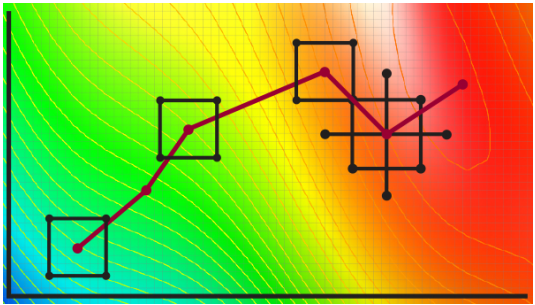
Experimentation for Improvement



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Design and Analysis of Experiments

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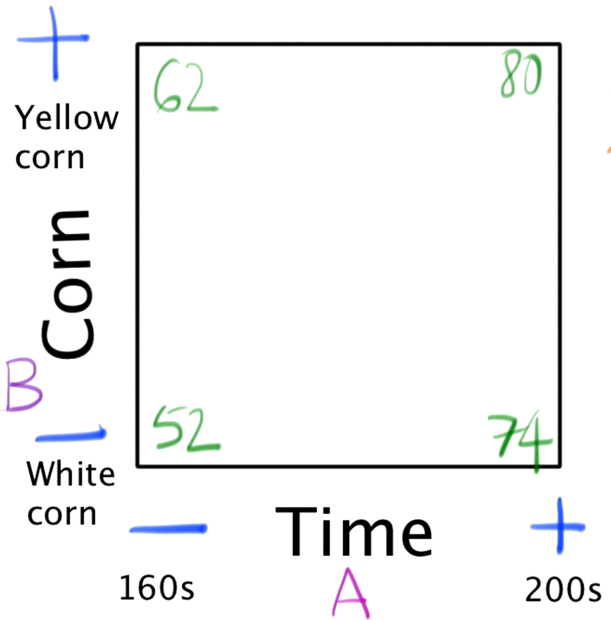
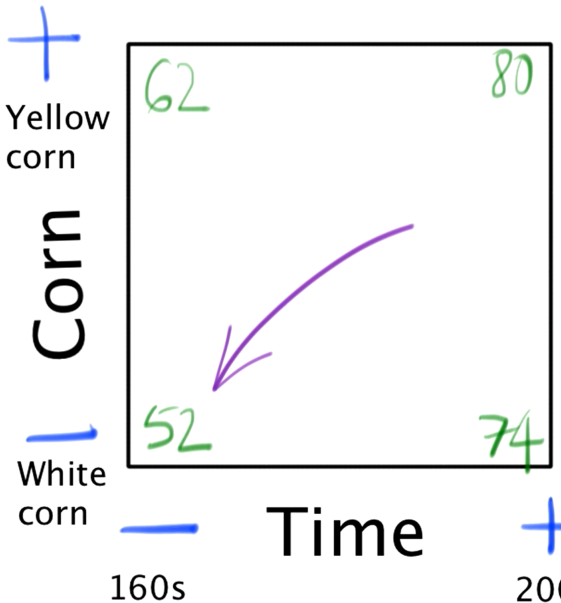


