Iteración 0

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As for the interpretation, separate *cells* will be taking into consideration (by setting one covariate to have value 1 or 0). For instance, suppose first that $x_1 = 0$. Then we end up with the equation $y = \beta_0 + \beta_4 \cdot x_2 + \epsilon$, whereas, if $x_1 = 1$, then $y = (\beta_0 + \beta_1 + \beta_2 + \beta_3) + (\beta_4 + \beta_5 + \beta_6 + \beta_7) \cdot x_2 + \epsilon$. We see that if $x_1 = 1$, then the intercept becomes $\beta_0 + \beta_1 + \beta_2 + \beta_3 = 1019,40761$, and the coefficient (slope) $\beta_4 + \beta_5 + \beta_6 + \beta_7 = -169,90548$, compared to $\beta_0 = 1137.23333$, and $\beta_4 = -81.05801$, if $x_1 = 0$. Since the covariates are indicator random variables, and the setting is balanced, their mean is 0.5, which suggests an overall increase in the mean in case $x_1 = 0$.

Similarly, if $x_2 = 0$, the formula becomes $y = \beta_0 + \beta_1 \cdot x_1 + \beta_2 \cdot x_1^2 + \beta_3 \cdot x_1^3 + \epsilon$, whereas if $x_2 = 1$, then $y = (\beta_0 + \beta_4) + (\beta_1 + \beta_5) \cdot x_1 + (\beta_2 + \beta_6) \cdot x_1^2 + (\beta_3 + \beta_7) \cdot x_1^3 + \epsilon$. Looking at the level function, we are able to see that, if $x_2 = 1$, the intercept becomes $\beta_0 + \beta_4 = 1056,17532$, and the accompanying coefficients of the different powers of x_1 become $\beta_1 + \beta_5 = -125,44837$, $\beta_2 + \beta_6 = 188,62929$ and $\beta_3 + \beta_7 = -269,85411$, compared to $\beta_0 = 1137.23333$, $\beta_1 = -43.08158$, $\beta_2 = 109.43333$ and $\beta_3 = -184.17747$ otherwise, which suggests the decrease in the mean for $x_2 = 1$.

Regarding, the slope coefficients, note that if $x_1 = 0$, then the a unit increase in x_2 (that is if $x_2 = 1$) leads to a decrease of -81.05801 in the moisture content. On the other hand, if $x_1 = 1$, then a unit increase in x_2 leads to a higher decrease of $-169,90548$. This change in the slopes can also be seen in the interaction plot (Figure **??**), where the change for the transpiration type 2 or *Slow transpiration* is larger than for transpiration type 1 or *Rapid transpiration*.

Finally, I have obtained the *Tukey Honest Significant Differences* (TukeyHSD) for the variable *transpiration*. I obtain that levels 1 (Slow transpiration) and 2 (Rapid transpiration) are significantly different $p - value = 6.8 \cdot 10^{-06}$ (< 0.05). We can confirm this result graphically: in Figure **??** Point 0 is not included in the 95% confidence interval corresponding to the difference mean "1" and "2".

Figure **??** shows that there are no major violations from the model assumptions. The mean and variance of the residuals does not seem to be varying with respect to the fitted values. As a consequence, we may conclude that the homoscedasticity assumption holds. However, judging by the upper corner at the right of the Normal Q-Q plot, the residuals seem to be slightly subgaussian. Nevertheless, given the small sample size, we may assume that the normality assumption holds.

1 Tables

El dataset, tras haber sido filtrados los registros erróneos, consta de 47828 filas correspondientes a los diferentes acciones de unos drones en una serie de mundos virtuales. En cada registro se detallan los siguientes atributos:

- *year*: identifica el curso académico en el que se realizó dicha acción.
- *group*: grupo de prácticas que ha prograda al dron que acomete la acción.
- *date*: fecha en la que se lleva a cabo la acción.
- *map*: mundo virtual en el que se ha realizado la acción.
- *action*: indica el tipo de acción realizada.

