

Investigate CPU Usage using Factorial Experiment

STA305 Final Project, L2021, W2022

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Introduction



Internet Explorer

Internet Explorer has encountered a problem and needs to close. We are sorry for the inconvenience.



If you were in the middle of something, the information you were working on might be lost.

Please tell Microsoft about this problem.

We have created an error report that you can send to help us improve Internet Explorer. We will treat this report as confidential and anonymous.

To see what data this error report contains, [click here](#).

[Send Error Report](#)

:(
:(

Your PC ran into a problem and needs to restart. We're just collecting some error info, and then we'll restart for you.

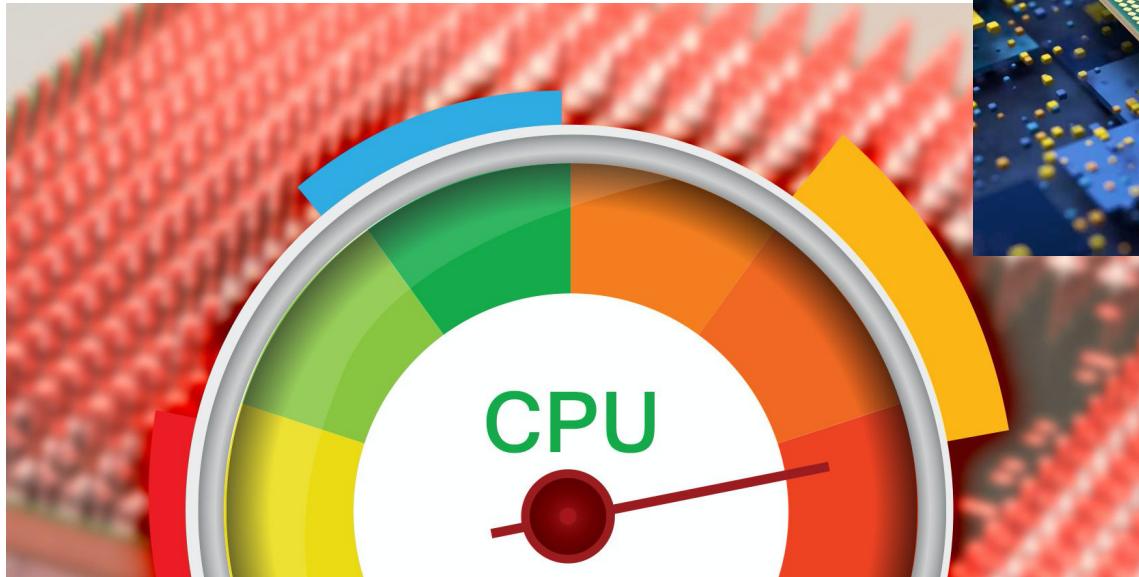
45% complete



For more information about this issue and possible fixes visit
<http://www.windows.com/stopcode>

If you need to report this issue, give them this info:
Blue screen text: NOT USED OR STUCK

High CPU Usage



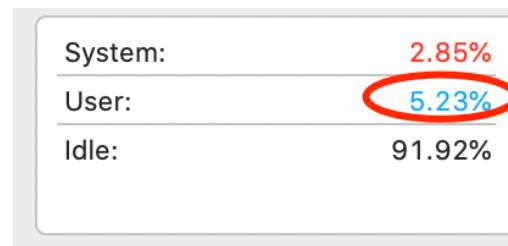
Experimental Design

Major Usage: Browse online, play video games, or record my screen

Factor	Name	Context	Level 1(-1)	Level 2(+1)
1	B	number of pages browsed	10 Pages	30 Pages
2	G	state of video game	not running	running
3	R	state of screen recorder	not running	running

y: CPU usage in percentage

2 replicated runs



Record the data

- Azure
- Different virtual computer
- Wait for 15 minutes
- 16 observations



Statistical Methods

- Cube plot
- Linear model

Let Browser be x_1 , Game be x_2 , Record be x_3 , the Usage from the i^{th} run be y_i , then we have

$$x_{i1} = \begin{cases} +1, & \text{if B = Running} \\ -1, & \text{if B = Not running} \end{cases} \quad x_{i2} = \begin{cases} +1, & \text{if G = Running} \\ -1, & \text{if G = Not running} \end{cases} \quad x_{i3} = \begin{cases} +1, & \text{if G = 30} \\ -1, & \text{if G = 10} \end{cases}$$

