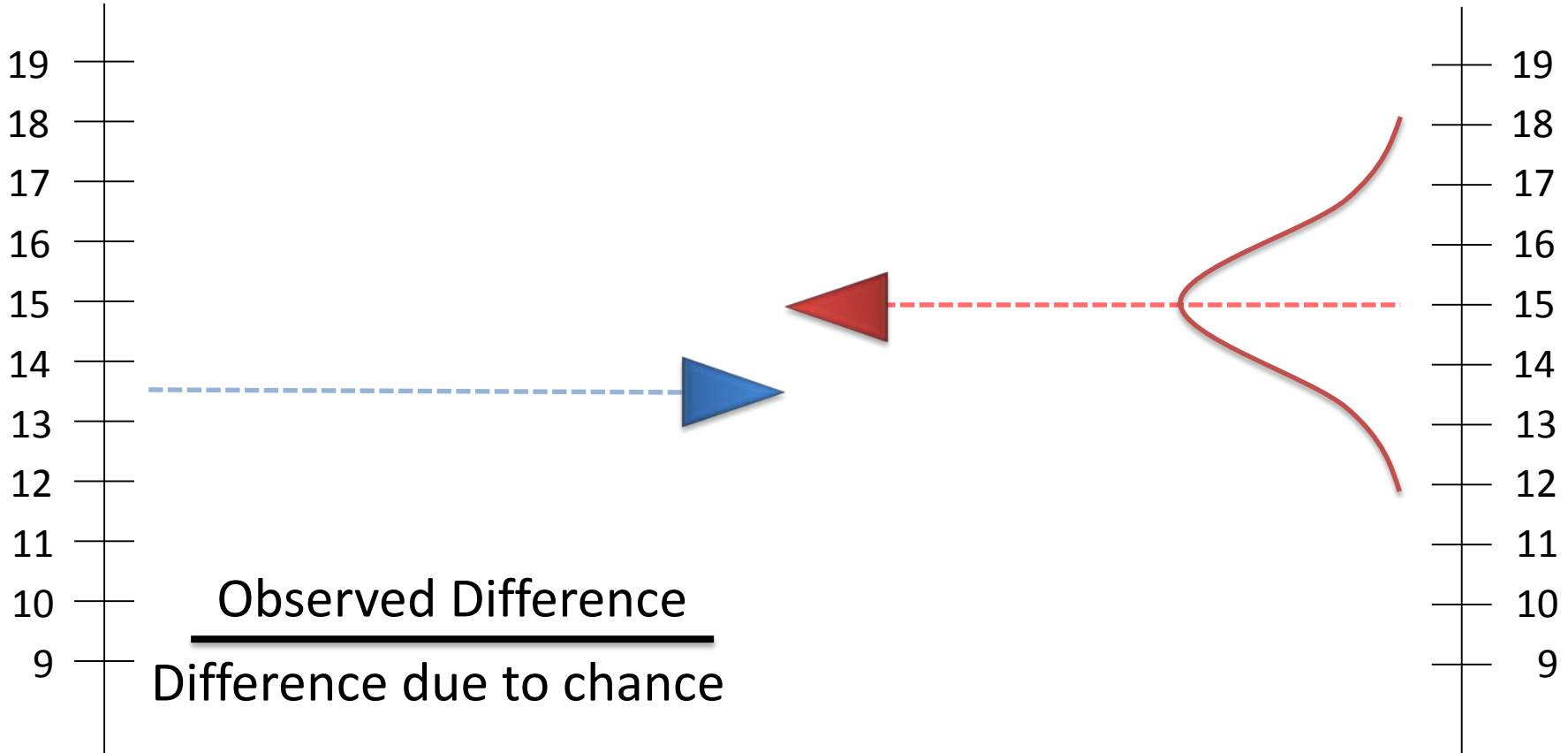
$H_1 : \mu > 13.5$



$\mu = 13.5$ $\bar{X} = 15$

$\sigma = 4.9$ $s = 4.9$

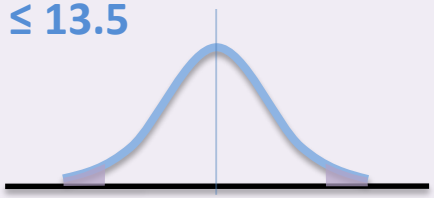
n=36



$$\frac{\text{Observed Difference}}{\text{Difference due to chance}}$$

H_0 : No, they don't

$H_0 : \mu \leq 13.5$

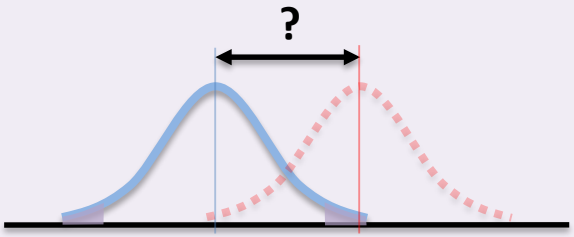


$\mu = 13.5$

$\sigma = 4.9$

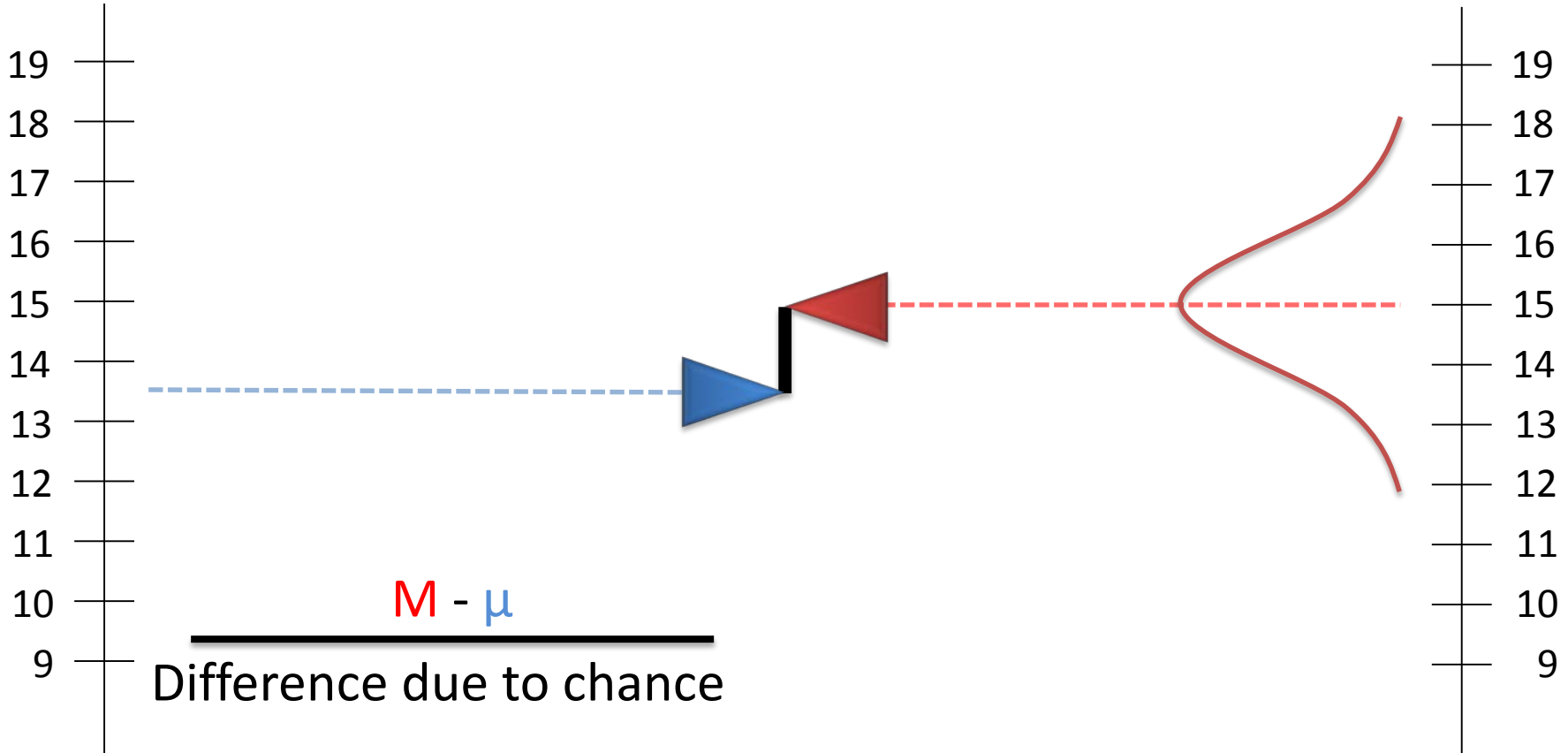
H_1 : Programmers need more control

$H_1 : \mu > 13.5$



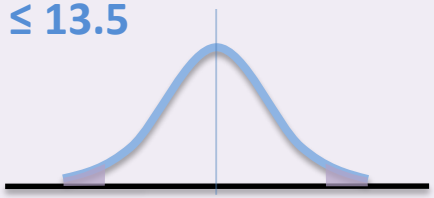
$\mu = 13.5$ $\bar{X} = 15$

$\sigma = 4.9$ $s = 4.9$



H_0 : No, they don't

$H_0 : \mu \leq 13.5$

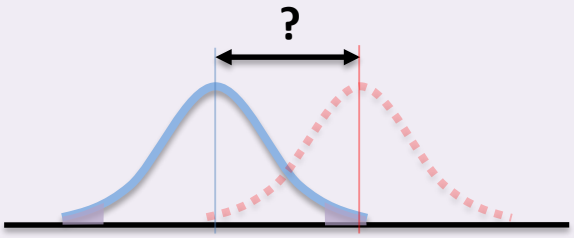


$\mu = 13.5$

$\sigma = 4.9$

H_1 : Programmers need more control

$H_1 : \mu > 13.5$



$\mu = 13.5$ $\bar{X} = 15$

$\sigma = 4.9$ $s = 4.9$

4.9

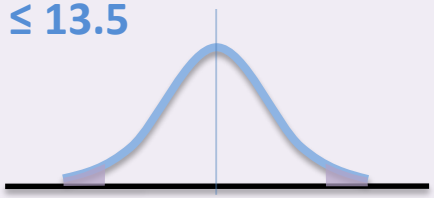
s^2

19 18 17 16 15 14 13 12 11 10 9

19 18 17 16 15 14 13 12 11 10 9

$$\frac{M - \mu}{s^2/\sqrt{n}}$$

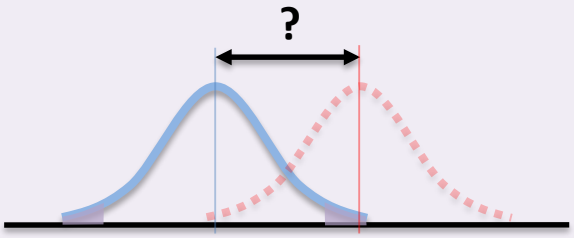
$H_0 : \mu \leq 13.5$



$\mu = 13.5$

$\sigma = 4.9$

$H_1 : \mu > 13.5$



$\mu = 13.5$ $\bar{X} = 15$

$\sigma = 4.9$ $s = 4.9$

4.9

s^2

s_M^2 0.82

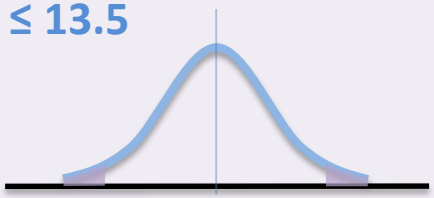
19 18 17 16 15 14 13 12 11 10 9

M - μ

19 18 17 16 15 14 13 12 11 10 9

H_0 : No, they don't

H_0 : $\mu \leq 13.5$

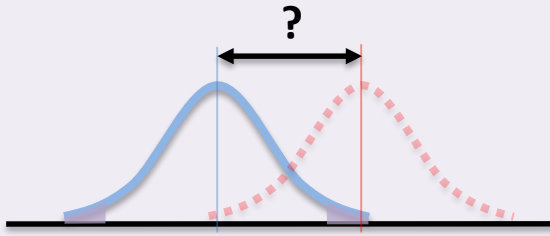