En la Tabla 1 se presentan los primeros seis registros del dataset. Además, en la Tabla 2 puede apreciarse un resumen de los datos que tenemos.

	year	group	date	map	action
1	1516	Achernar	17/10/2015 19:41:45	0	0
2	1516	Bellatrix	17/10/2015 19:41:45	0	0
3	1516	Cerastes	17/10/2015 19:41:45	0	0
4	1516	Denebola	17/10/2015 19:41:45	0	0
5	1516	Elnath	17/10/2015 19:41:45	0	0
6	1516	Furud	17/10/2015 19:41:45	0	0

Table 1: Table caption goes here

year	group	date	map	action
Min. :1516	Length:47828	Length:47828	Min. :0.000	Min. :0.000
1st Qu.:1516	Class :character	Class :character	1st Qu.:1.000	1st Qu.:1.000
Median :1617	Mode :character	Mode :character	Median :3.000	Median :2.000
Mean :1700			Mean :3.834	Mean :2.325
3rd Qu.:1920			3rd Qu.:6.000	3rd Qu.:3.000
Max. :1920			Max. :9.000	Max. :5.000

Table 2: Table caption goes here

Un resumen de los resultados obtenidos al realizar el test two way ANOVA se muestra en la Tabla 3. Puede observarse que la variable *map* es significante al nivel 0, que la variable *action* es significante al nivel 0 y que la variable *map:action* (el término de interacción) es significante al nivel 0 también.

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
map	9	93731934.01	10414659.33	462.78	0.0000
action	4	1392357.62	348089.40	15.47	0.0000
map:action	32	11542304.03	360697.00	16.03	0.0000
Residuals	47782	1075308032.78	22504.46		

Table 3: Table caption goes here

La notación escalar del modelo ajustado al aplicar el test tiene la siguiente estructura:

$$
\begin{aligned}
y = \beta_0 &+ \text{map.L} \cdot x_1 + \text{map.Q} \cdot x_1^2 + \text{map.C} \cdot x_1^3 + \text{map}^4 \cdot x_1^4 + \text{map}^5 \cdot x_1^5 + map^6 \cdot x_1^6 \\
&+ map^7 \cdot x_1^7 + map^8 \cdot x_1^8 + map^9 \cdot x_1^9 + action.L \cdot x_2 + action.Q \cdot x_2^2 + action.C \cdot x_2^3 \\
&+ action^4 \cdot x_2^4 + map.L : action.L \cdot x_1 \cdot x_2 + map.Q : action.L \cdot x_1^2 \cdot x_2 \\
&+ map.C : action.L \cdot x_1^3 \cdot x_2 + map^4 : action.L \cdot x_1^4 \cdot x_2 + map^5 : action.L \cdot x_1^5 \cdot x_2 \\
&+ map^6 : action.L \cdot x_1^6 \cdot x_2 + map^7 : action.L \cdot x_1^7 \cdot x_2 + map^8 : action.L \cdot x_1^8 \cdot x_2 \\
&+ map.L : action.Q \cdot x_1 \cdot x_2^2 + map.Q : action.Q \cdot x_1^2 \cdot x_2^2 + map.C : action.Q \cdot x_1^3 \cdot x_2^2 \\
&+ map^4 : action.Q \cdot x_1^4 \cdot x_2^2 + map^5 : action.Q \cdot x_1^5 \cdot x_2^2 + map^6 : action.Q \cdot x_1^6 \cdot x_2^2 \\
&+ map^7 : action.Q \cdot x_1^7 \cdot x_2^2 + map^8 : action.Q \cdot x_1^8 \cdot x_2^2 + map.L : action.C \cdot x_1 \cdot x_2^3 \\
&+ map.Q : action.C \cdot x_1^2 \cdot x_2^3 + map.C : action.C \cdot x_1^3 \cdot x_2^3 + map^4 : action.C \cdot x_1^4 \cdot x_2^3 \\
&+ map^5 : action.C \cdot x_1^5 \cdot x_2^3 + map^6 : action.C \cdot x_1^6 \cdot x_2^3 + map^7 : action.C \cdot x_1^7 \cdot x_2^3 \\
&+ map^8 : action.C \cdot x_1^8 \cdot x_2^3 + map.L : action^4 \cdot x_1 \cdot x_2^4 + map.Q : action^4 \cdot x_1^2 \cdot x_2^4 \\
&+ map.C : action^4 \cdot x_1^3 \cdot x_2^4 + map^4 : action^4 \cdot x_1^4 \cdot x_2^4 + map^5 : action^4 \cdot x_1^5 \cdot x_2^4 \\
&+ map^6 : action^4 \cdot x_1^6 \cdot x_2^4 + map^7 : action^4 \cdot x_1^7 \cdot x_2^4 \\
&+ map^8 : action^4 \cdot x_1^8 \cdot x_2^4 + \epsilon
\end{aligned}
\tag{1}
$$

donde β_0 es el intercept, map.L y action.L son los coeficientes de los principales efectos, x_1 y x_2 son los parámetros sometidos a investigación (en este caso, x_1 representa el parámetro mapa y x_2 representa la acción), y representa el año y ϵ es el término error.