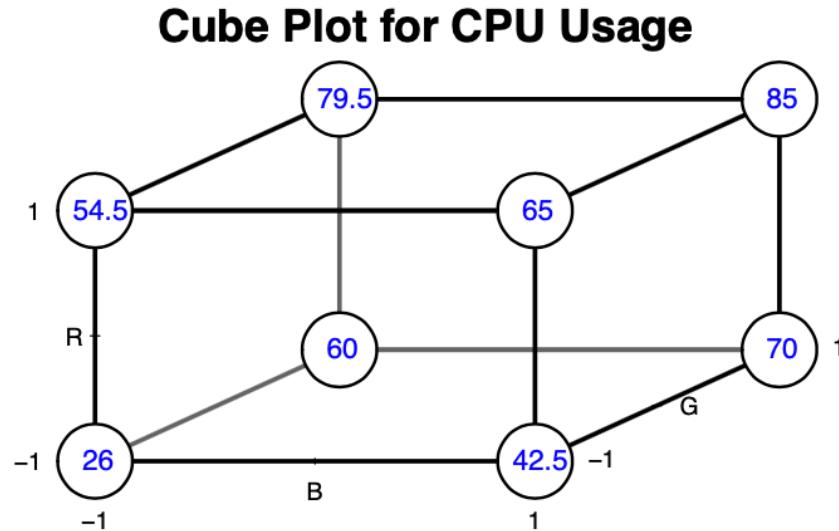
The linear model for this design is:

$$y_i = \beta_0 + \beta_1 x_{i1} + \beta_2 x_{i2} + \beta_3 x_{i3} + \beta_4 x_{i1}x_{i2} + \beta_5 x_{i1}x_{i3} + \beta_6 x_{i2}x_{i3} + \beta_7 x_{i1}x_{i2}x_{i3} + \epsilon_i$$

- Significant level $\alpha = 0.05.$
- Hypothesis testing
- Confidence interval
- Main effect, interaction effect, variance of effect
- Interaction plot, Half-normal plot

Run	R	G	B	y
1	1	1	1	81
2	1	1	-1	76
3	1	-1	1	61
4	1	-1	-1	56
5	-1	1	1	71
6	-1	1	-1	63
7	-1	-1	1	46
8	-1	-1	-1	32
9	1	1	1	89
10	1	1	-1	83
11	1	-1	1	69
12	1	-1	-1	53
13	-1	1	1	69
14	-1	1	-1	57
15	-1	-1	1	39
16	-1	-1	-1	20