$\mu = 13.5$
$\sigma = 4.9$

H_1 : Programmers need more control

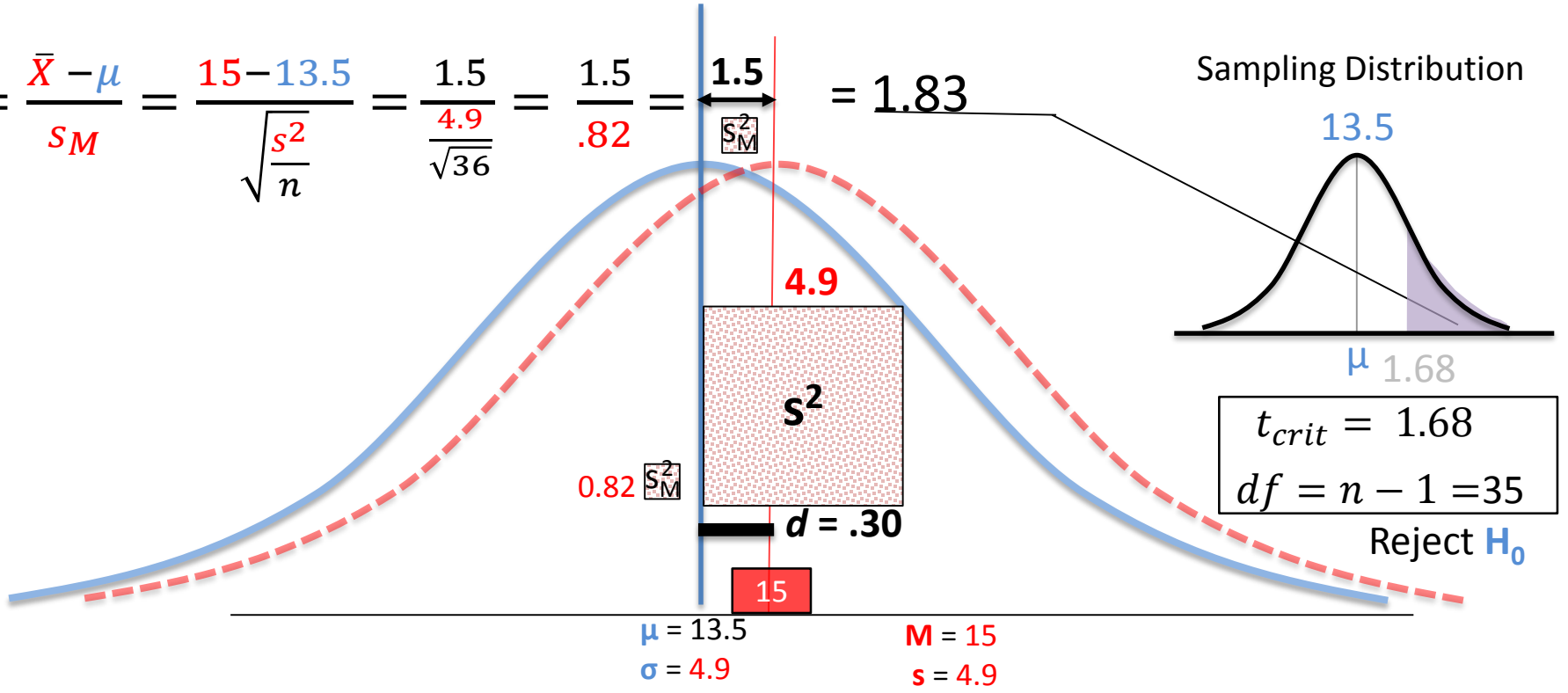
H_1 : $\mu > 13.5$

s^2_M



$\mu = 13.5$ $\bar{X} = 15$
$\sigma = 4.9$ $s = 4.9$

$$t = \frac{\bar{X} - \mu}{s_M} = \frac{15 - 13.5}{\sqrt{\frac{s^2}{n}}} = \frac{1.5}{\frac{4.9}{\sqrt{36}}} = \frac{1.5}{.82} = \frac{1.5}{s^2_M} = 1.83$$



Sampling Distribution

$t_{crit} = 1.68$

$df = n - 1 = 35$

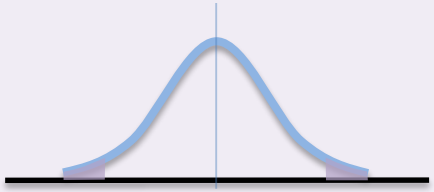
Reject H_0

One-sample t-test indicated that programmers(M = 15, s = 4.9, n = 36) have greater need for control than 13.5, $t(35) = 1.83$, $p<.05$, SEM=0.82, Cohen's D =0.30.

One-Sample T-test

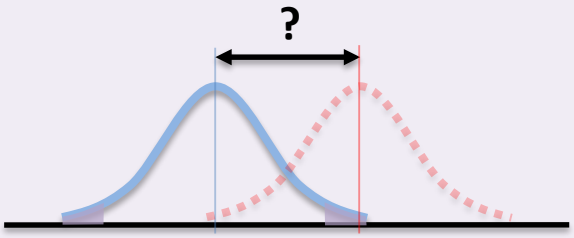
Scenario 4

H_0 :



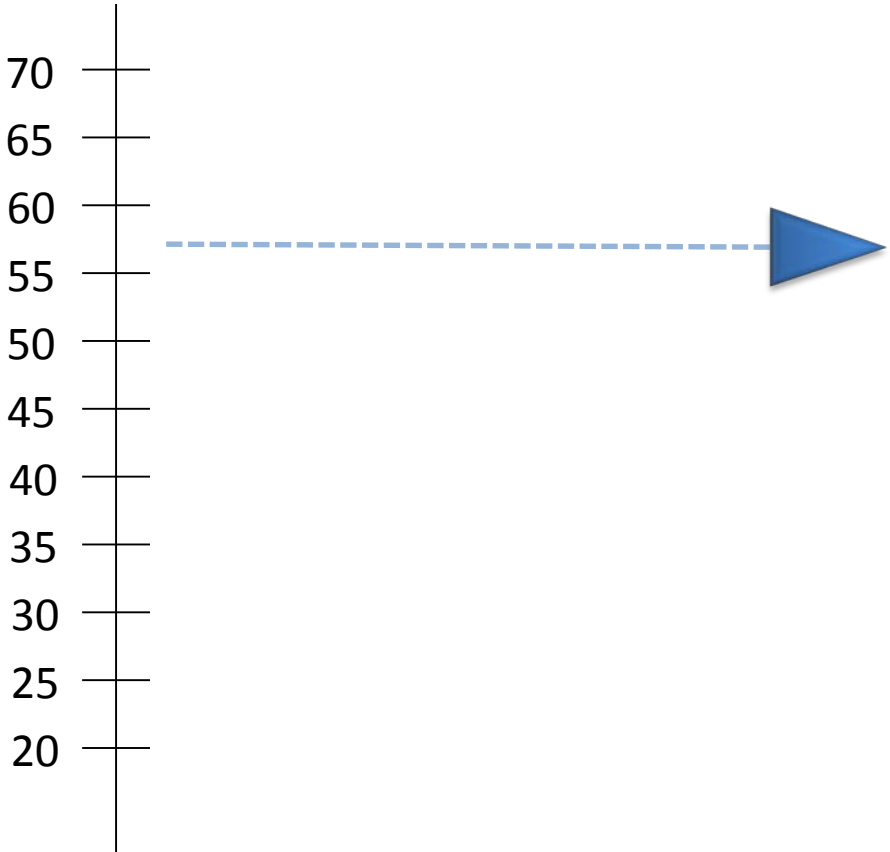
$\mu = 40$
$\sigma = ?$

H_1 :



$\mu = 40$ $\mu = ?$
$\sigma = ?$ $\sigma = ?$

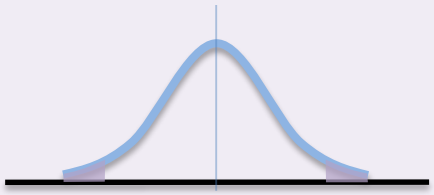
Are grad students stressed more than general population?



A faculty member wanted to know how the stress levels of graduate students compares to the general population. The faculty member administered a stress test to 17 graduate students. Sample average was 50 with a standard deviation of 12. The stress test is known to have an average of 40 for the general population. Are graduate students stress more than the average population? Use an alpha of .05

