Report coursework assignment A - 2021

CS4125 Seminar Research Methodology for Data Science

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20/04/2021

Contents

1 Part 1 - Design and set-up of true experiment

1.1 The motivation for the planned research

(Max 250 words)

1.2 The theory underlying the research

(Max 250 words) Preferable based on theories reported in literature

1.3 Research questions

The research question that will be examined in the experiment (or alternatively the hypothesis that will be tested in the experiment)

1.4 The related conceptual model

This model should include: *Independent variable(s)* Dependent variable *Mediating variable (at least 1)* Moderating variable (at least 1)

1.5 Experimental Design

Note that the study should have a true experimental design

1.6 Experimental procedure

Describe how the experiment will be executed step by step

1.7 Measures

Describe the measure that will be used

1.8 Participants

Describe which participants will recruit in the study and how they will be recruited

1.9 Suggested statistical analyses

Describe the statistical test you suggest to care out on the collected data

2 Part 2 - Generalized linear models

2.1 Question 1 Twitter sentiment analysis (Between groups - single factor)

2.1.1 Conceptual model

Make a conceptual model for the following research question: Is there a difference in the sentiment of the tweets related to the different celebrities?

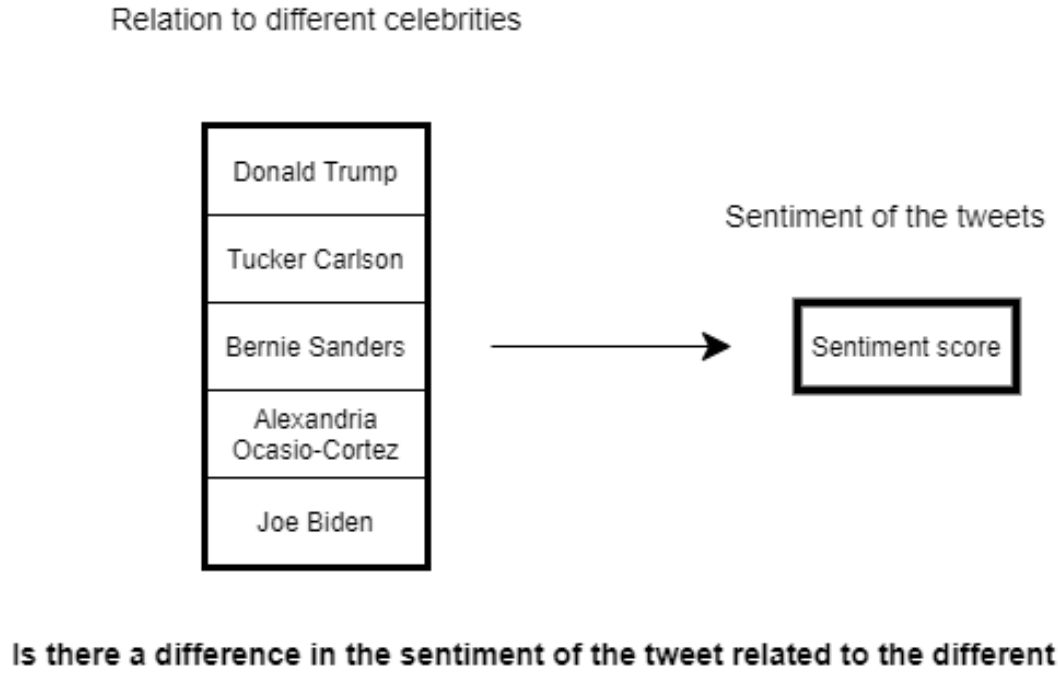


Figure 1: The conceptual model for the research question: Is there a difference in the sentiment of the tweets related to the different celebrities?r

2.1.2 Collecting tweets, and data preparation

We found 5 celebrities in US politics: Donald Trump, Tucker Carlson, Bernie Sanders, Alexandria Ocasio-Cortez, Joe Biden. As dutch students we are not well-versed in the popular English twitter celebrities, so US politics was the best option for us to find celebrities that had enough recent Tweets for the Twitter API.