La Tabla 4 muestra los valores de los coeficientes de la fórmula que se han obtenido tras ajustar el regression model con los datos.

	x
(Intercept)	-3028.03
map.L	23654.26
map.Q	-24955.00
map.C	21598.74
map^4	-15994.08
map^5	10348.56
map^6	-5647.81
map^7	2498.01
map^8	-914.27
map^9	286.26
action.L	-3862.79
action.Q	2831.94
action.C	-2099.11
action^4	1259.94
map.L:action.L	18957.56
map.Q:action.L	-19571.62
map.C:action.L	17087.65
map^4:action.L	-12803.65
map^5:action.L	7719.13
map^6:action.L	-4226.21
map^7:action.L	2059.40
map^8:action.L	-642.03
map.L:action.Q	-13883.73
map.Q:action.Q	14397.91
map.C:action.Q	-12449.92
map^4:action.Q	9397.10
map^5:action.Q	-5606.73
map^6:action.Q	3080.43
map^7:action.Q	-1509.95
map^8:action.Q	511.33
map.L:action.C	10334.24
map.Q:action.C	-10690.73
map.C:action.C	9289.41
map^4:action.C	-6940.32
map^5:action.C	4181.43
map^6:action.C	-2240.23
map^7:action.C	1121.38
map^8:action.C	-369.64
map.L:action^4	-6184.41
map.Q:action^4	6398.77
map.C:action^4	-5539.15
map^4:action^4	4172.09
map^5:action^4	-2476.48
map^6:action^4	1375.66
map^7:action^4	-664.54
map^8:action^4	223.22

Table 4: Table caption goes here

	diff	lwr	upr	p adj
1-0	-44.48	-125.96	37.00	0.78
2-0	-59.45	-141.02	22.13	0.39
3-0	12.11	-69.67	93.88	1.00
4-0	13.58	-68.33	95.49	1.00
5-0	66.71	-15.20	148.61	0.23
6-0	51.63	-30.11	133.36	0.60
7-0	36.94	-44.86	118.75	0.92
8-0	47.86	-33.96	129.68	0.70
9-0	21.00	-60.67	102.68	1.00
2-1	-14.97	-21.62	-8.31	0.00
3-1	56.59	47.82	65.35	0.00
4-1	58.06	48.14	67.98	0.00
5-1	111.19	101.30	121.07	0.00
6-1	96.10	87.70	104.51	0.00
7-1	81.42	72.42	90.43	0.00
8-1	92.34	83.16	101.52	0.00
9-1	65.48	57.73	73.23	0.00
3-2	71.55	61.93	81.18	0.00
4-2	73.03	62.34	83.71	0.00
5-2	126.15	115.50	136.81	0.00
6-2	111.07	101.78	120.36	0.00
7-2	96.39	86.55	106.23	0.00
8-2	107.31	97.31	117.30	0.00
9-2	80.45	71.74	89.16	0.00
4-3	1.47	-10.64	13.59	1.00
5-3	54.60	42.51	66.69	0.00
6-3	39.52	28.61	50.43	0.00
7-3	24.84	13.46	36.22	0.00
8-3	35.75	24.24	47.27	0.00
9-3	8.90	-1.52	19.31	0.17
5-4	53.13	40.18	66.08	0.00
6-4	38.04	26.19	49.90	0.00
7-4	23.36	11.07	35.65	0.00
8-4	34.28	21.86	46.69	0.00
9-4	7.42	-3.98	18.83	0.56
6-5	-15.08	-26.91	-3.25	0.00
7-5	-29.76	-42.03	-17.50	0.00
8-5	-18.85	-31.24	-6.46	0.00
9-5	-45.70	-57.08	-34.33	0.00
7-6	-14.68	-25.78	-3.58	0.00
8-6	-3.77	-15.01	7.47	0.99
9-6	-30.62	-40.73	-20.51	0.00
8-7	10.91	-0.78	22.61	0.09
9-7	-15.94	-26.56	-5.33	0.00
9-8	-26.86	-37.61	-16.10	0.00

Table 5: Table caption goes here