H_0 : Grad students are as stressed as everyone

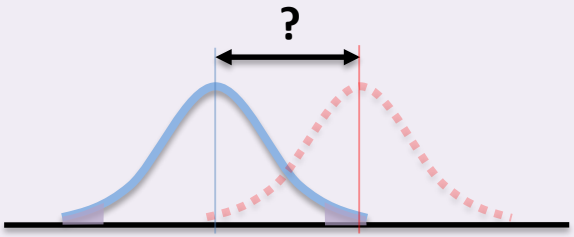
$H_0 : \mu = 40$



$\mu = 40$
$\sigma = 12$

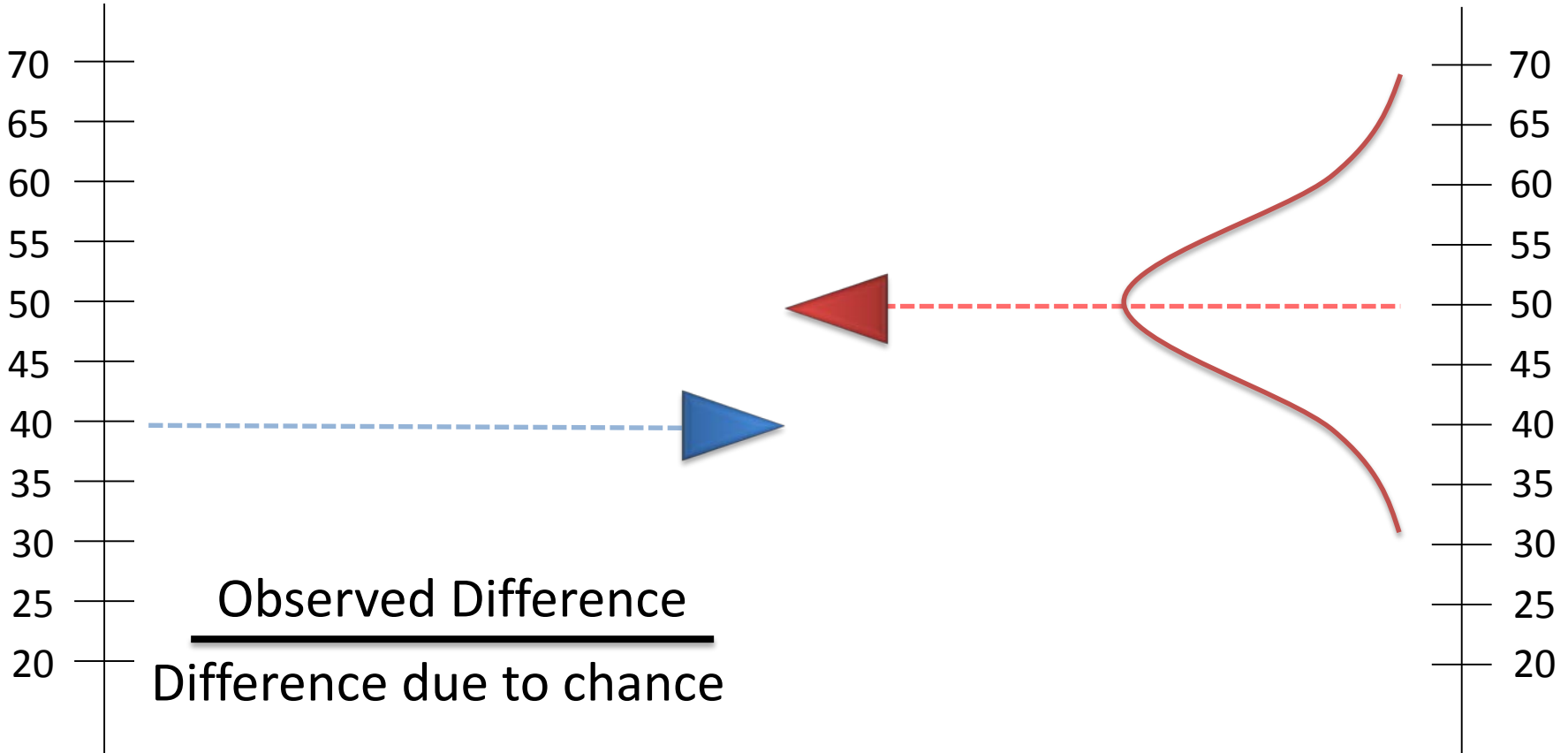
H_1 : No, they are not

$H_1 : \mu \neq 40$



$\mu = 40$ $\bar{X} = 50$
$\sigma = 12$ $s = 12$

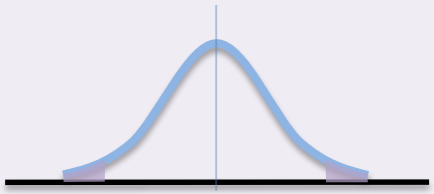
n=17



$$\frac{\text{Observed Difference}}{\text{Difference due to chance}}$$

H_0 : Grad students are as stressed as everyone

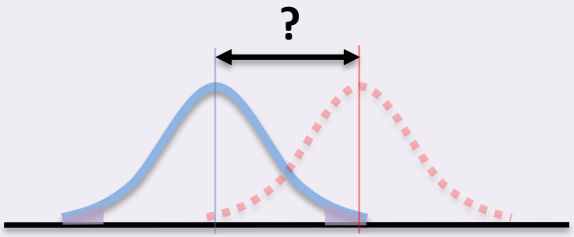
H_0 : $\mu = 40$



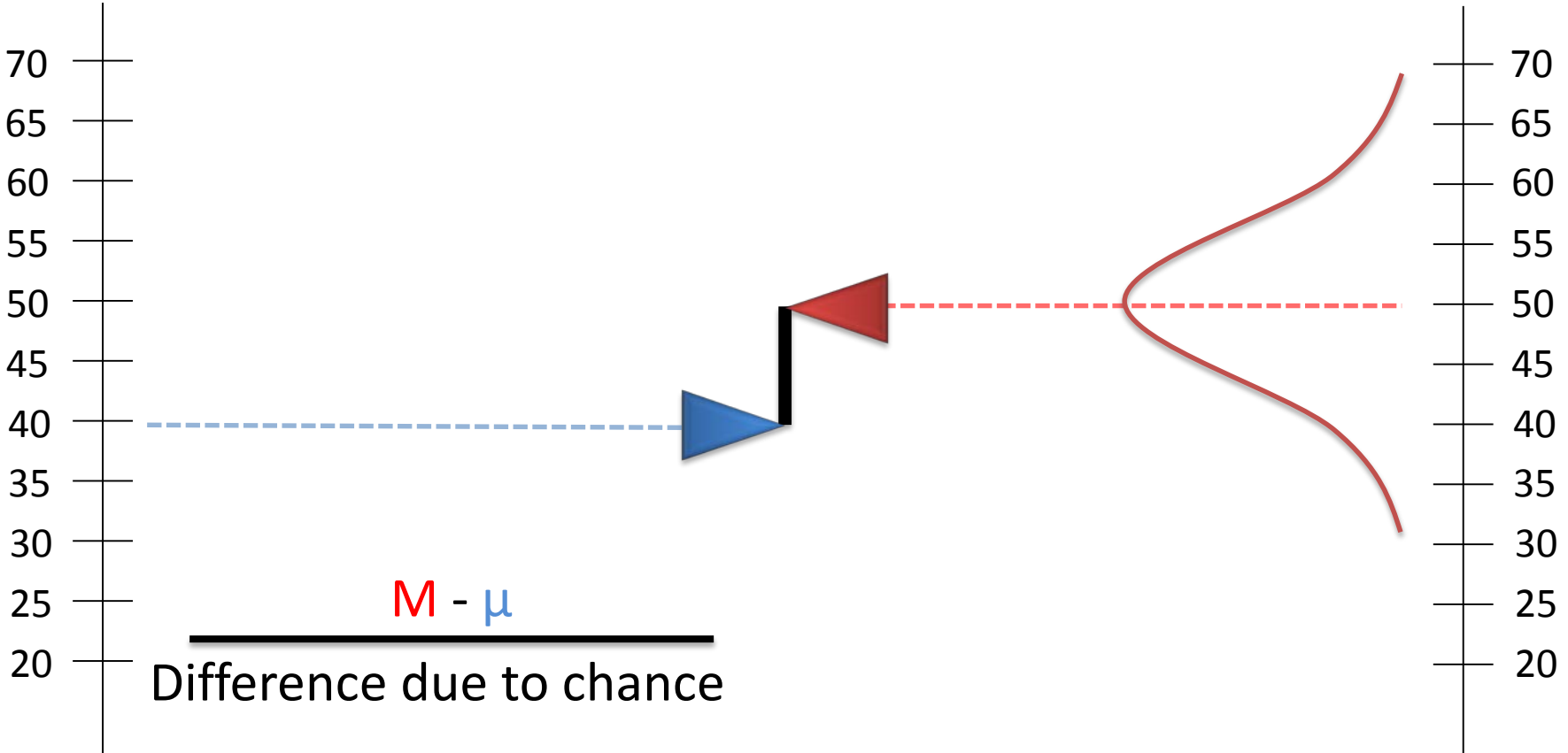
$\mu = 40$
$\sigma = 12$

H_1 : No, they are not

H_1 : $\mu \neq 40$

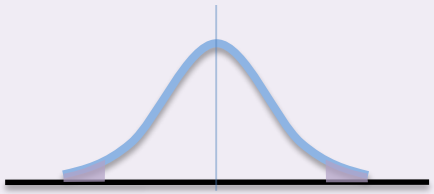


$\mu = 40$ $\bar{X} = 50$
$\sigma = 12$ $s = 12$



H_0 : Grad students are as stressed as everyone

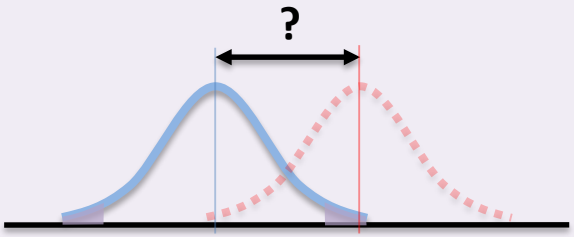
H_0 : $\mu = 40$



$\mu = 40$
$\sigma = 12$

H_1 : No, they are not

H_1 : $\mu \neq 40$



$\mu = 40$ $\bar{X} = 50$
$\sigma = 12$ $s = 12$

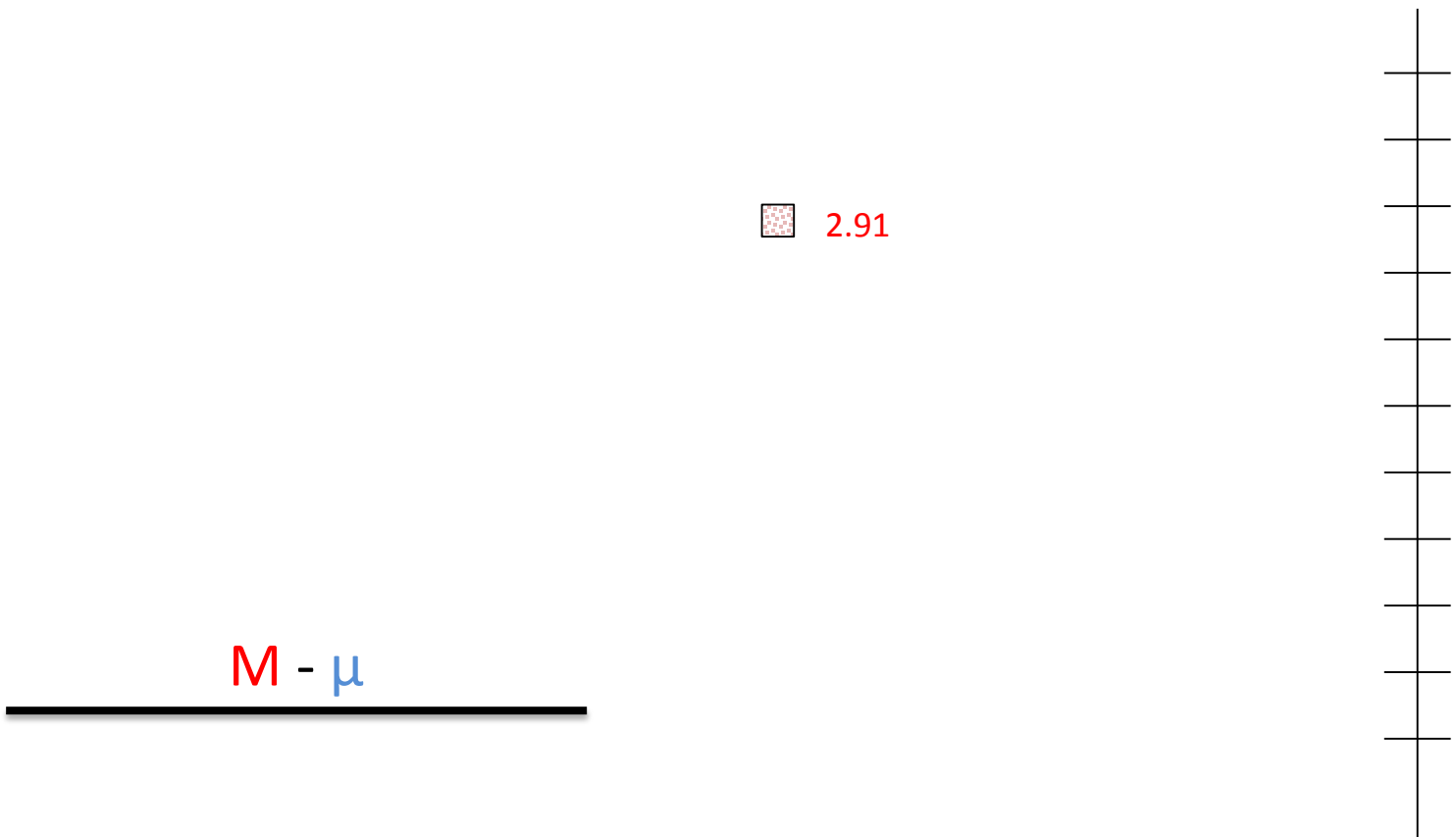
12

s^2

70
65
60
55
50
45
40
35
30
25
20

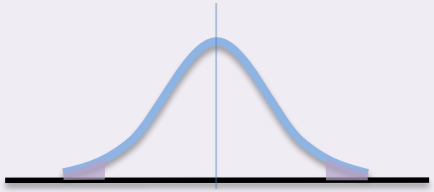
$$\frac{M - \mu}{s^2/\sqrt{n}}$$

70
65
60
55
50
45
40
35
30
25
20


2.91
M - μ

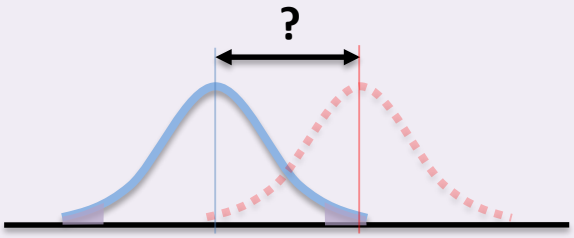
H_0 : Grad students are as stressed as everyone

$H_0 : \mu = 40$



$\mu = 40$
$\sigma = 12$

$H_1 : \mu \neq 40$

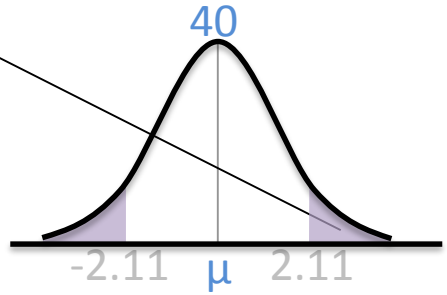


$\mu = 40$ $\bar{X} = 50$
$\sigma = 12$ $s = 12$

$$t = \frac{\bar{X} - \mu}{s_M} = \frac{50-40}{\sqrt{\frac{s^2}{n}}} = \frac{10}{\frac{12}{\sqrt{17}}} = \frac{10}{2.91} = 3.41$$

10

Sampling Distribution



$t_{crit} = \pm 2.11$

$df = n - 1 = 16$

Reject H_0

s^2

s^2_M

2.91

d = .83

50

$\mu = 40$
$\sigma = 12$

M = 50
s = 12

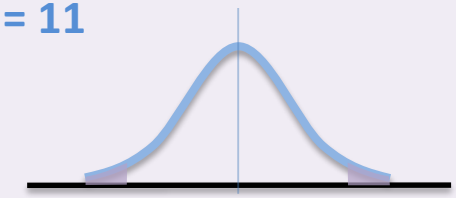
One-sample t-test indicated that graduate student(M = 50, s = 12, n = 17) were more stressed than general population, $t(16) = 3.41$, $p<.05$, SEM=2.91, Cohen's D =0.83.