2.1.3 Homogeneity of variance analysis

```
pander(leveneTest(semFrame$score, semFrame$Celeb))
```

Table 1: Levene's Test for Homogeneity of Variance (center = median)

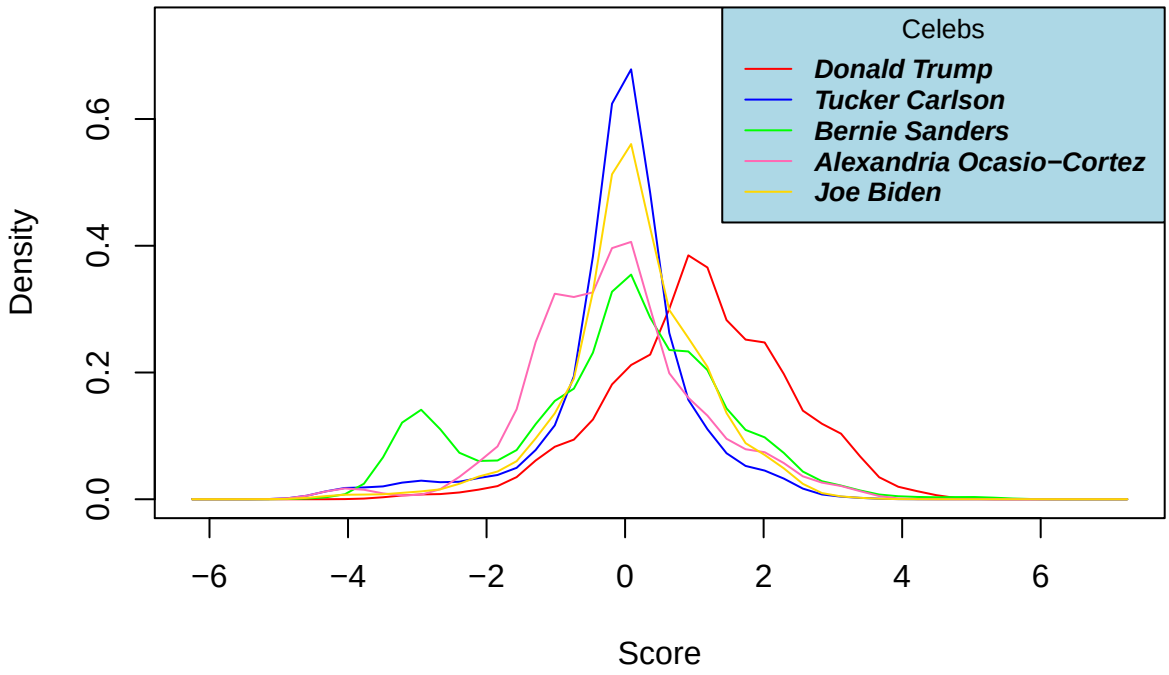
	Df	F value	Pr(>F)
group	4	23.64	5.714e-19
	1465	NA	NA

The Levene test reveals a p-value smaller than 0.001, indicating that there is significant difference between the group variances in sentiment score. We conclude that the variance among the five groups is not equal.