$$\hat{y} = 67 + 10x_A + 4x_B$$

prediction



$$\hat{y} = 67 + 10x_A + 4x_B$$

Predicted popcorn $= \hat{y}$

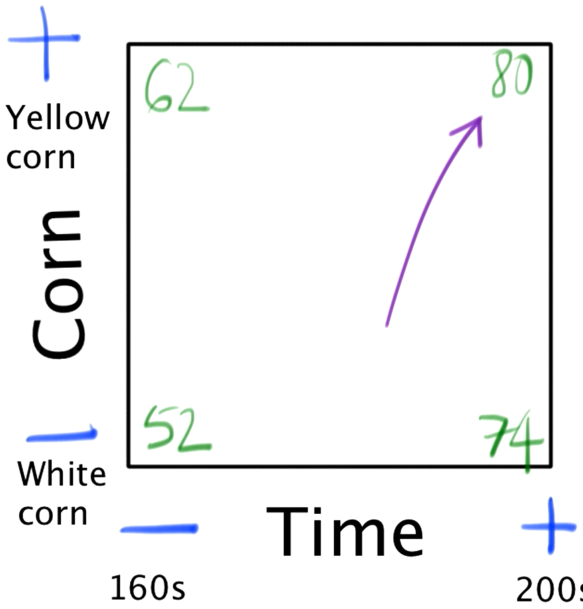
$$\hat{y} = 67 + (10)(-1) + (4)(-1)$$

(10): the "time" [A] effect

(4): the "corn" [B] effect

$$\hat{y} = 67 - 10 - 4$$

$= 53$ popped corns



$$\hat{y} = 67 + 10x_A + 4x_B$$

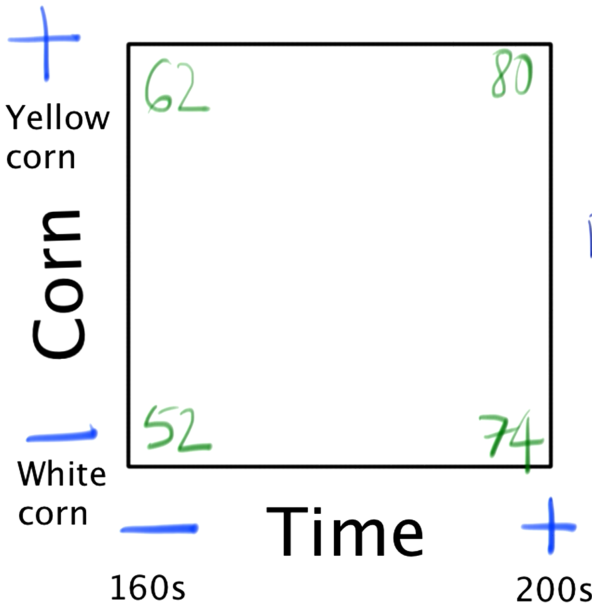
Predicted popcorn $= \hat{y}$

$$\hat{y} = 67 + (10)(+1) + (4)(+1)$$

A effect B effect

$$\hat{y} = 67 + 10 + 4$$

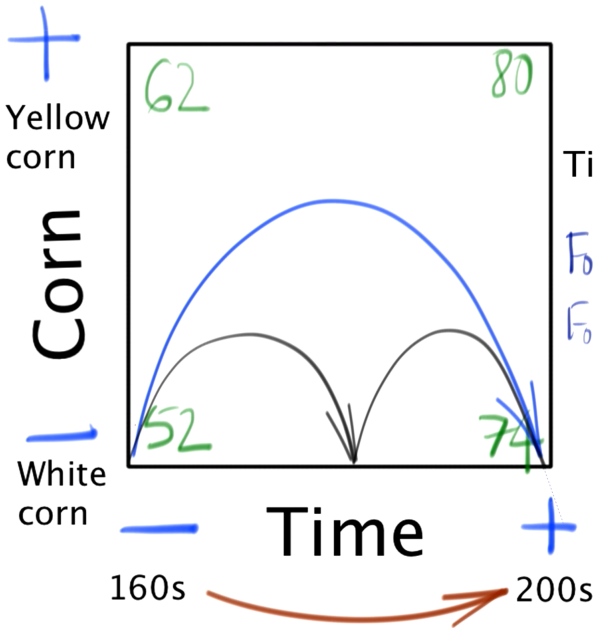
$$\hat{y} = 81 \quad (\text{close to } 80)$$



$$\hat{y} = 67 + 10x_A + 4x_B$$

$$\text{Baseline} = \frac{52 + 74 + 62 + 80}{4}$$

$$= 67$$



$$\hat{y} = 67 + 10x_A + 4x_B$$

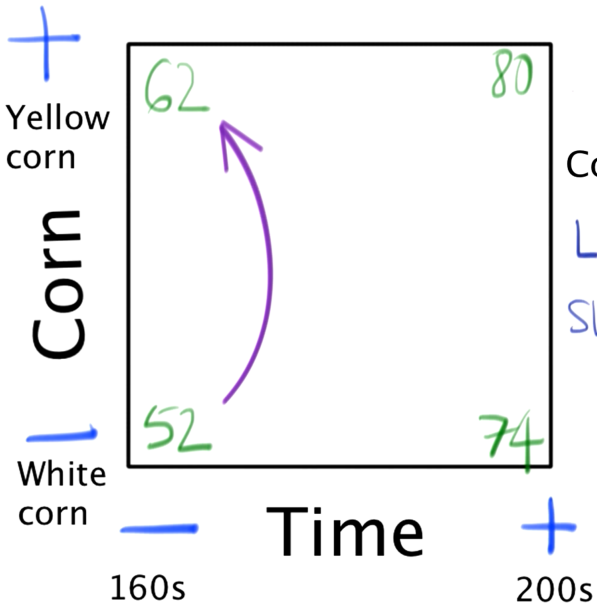
Time effect (A): from **high** to **low**