Result

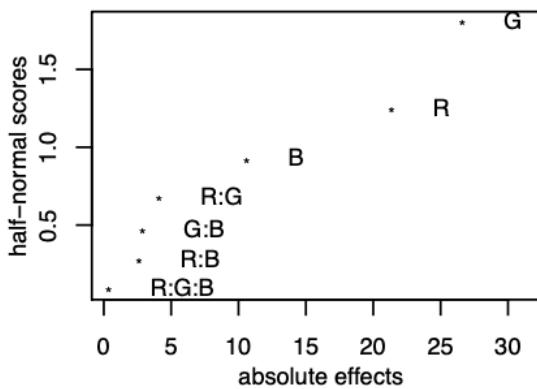
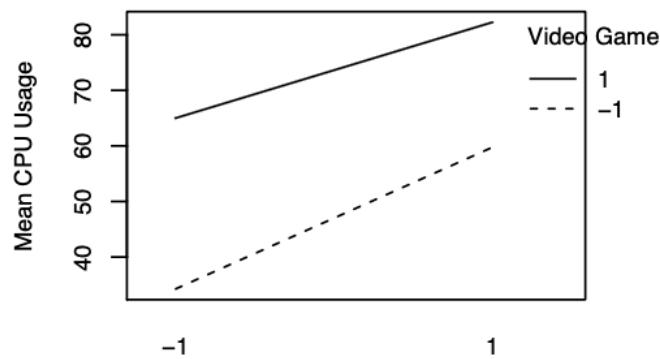
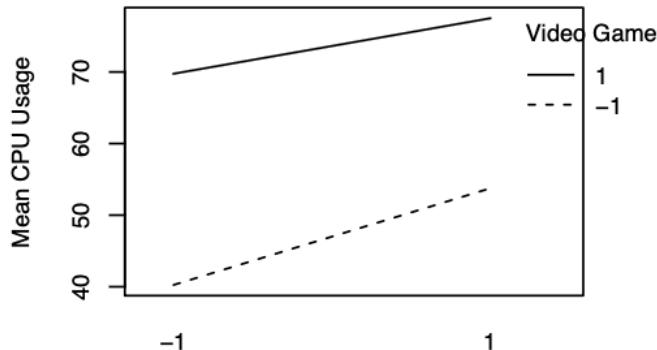
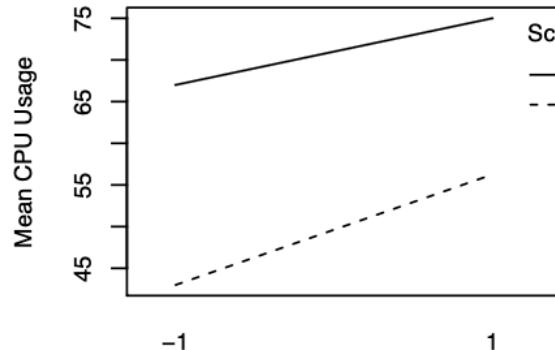


	Estimate	Std. Error	t-value	p-value	2.5%	97.5%	Effect
(Intercept)	60.312	1.279	47.143	0.000	114.725	126.525	120.624
R	10.688	1.279	8.354	0.000	15.475	27.275	21.376
G	13.313	1.279	10.406	0.000	20.725	32.525	26.626
B	5.312	1.279	4.153	0.003	4.725	16.525	10.624
R:G	-2.062	1.279	-1.612	0.146	-10.025	1.775	-4.124
R:B	-1.312	1.279	-1.026	0.335	-8.525	3.275	-2.624
G:B	-1.437	1.279	-1.124	0.294	-8.775	3.025	-2.874
R:G:B	0.188	1.279	0.147	0.887	-5.525	6.275	0.376

- Only R, G, B have p-values < 0.05
 - Reject null hypothesis that there is no effect
- Main effect: the mean CPU usage
 - increases by 21.38% when we run the screen recorder
 - increases by 26.625% when we run the video game
 - increases by 10.625% when we browse 30 pages compared to browsing 10 pages.

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- 95% Confidence interval
 - Interaction effects: include 0
 - (20.725, 32.525) for running the video game
 - (15.475, 27.275) for running the screen recorder
 - (4.725, 16.525) for browsing 30 pages compared to 10 pages.
- $\text{Var(effect)} = 1.636$



Conclusion

- Running the video game, running the screen recorder, and opening 30 pages compared to 10 pages increases CPU usage.
 - Video Game > Screen Recorder > Browsing pages
 - No interaction between effects
 - Safe to browse many pages
 - Avoid running multiple tasks when running the video game or the screen recorder
-
- | | Effect |
|---|--------|
| R | 21.376 |
| G | 26.626 |
| B | 10.624 |