R-Square as Proportion of Variance Explained

Visual Guide

H_0 : Boxers live 11 years

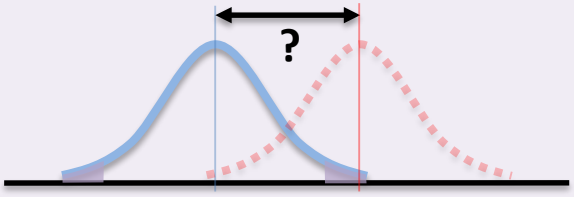
$H_0 : \mu = 11$



$\mu = 11$
$\sigma = ?$

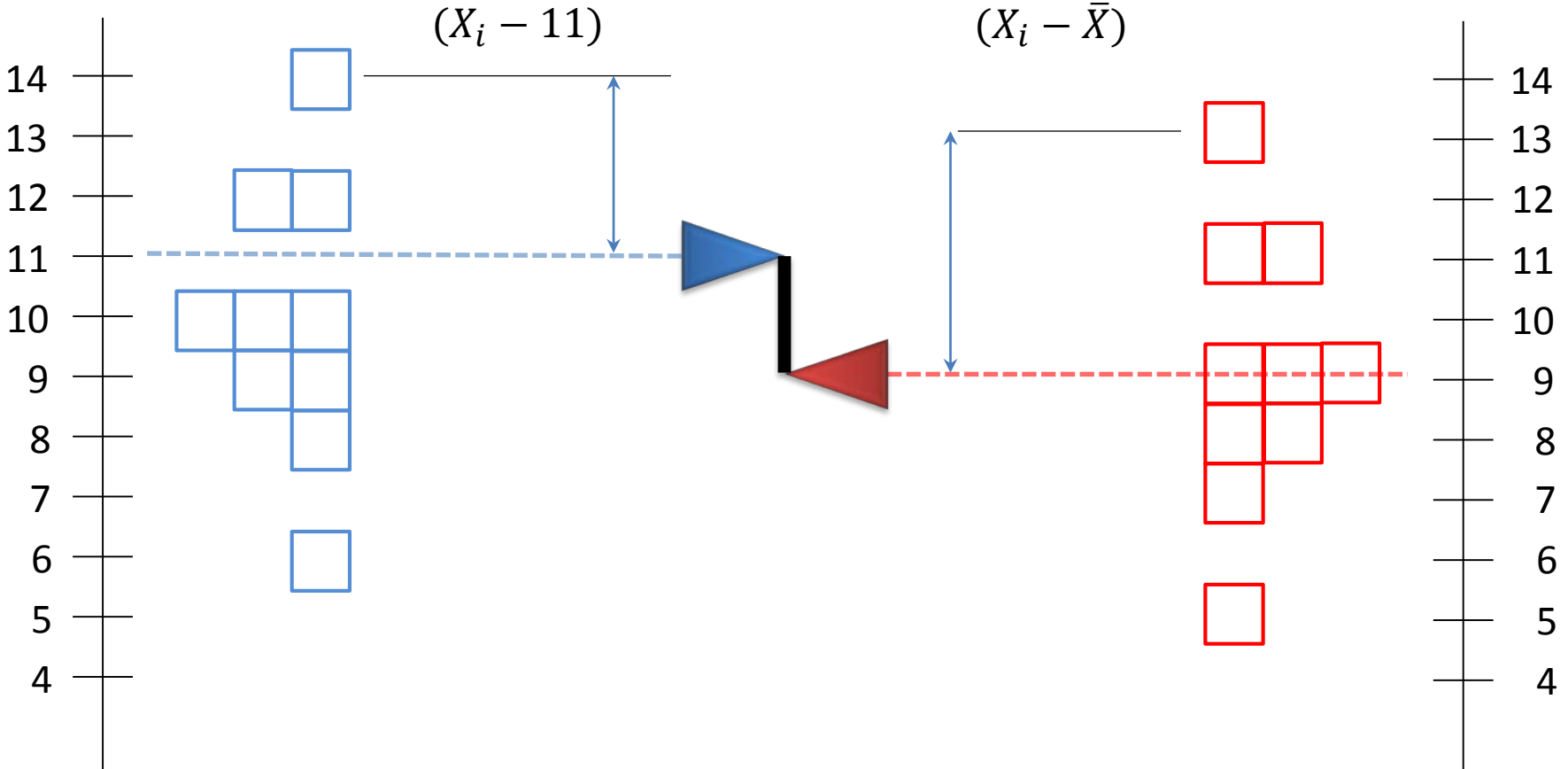
H_1 : No, something else

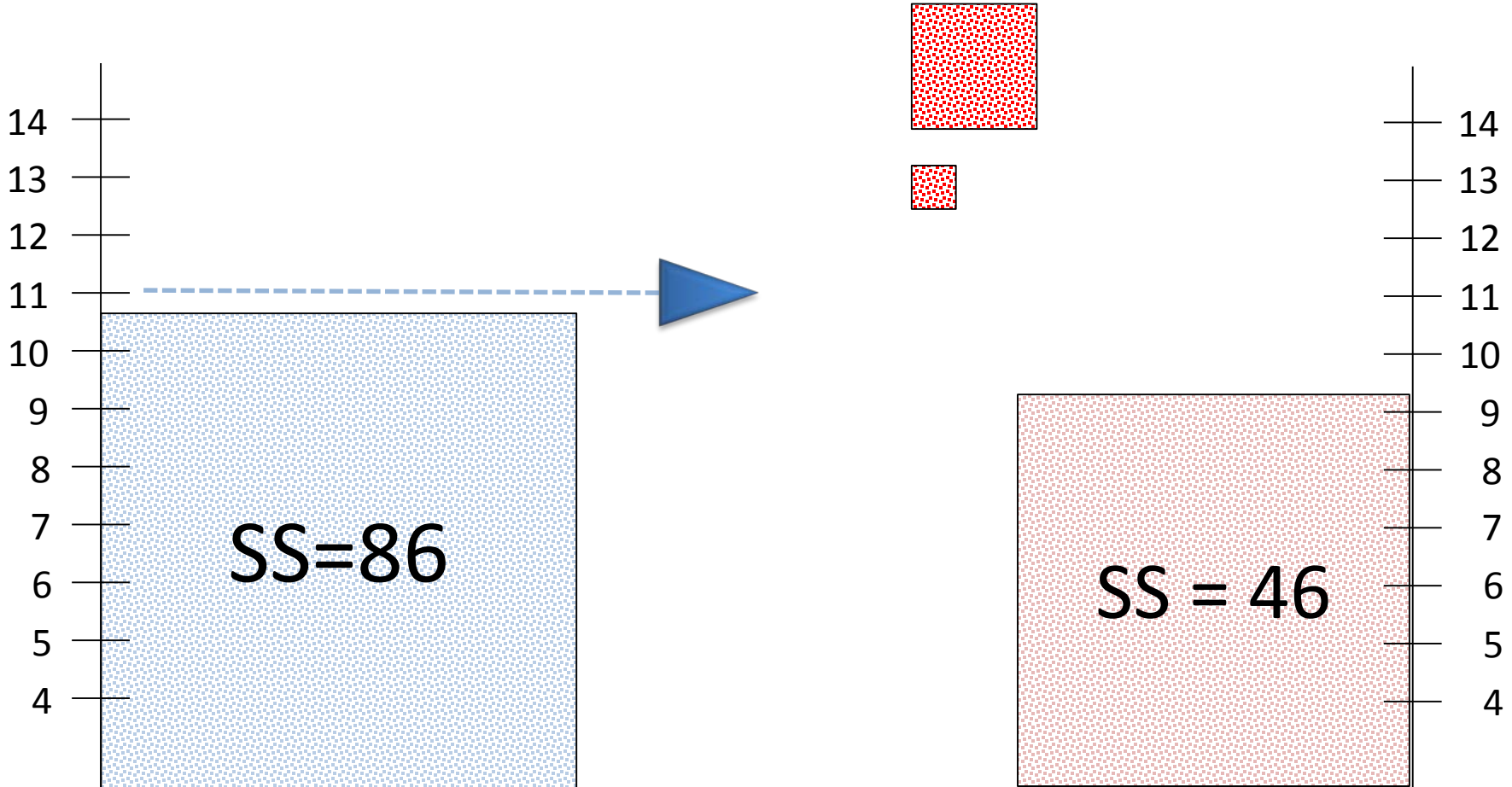
$H_1 : \mu \neq 11$

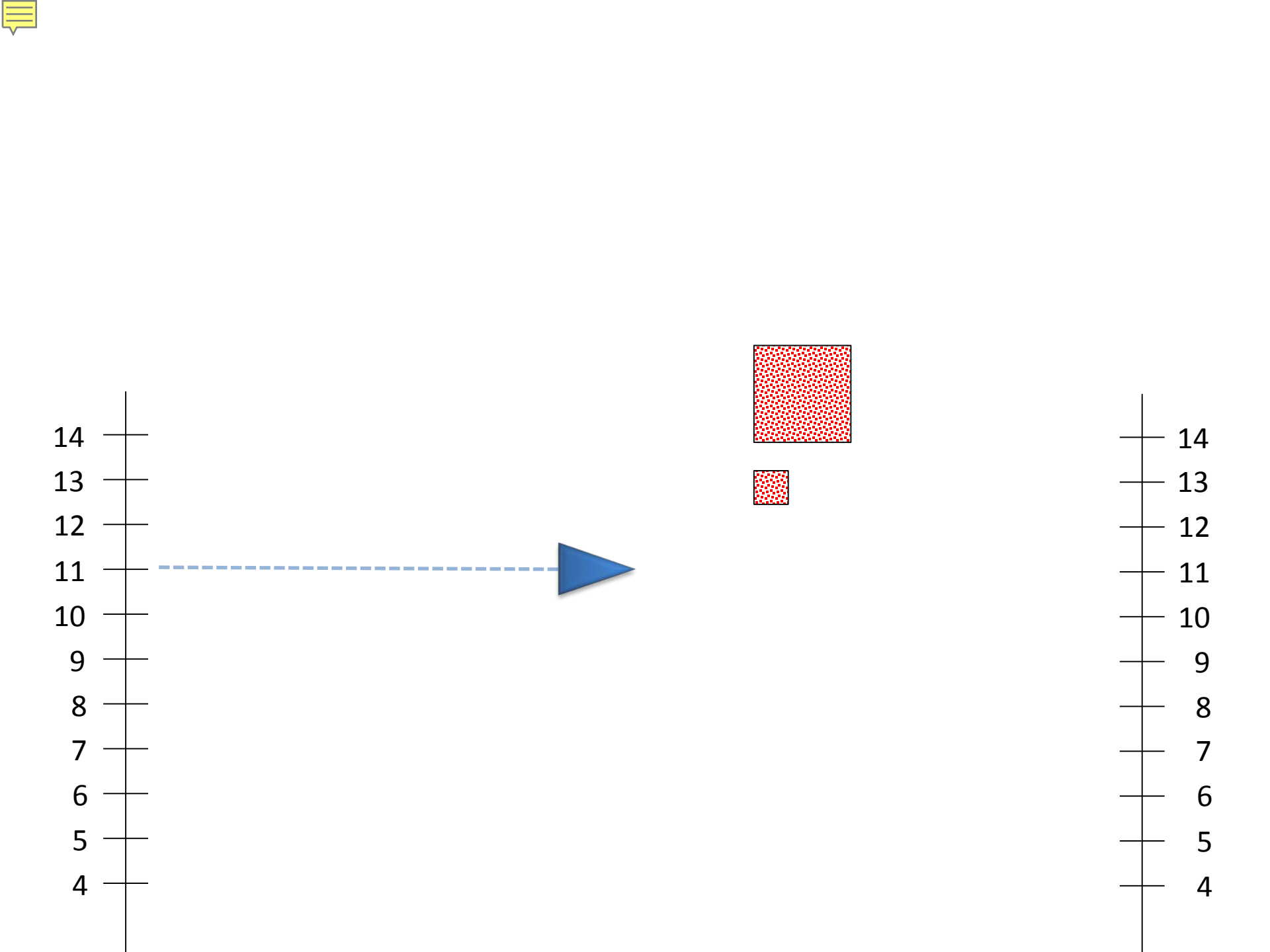


$\mu = 11$ $\mu = ?$
$\sigma = ?$ $\sigma = ?$

R^2




14
13
12
11
10
9
8
7
6
5
4
SS=86
SS = 46
14
13
12
11
10
9
8
7
6
5
4


14
13
12
11
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9
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4
14
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12