For yellow corn: $80 - 62 = 18$

For white corn: $74 - 52 = 22$

Average $= 20$

Report it as: 10 extra popped corns when cooking time is increased by 20 seconds.



$$\hat{y} = 67 + 10x_A + 4x_B$$

Corn effect (B): from **high** to **low**

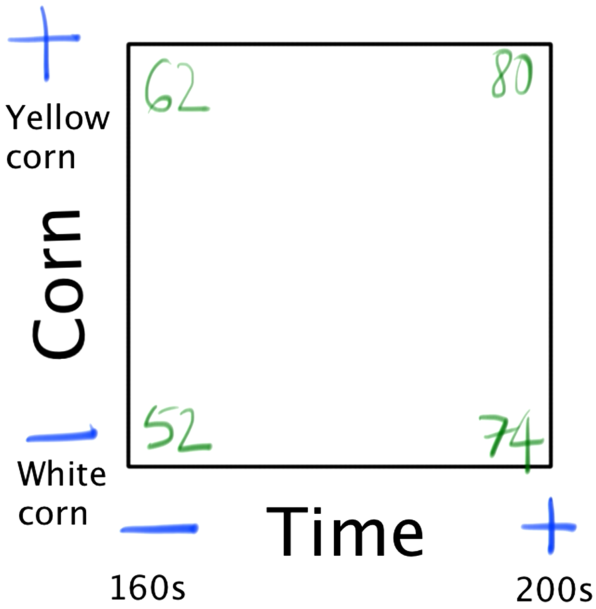
Long (200s) cooking time: $80 - 74 = 6$

Short cooking time: $62 - 52 = 10$

Average $= 8$

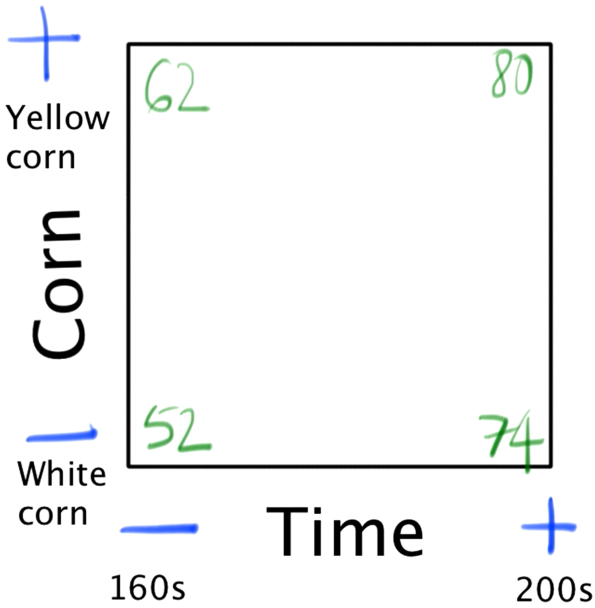
Report it as: 4 extra popped corns for the corn (B) effect.

But note that categorical factors have a messier interpretation.



$$\hat{y} = 67 + 10x_A + 4x_B$$

coded variables



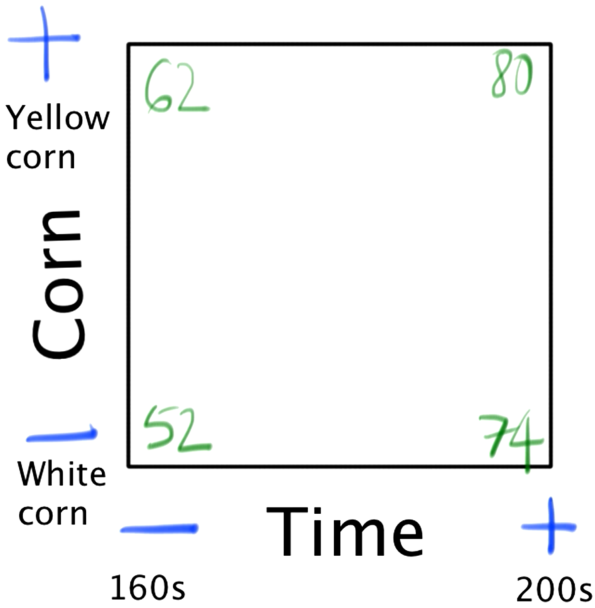
$$\hat{y} = 67 + 10x_A + 4x_B$$

coded variables

"to represent"

$x_B = -1$ represents "white corn"