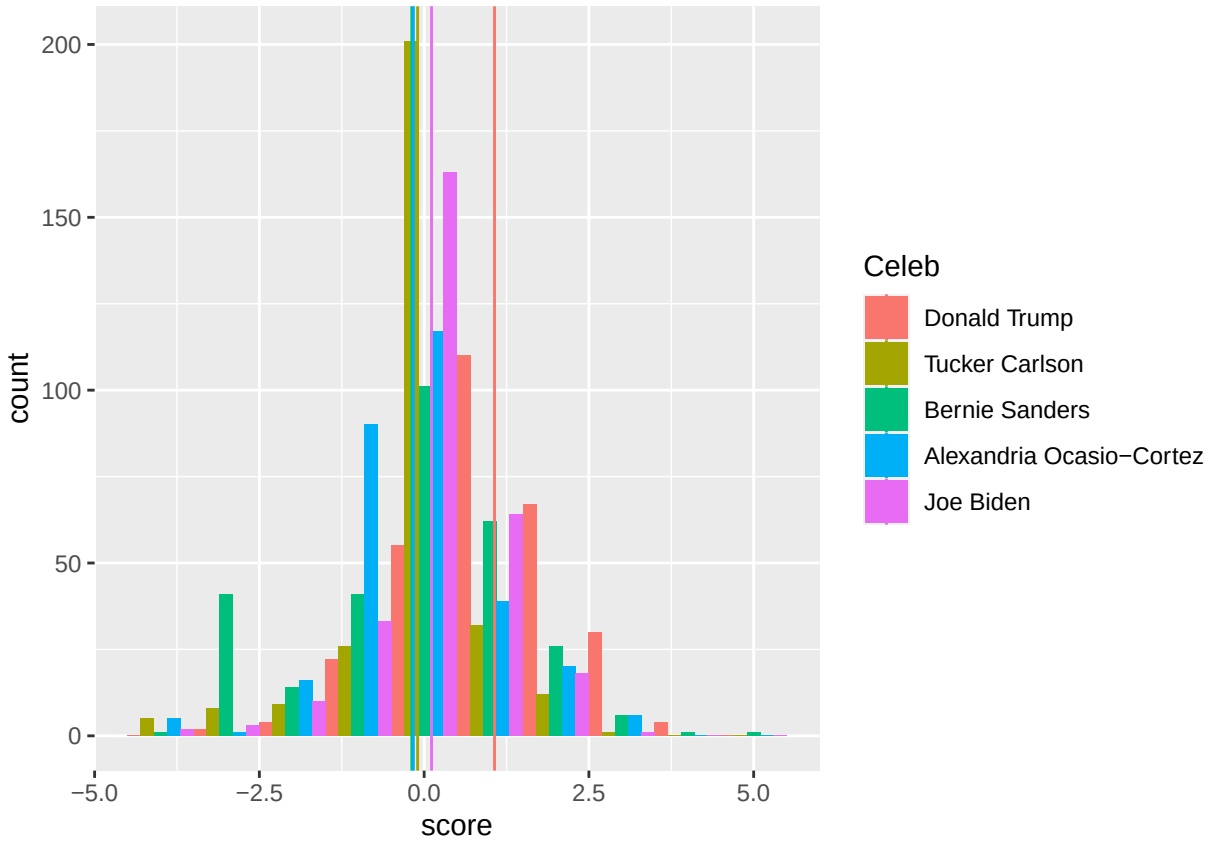
2.1.4 Visual inspection Mean and distribution sentiments

We plot both a line density and a distribution histogram which includes a mean line.

```
#boxplot(score ~ Celeb, data = semFrame, text.font = 4)
sm.density.compare(semFrame$score, semFrame$Celeb, xlab = "Score",
                   col=c('red', 'blue', 'green', 'hotpink', 'gold'), lty=c(1,1,1,1,1))
  title(main="Visual inspection Mean and distribution sentiments")
  legend('topright', legend = levels(semFrame$Celeb),
         col=c('red', 'blue', 'green', 'hotpink', 'gold'),
         title="Celebs", lty=1, cex=0.8, text.font = 4, bg='lightblue')
```




```
cdat <- ddply(semFrame, "Celeb", summarise, score.mean=mean(score))
ggplot(semFrame, aes(x=score, fill=Celeb)) +
  geom_histogram(binwidth=1, position="dodge") +
  geom_vline(data=cdat, aes(xintercept=score.mean,  colour=Celeb),
               linetype="solid", size=0.5)
```



We see all US politic Celebs have a mean around 0. #trump has the highest sentiment mean and the largest difference with the rest.

2.1.5 Frequentist approach

2.1.5.1 Linear model A one-way between subjects ANOVA was conducted to compare the effect of relation to celebrities on sentiment score in five conditions.

```
model0 <- lm(formula = score ~ 1 , data = semFrame)
model1 <- lm(formula = score ~ Celeb , data = semFrame)
pander(anova(model0, model1, test = "F"))
```

Table 2: Analysis of Variance Table

Res.Df	RSS	Df	Sum of Sq	F	Pr(>F)
1469	2476	NA	NA	NA	NA
1465	2147	4	328.6	56.06	4.859e-44

There was a significant effect of relation to celebrities on sentiment score at the p<.001 level for the five conditions [$F(4, 1465) = 56.06$, $p < 0.001$].

```
#AIC
models <- list(model0, model1)
model.names <- c("model0", "model1")
pander(aictab(cand.set = models, modnames=model.names),
       caption="Model selection based on AICc.")
```

Table 3: Model selection based on AICc.