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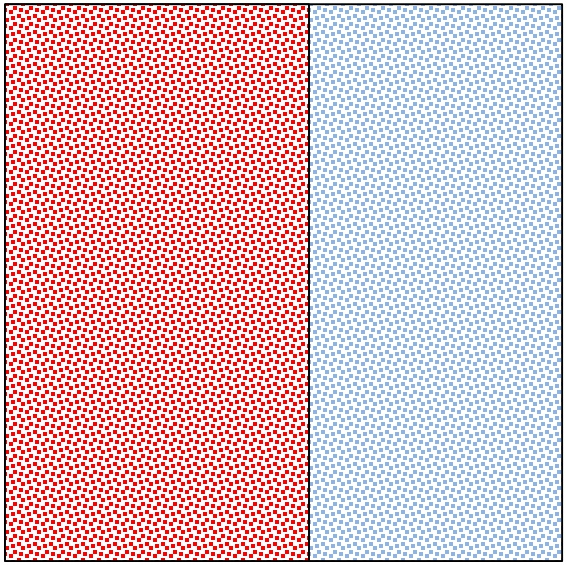
6
5
4

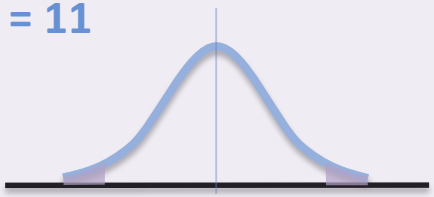


46

SST = 86

H_0 : Boxers live 11 years

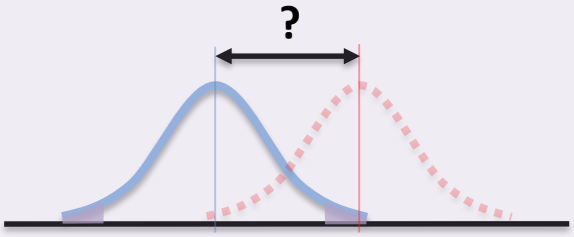
$H_0 : \mu = 11$



$\mu = 11$
$\sigma = 2.3$

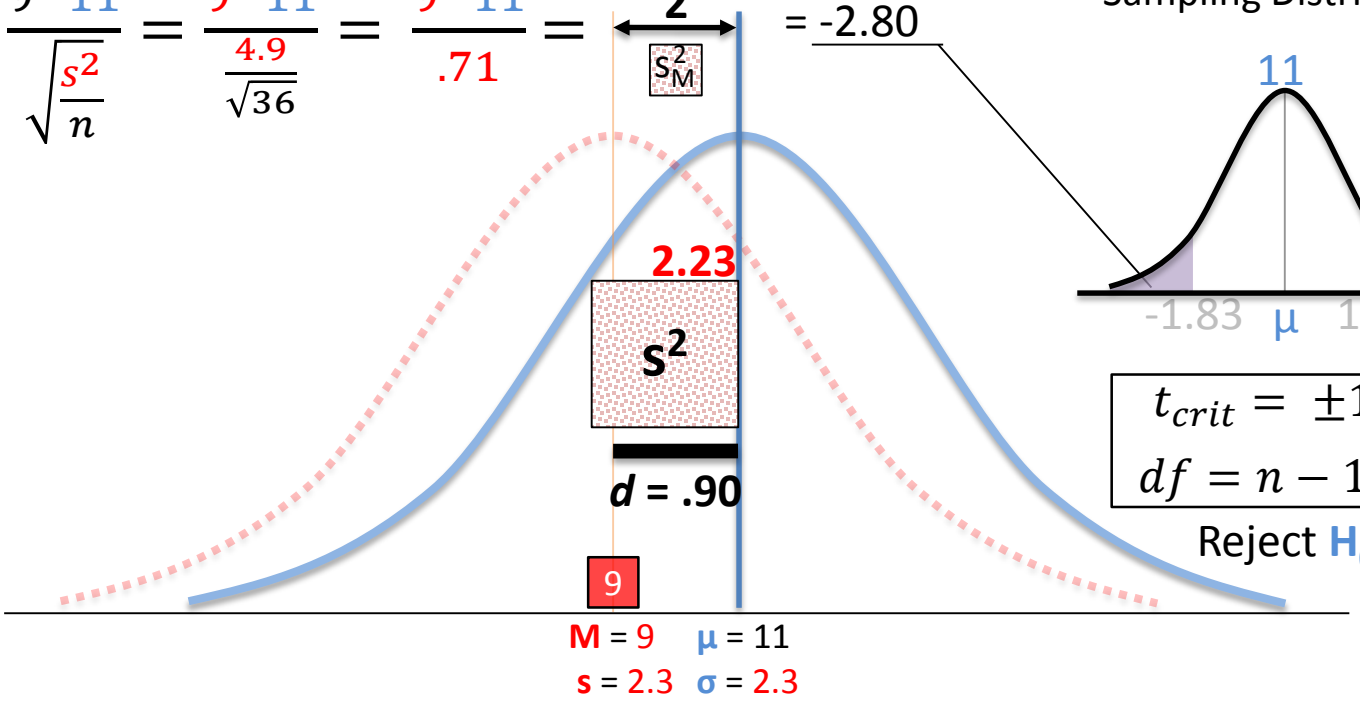
H_1 : No, something else

$H_1 : \mu \neq 11$

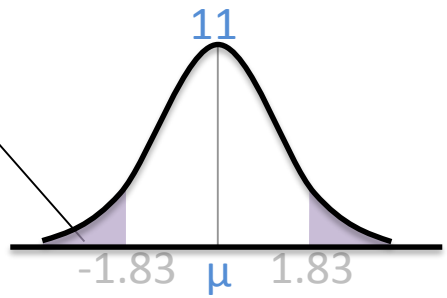


$\mu = 11$ $\bar{X} = 9$
$\sigma = 2.3$ $s = 2.3$

$$t = \frac{\bar{X} - \mu}{s_M} = \frac{9-11}{\sqrt{\frac{s^2}{n}}} = \frac{9-11}{\frac{4.9}{\sqrt{36}}} = \frac{9-11}{.71} = \frac{2}{s_M^2} = -2.80$$