$x_B = +1$ represents "yellow corn"



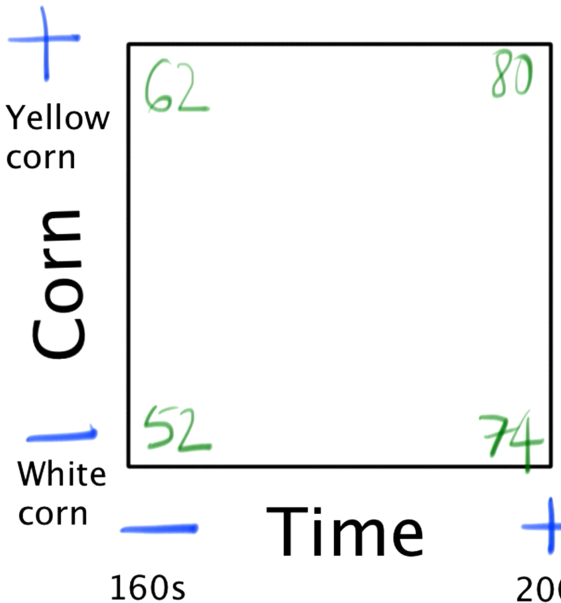
$$\hat{y} = 67 + 10x_A + 4x_B$$

coded variables

"to represent"

$x_A = -1$ represents 160 seconds

$x_A = +1$ represents 200 seconds



$$\hat{y} = 67 + 10x_A + 4x_B$$

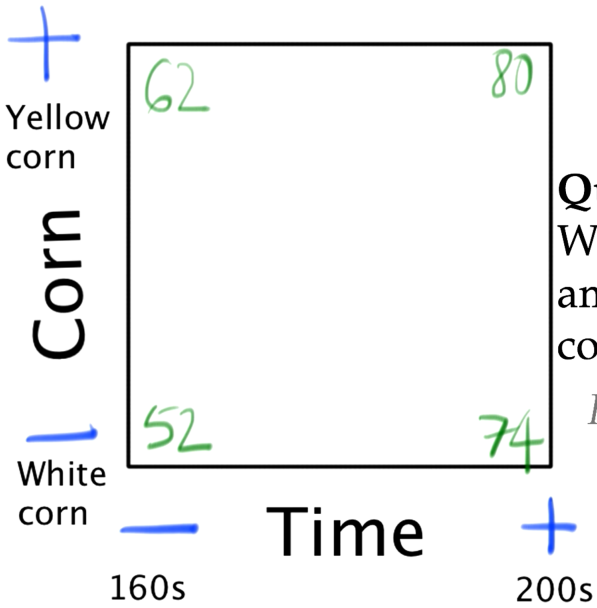
coded variables

"to represent"

$x_A =$ 0	represents	180 seconds
$x_A =$ 0.5	represents	190 seconds

coded units

real-world values

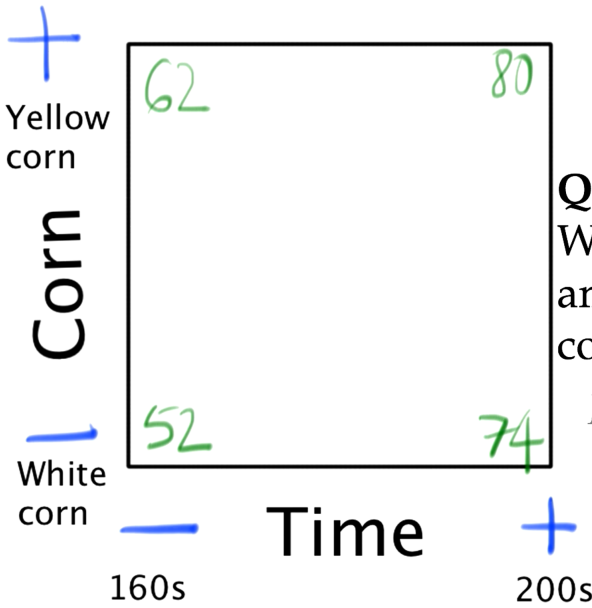


$$\hat{y} = 67 + 10x_A + 4x_B$$

Question

What is the predicted popcorn amount for white corn and a cooking time of 200 seconds?