	Modnames	K	AICc	Delta_AICc	ModelLik	AICcWt	LL	Cum.Wt
2	model1	6	4741	0	1	1	-2364	1
1	model0	2	4942	201.3	1.939e-44	1.939e-44	-2469	1

A lower AIC indicates a better fit, which is the model with the predictor.

```
(pairwise.t.test(semFrame$score, semFrame$Celeb, paired = FALSE, p.adjust.method = "bonferroni"))
```

2.1.5.2 Post Hoc analysis

```
##
##  Pairwise comparisons using t tests with pooled SD
##
## data:  semFrame$score and semFrame$Celeb
##
##                           Donald Trump Tucker Carlson Bernie Sanders
## Tucker Carlson            <2e-16       -              -
## Bernie Sanders            <2e-16       1.000          -
## Alexandria Ocasio-Cortez  <2e-16       1.000          1.000
## Joe Biden                 <2e-16       0.348          0.028
##                           Alexandria Ocasio-Cortez
## Tucker Carlson            -
## Bernie Sanders            -
## Alexandria Ocasio-Cortez  -
## Joe Biden                 0.059
##
## P value adjustment method: bonferroni
```

Post hoc comparisons using the Bonferroni correction indicated that the corrected p-value for the trump condition was significantly different than the other conditions (p<0.001). However, between the others condition it does not show a significantly difference.

2.1.5.3 Report section for a scientific publication A one-way between subjects ANOVA was conducted to compare the effect of relation to celebrities on sentiment score in five conditions. There was a significant effect of relation to celebrities on sentiment score at the p<.001 level for the five conditions [F(4, 1465) = 56.06, p < 0.001]. However, post hoc comparisons using the Bonferroni correction indicated that only the corrected p-value for the trump condition was significantly different than the other conditions (p<0.001), between the others condition it does not show a significantly difference. Taken together, these results suggest that some celebrities really do have an effect on the sentiment in Tweets.

2.1.6 Bayesian Approach

2.1.6.1 Model description The sentiment scores seem to center around 0, and all seem to be single digits.

$$score \sim Norm(\mu, \sigma)$$

$$\mu = \alpha$$

$$\alpha = Norm(0, 10)$$

$$\sigma = Uniform(0.001, 10)$$

```
m0 <-map2stan(alist(
  score ~ dnorm(mu, sigma),
  mu <-a,
  a ~ dnorm(0, 10),
  sigma ~ dunif(0.001, 10)),
  data =  semFrame ,  iter= 10000, chains = 4,   cores = 4 )
```

2.1.6.2 Model comparison

```
## Computing WAIC
```

```
m1 <-map2stan(alist(
  score ~ dnorm(mu, sigma),
  mu <-a[Celeb] ,
  a[Celeb] ~ dnorm(0, 10),
  sigma ~ dunif(0.001, 10)),
  data =  semFrame ,iter= 10000, chains = 4, cores = 4 )
```

```
## Computing WAIC
```

```
pander(compare(m0, m1, func=WAIC))
```

	WAIC	SE	dWAIC	dSE	pWAIC	weight
m1	4741	70.16	0	NA	6.7	1
m0	4942	67.72	201.1	28.92	2.547	2.13e-44

Lower WAIC indicates a better performing model, so with predictors is the winning model.

```
pander(precis(m1, depth=2, prob = .95))
```

2.1.6.3 Comparison celebrity pair

	mean	sd	2.5%	97.5%	n_eff	Rhat4
a[1]	1.068	0.07061	0.93	1.207	30857	1
a[2]	-0.09894	0.07122	-0.2403	0.04162	30326	0.9999
a[3]	-0.1873	0.07119	-0.3262	-0.0487	31044	0.9999
a[4]	-0.1637	0.07125	-0.3029	-0.02216	31827	0.9999
a[5]	0.1119	0.07113	-0.02708	0.2519	29609	0.9999
sigma	1.212	0.02232	1.169	1.256	32402	0.9999

Looking at the credibility intervals of the celebrities effects, We see the conditions where the mean of a condition does not fall within a credibility interval of an other condition. This holds for the Trump condition and a couple other combinations. We can again conclude that some celebrities really do have an effect on the sentiment in Tweets.