Sampling Distribution

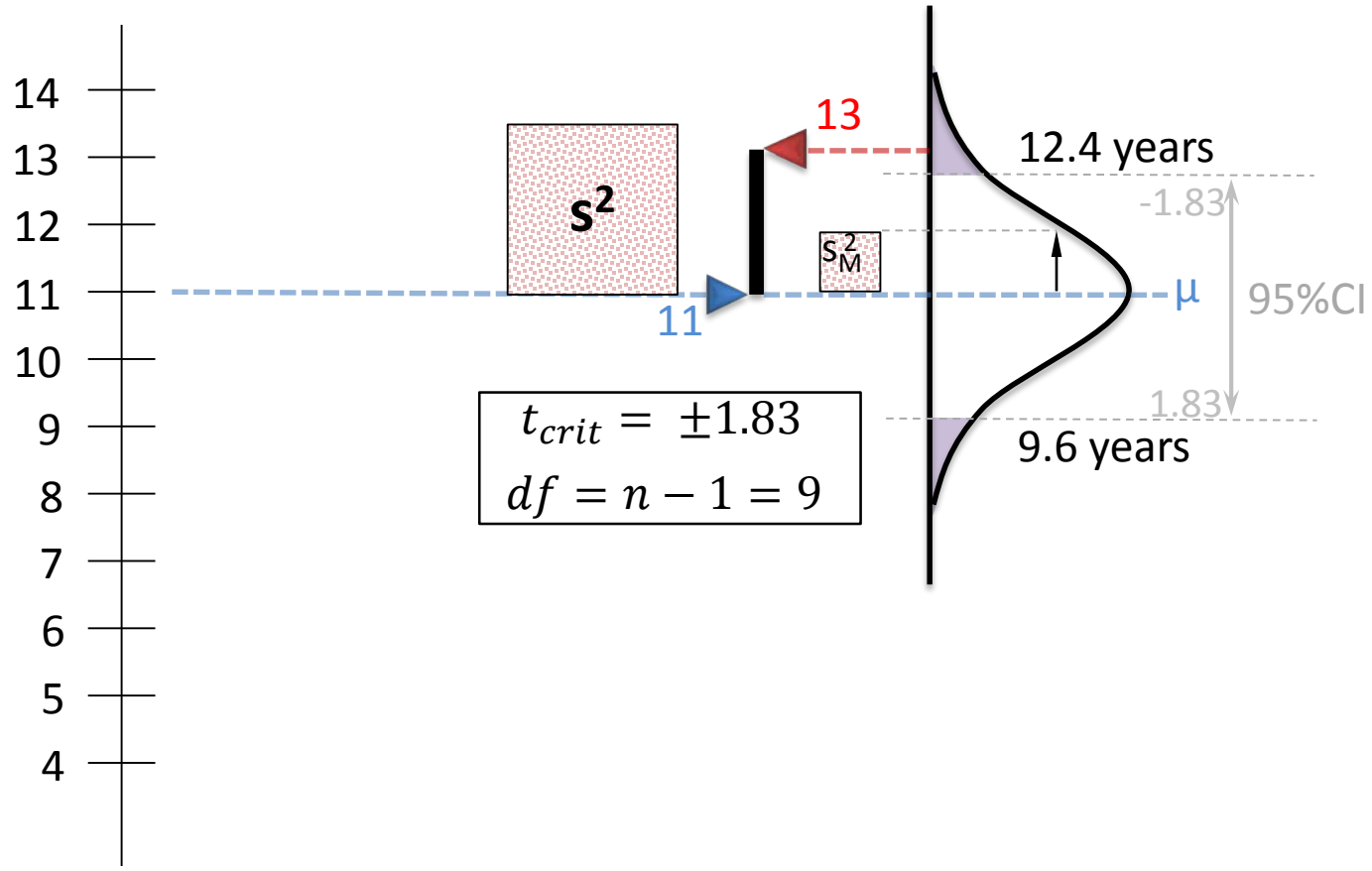


$t_{crit} = \pm 1.83$

$df = n - 1 = 9$

Reject H_0

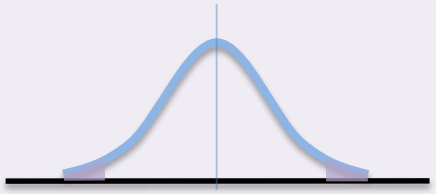
One-sample t-test indicated that boxers (M = 9, s = 2.23, n = 10) live significantly less than 11 years, $t(9)$ = -2.80, p<.05, SEM=0.71, , Cohen's D =0.90.


14
13
12
11
10
9
8
7
6
5
4
13
s^2
s^2_M
11
μ
12.4 years
-1.83
95%CI
1.83
9.6 years
$t_{crit} = \pm 1.83$
$df = n - 1 = 9$

1.83

H_0 : Males Boxers live as long as Females

$H_0 : \mu_{male} = \mu_{female}$

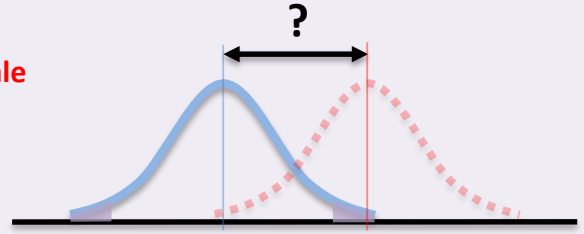


$\mu = 9$

$\sigma = 2.3$

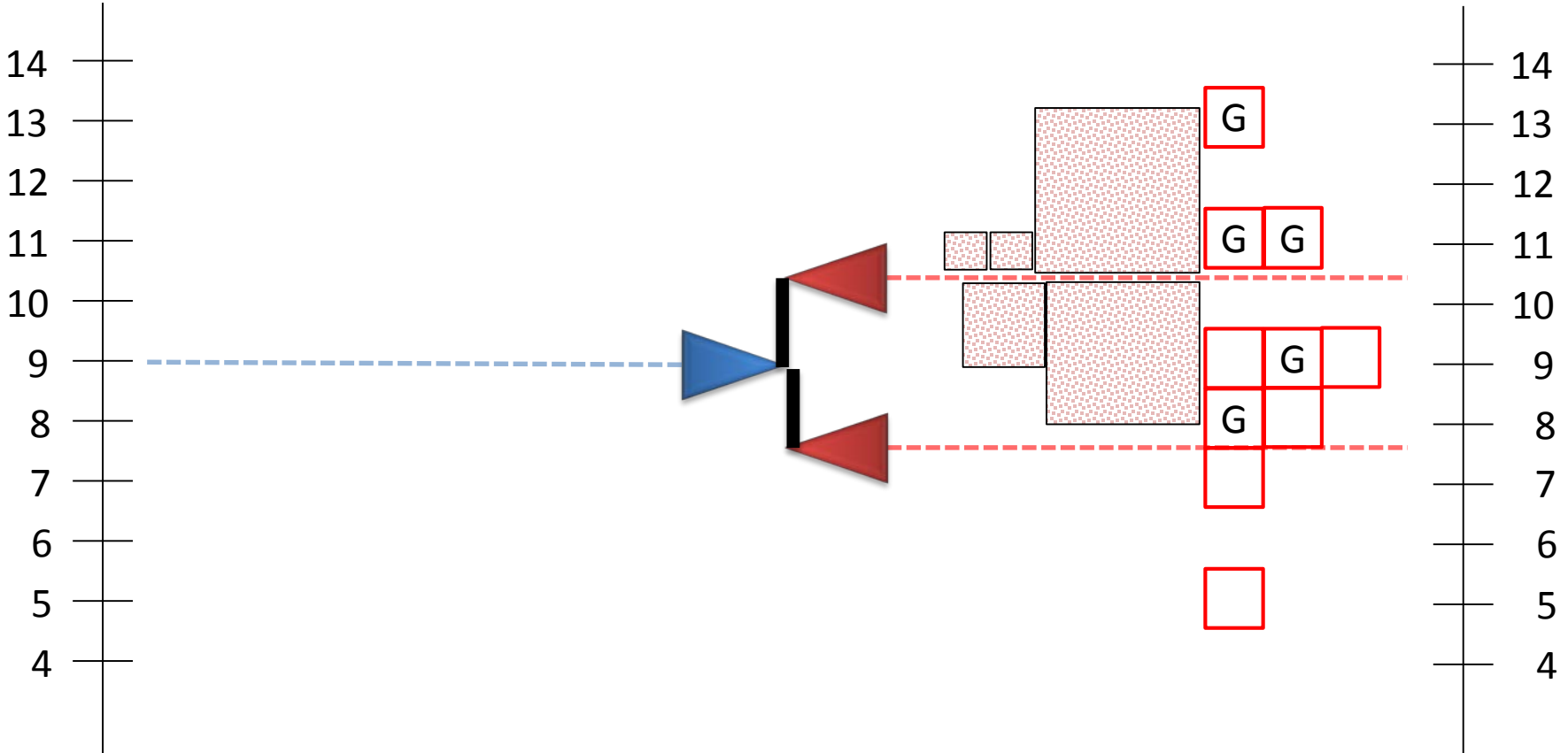
H_1 : No, they are different

$H_1 : \mu_{male} \neq \mu_{female}$



$X = 10.4$ $\bar{X} = 9.6$

$s = 1.81$ $s = 1.81$



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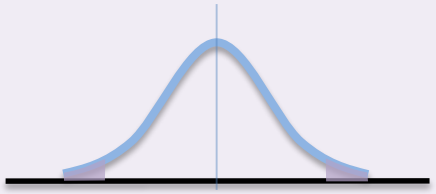

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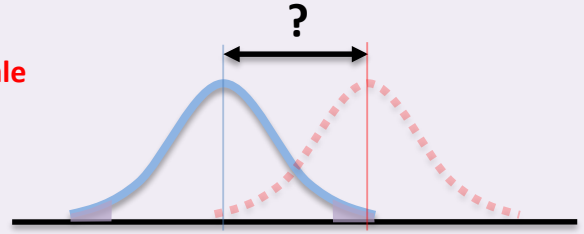