Hint: $x_A = +1$ and $x_B = -1$



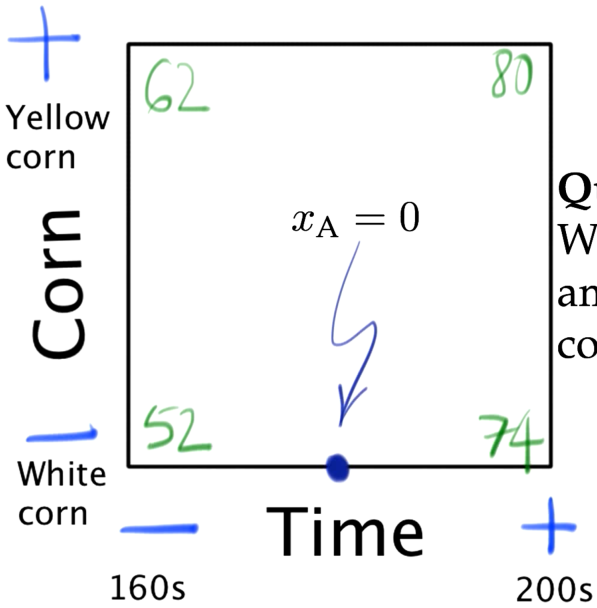
$$\hat{y} = 67 + 10x_A + 4x_B$$

Question

What is the predicted popcorn amount for white corn and a cooking time of 200 seconds?

Hint: $x_A = +1$ and $x_B = -1$

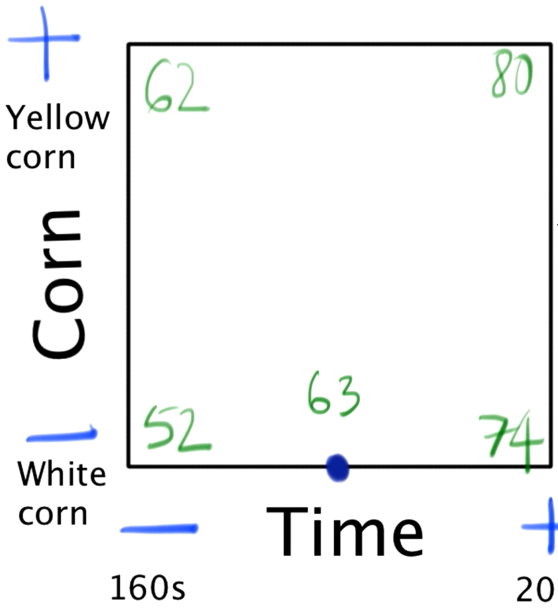
$$\hat{y} = 67 + (10)(+1) + (4)(-1)$$
$$= 67 + 10 - 4 = 73$$



$$\hat{y} = 67 + 10x_A + 4x_B$$

Question
What is the predicted popcorn amount for white corn and a cooking time of **180 seconds**?

Hint: Visualize this point on the cube plot



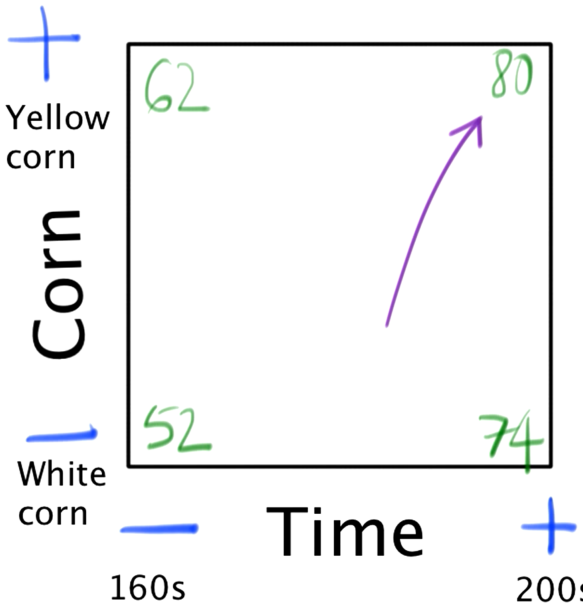
$$\hat{y} = 67 + 10x_A + 4x_B$$

Question

What is the predicted popcorn amount for white corn and a cooking time of **180 seconds**?

$$\hat{y} = 67 + (10)(0) + (4)(-1)$$

$$\hat{y} = 67 + 0 - 4 = 63$$



$$\hat{y} = 67 + 10x_A + 4x_B$$

Predicted popcorn $= \hat{y}$

$$\hat{y} = 67 + (10)(+1) + (4)(+1)$$

A effect B effect

$$\hat{y} = 67 + 10 + 4$$

$$\hat{y} = 81 \quad (\text{close to } 80)$$