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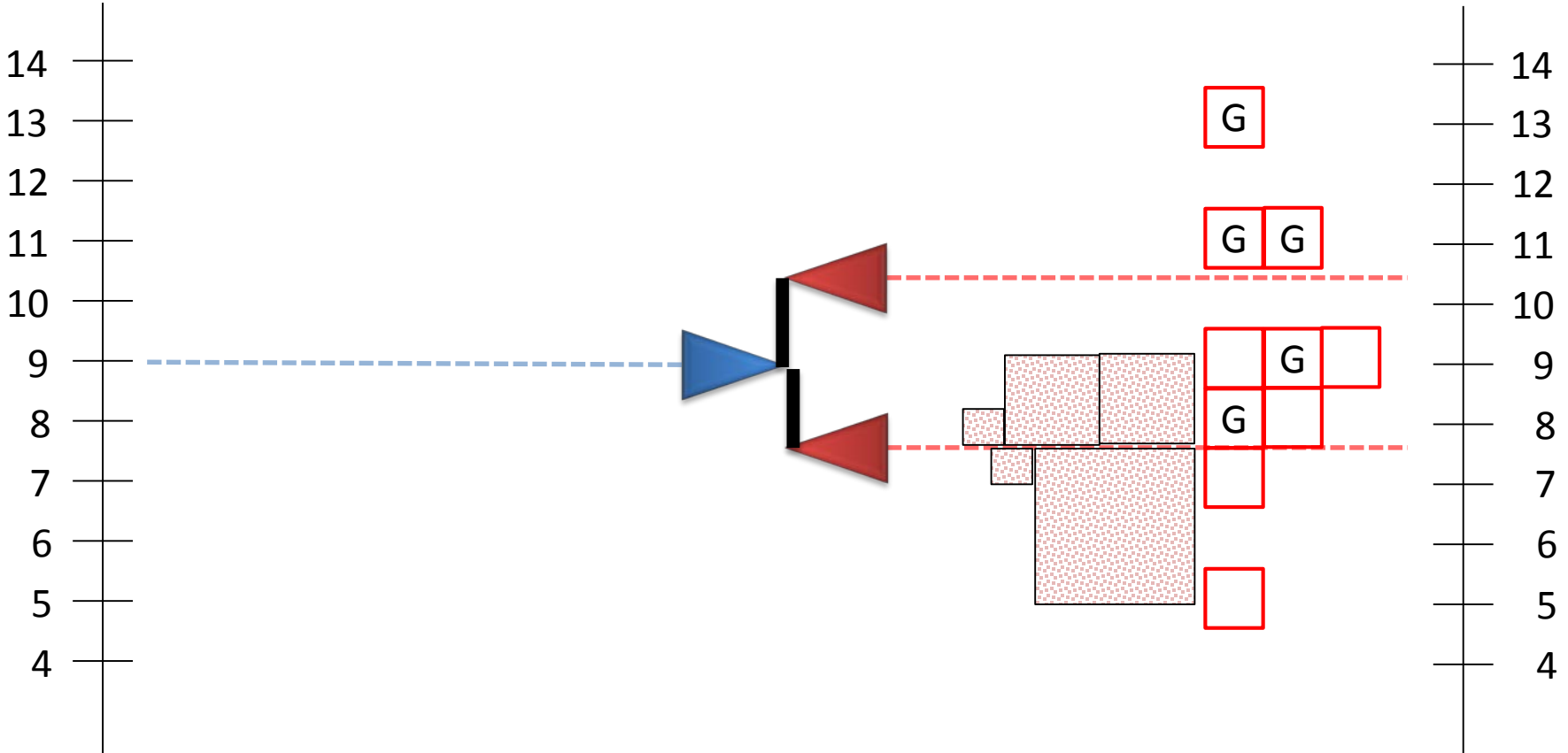

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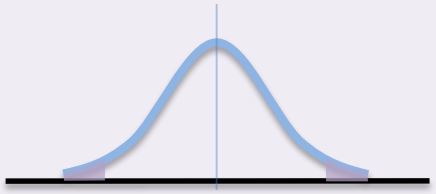

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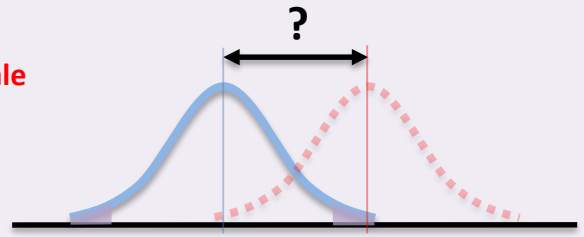

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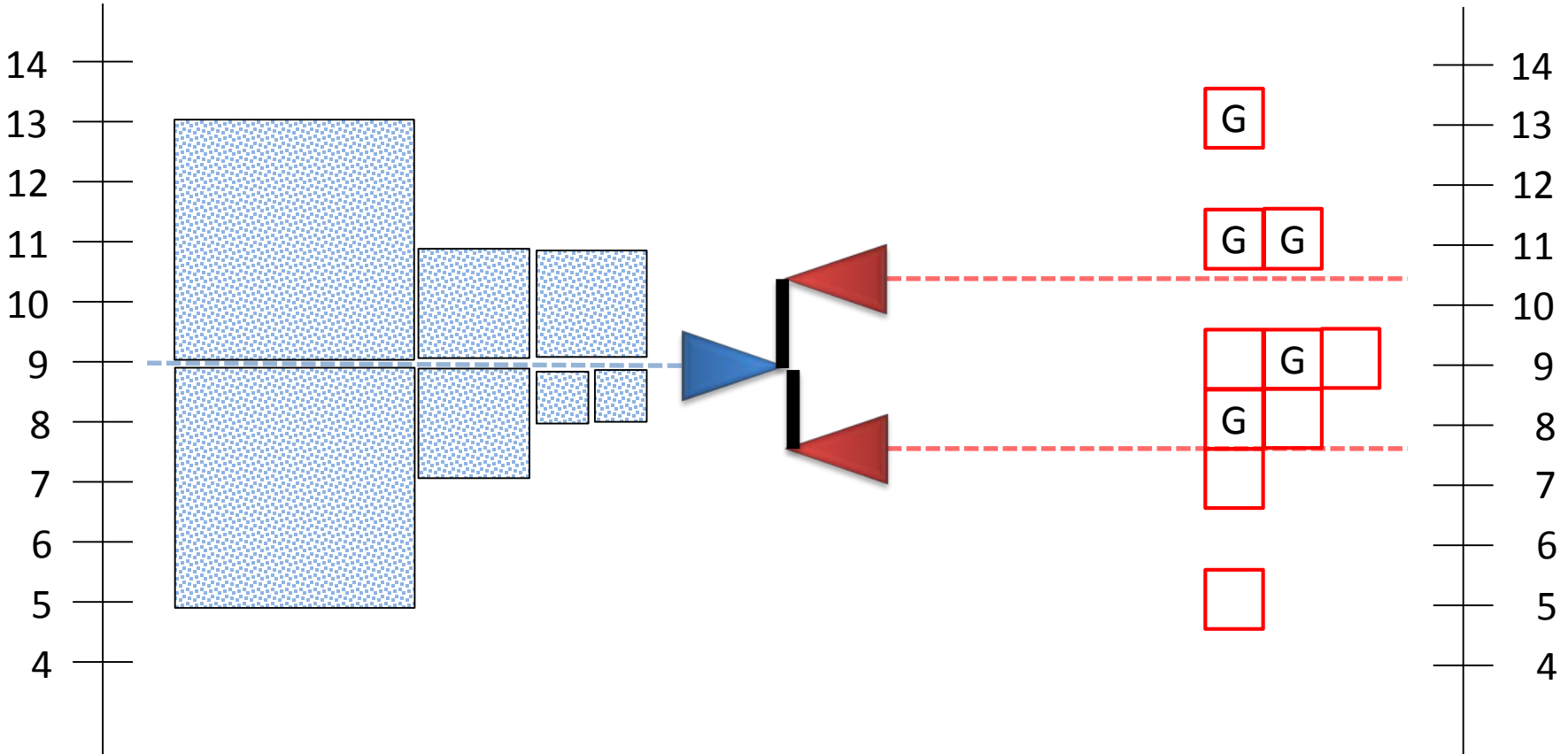

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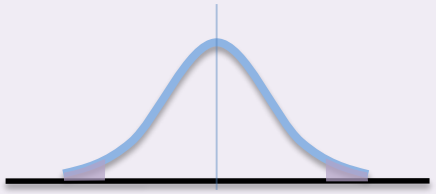

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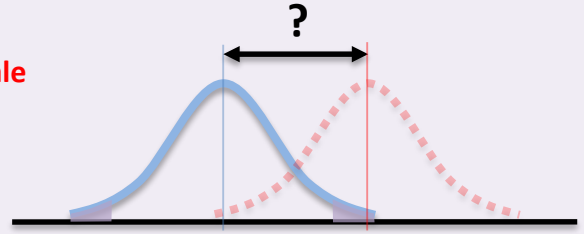

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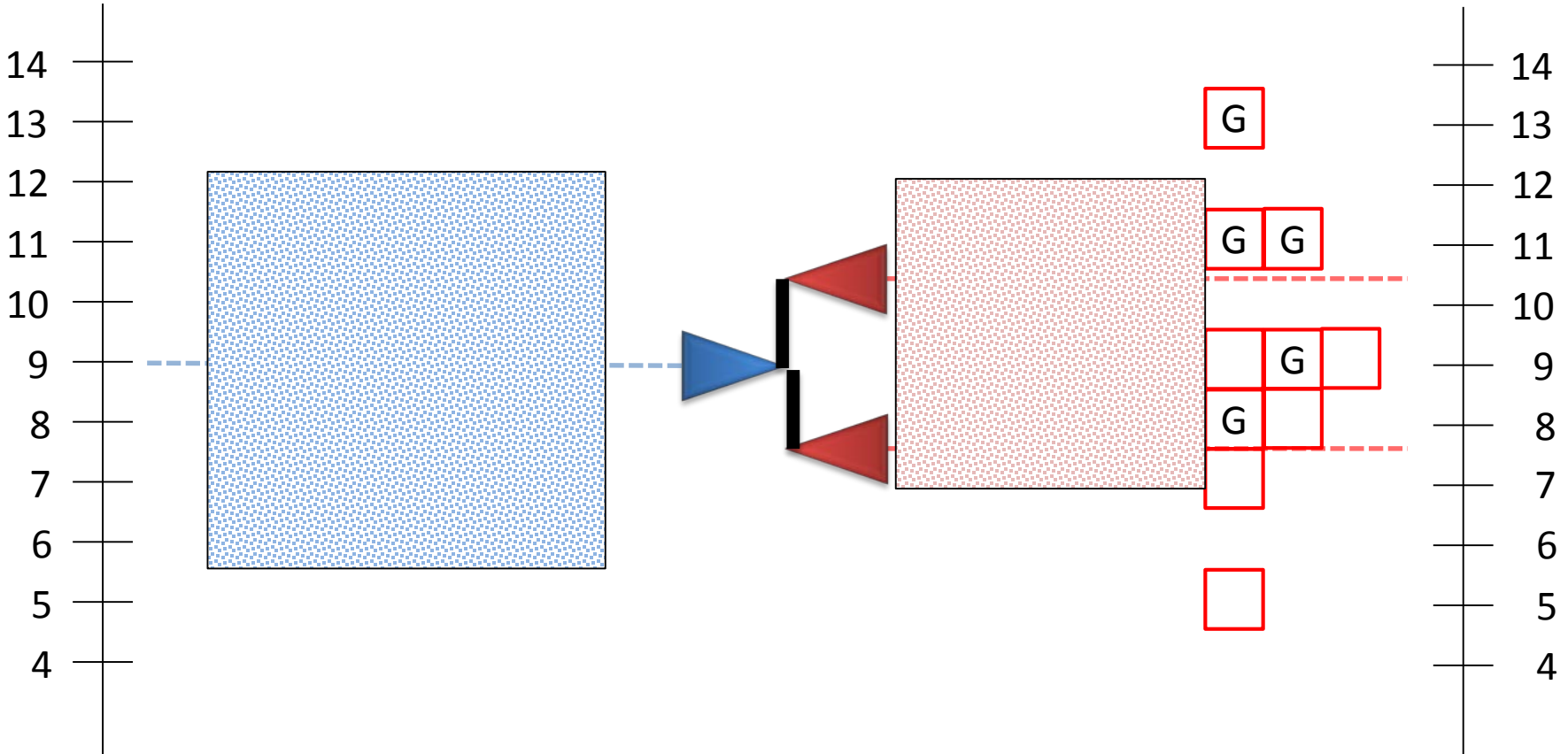

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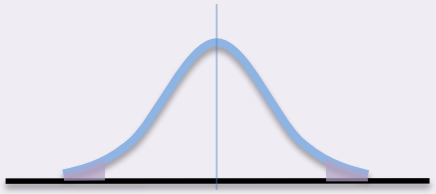

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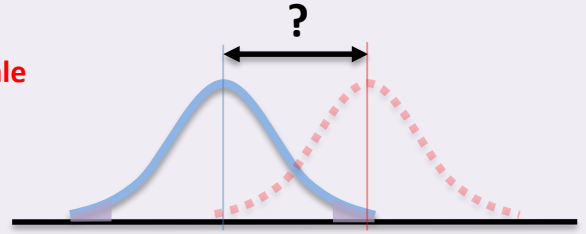

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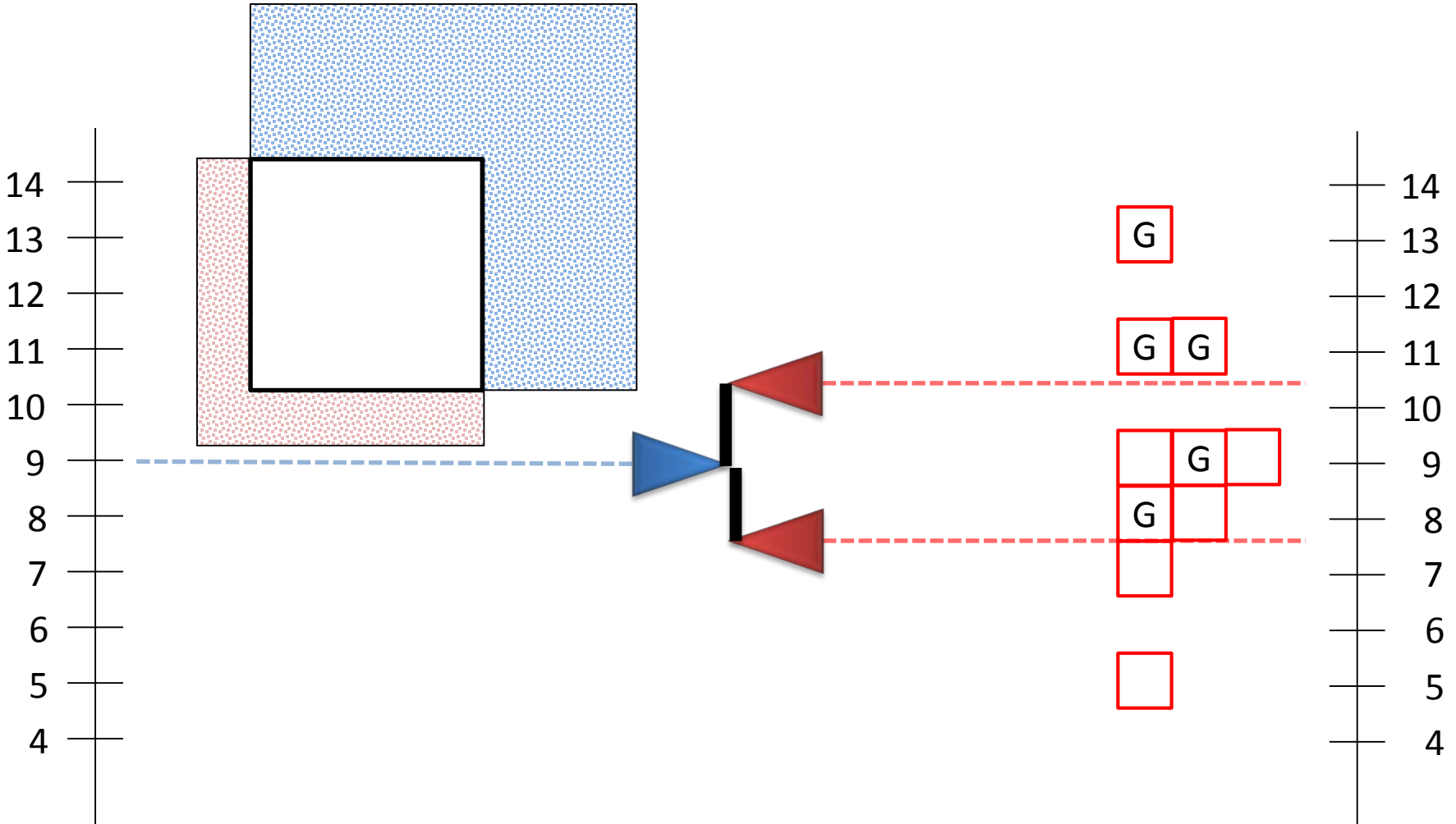

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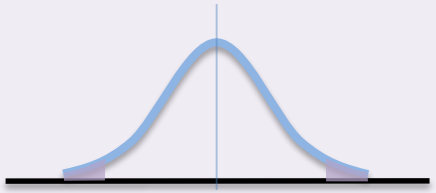

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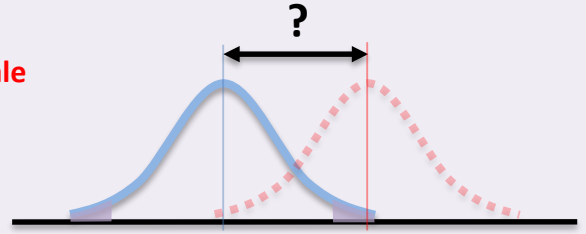

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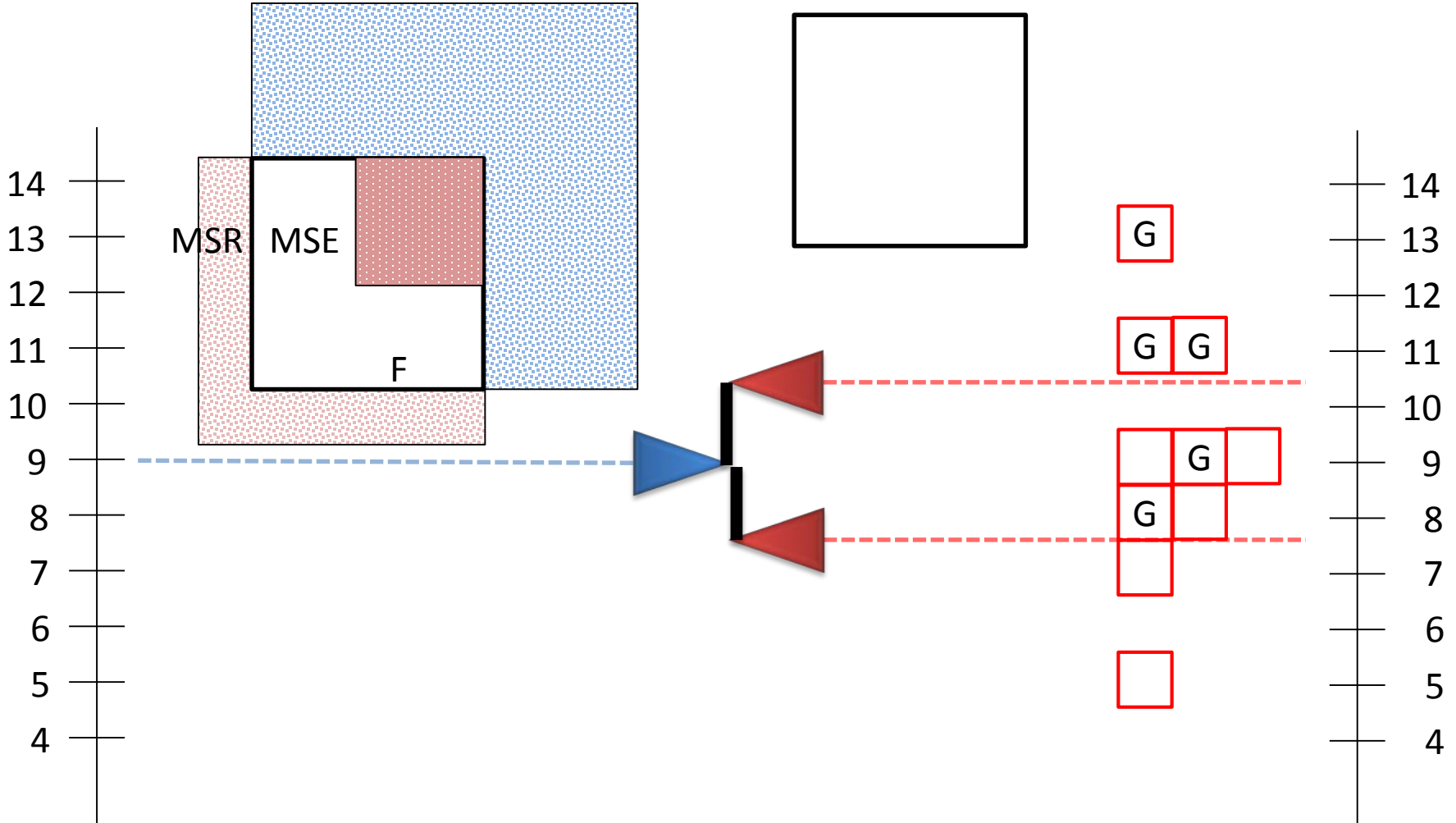
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