Investigating the impacts of COVID-19 pandemic on Eco-driving behavior

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ECODRIVE

- Main objective: Develop an ecosystem of mechanisms and platforms aiming at promoting ecological driving
- Individual Objectives:
  - Investigate the use and accuracy of novel European Global Navigation Satellite System "Galileo"
  - Fuel consumption estimation model based on driving behavior
  - Ecological routing algorithm
  - Eco-driving recommendation system
  - Pilot

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Effects of COVID-19 and related measures

- Active research topic
- Obvious consensus: reduction of long and short distance trips due to mobility restrictions imposed by the governments – teleworking and closure of retail shops and restaurants.
- Significant changes in mobility characteristics and habits (mode choice, e.g. decreased use of public transport)

- Strong correlation with infection rates

Scope

Identify changes in the population's behavior, related to

- ecological and
- safe driving

triggered by the exceptional conditions during the pandemic (lower traffic flow, less trips, modal shift).

What is Eco-driving?

- Adoption of a driving behavior that leads to reduced fuel consumption and greenhouse gases emissions.
- Adjustment of the vehicle's speed and acceleration, as well as the choice of routes and departure time that minimize fuel consumption.

For example, accelerating smoothly, maintaining a constant speed and avoiding driving in congested conditions play a very important role in fuel economy.

It is estimated that eco-driving is capable of reducing fuel consumption by 15% to 25% and GHG emissions by about 30%.

Methodology

Clustering (K-Means) on trips of naturalistic driving data before, during and after the pandemic.

Use eco-relevant variables, such as acceleration and braking.

Identify different clusters (profiles) of trips, e.g. eco, typical, non-eco

Investigate the distributions of the trips in the profiles during different time periods.

Data collection

- Data collection using OSeven app (or Eco-Drive dedicated app)
  - Always running on the background – no user action required
  - Collect driving data using smartphone sensors (accelerometer, GPS, gyroscope)
  - Data stored in an anonymized format
- Trips conducted between January and December of 2020

Variables exploited

Variable	Description
Harsh acceleration per min	The number of harsh accelerations per minute.
Harsh brakes per min	The number of harsh brakes per minute.
Smoothness indicator	The sum of differences of squares of final and initial speed, divided by trip distance.
Non-eco acceleration duration	The duration of the trip where the driver adopts a non-eco acceleration.

Clustering results

Cluster centers				
Cluster name	**Smoothness indicator**	**Harsh acceleration per min**	**Harsh brakes per min**	**Non-eco acceleration duration**
eco	0.285	0.030	0.035	0.004
typical	0.403	0.091	0.343	0.009
aggressive	0.529	0.573	0.351	0.021

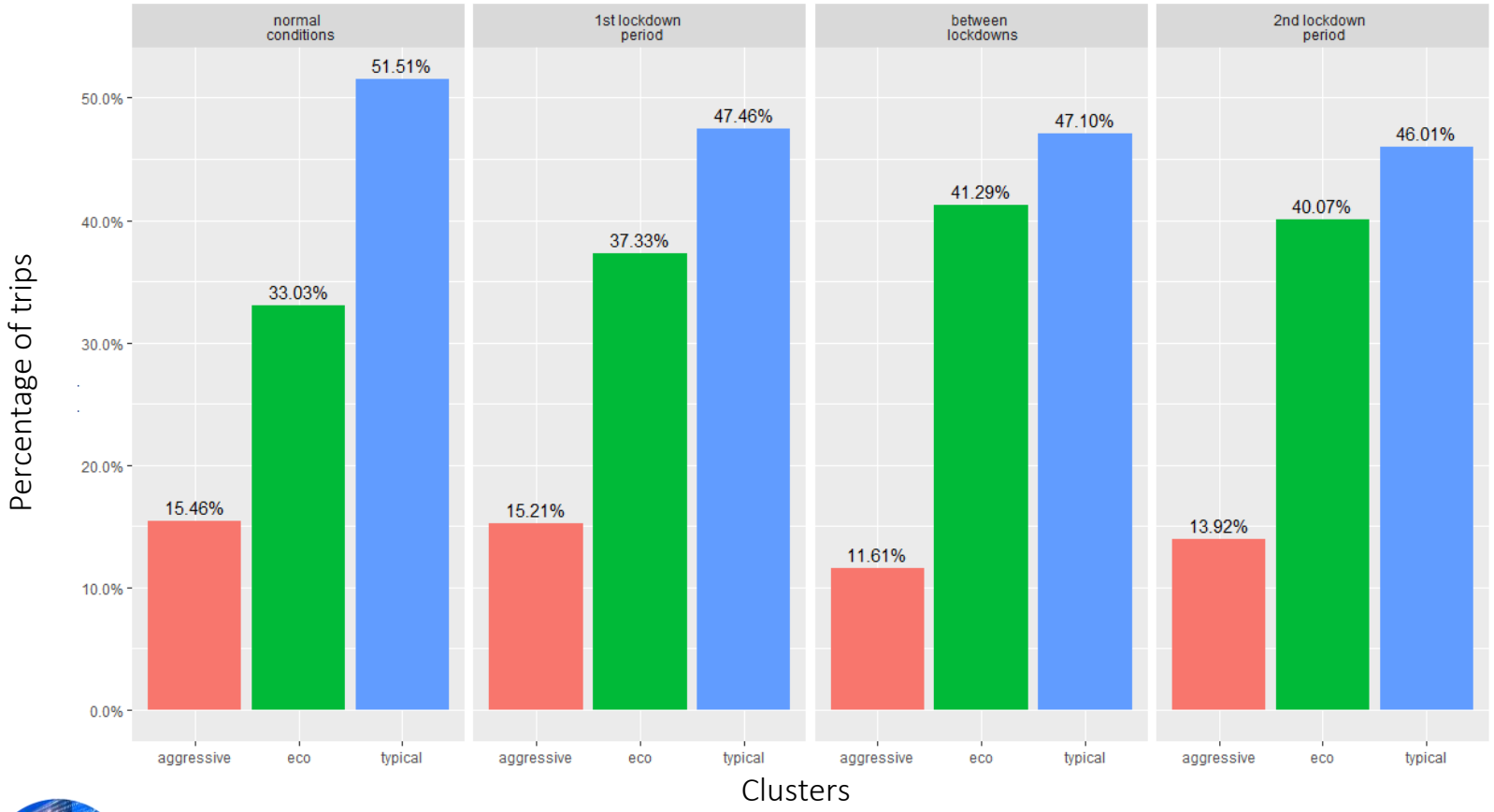
- **Eco trips:** lowest values of all the variables, can also be considered as the safest and smoothest driving style, due to the low number of harsh events per minute.
- **Aggressive trips:** with the highest values of all variables, can also be considered as the less ecological behavior.
- **Typical trips:** values of the four variables that fall in between the two previous clusters.

Study period

Period reference	Duration	Description
1st period: Normal conditions	January- February 2020	Until the end of February only three cases have been confirmed in Greece.
2nd period: 1st lockdown	March, April, May 2020	On the early days of March, local guidelines and regulations started to take effect, such as closure of schools and suspension of cultural events. Shortly afterwards cafes, bars, restaurants and more facilities were also closed. On 22 of March the country was put on full lockdown, which suspended all non-essential activities outside people's homes and teleworking.
3rd period: between lockdowns	June- October 2020	On May 4, the restrictions were gradually lifted, with local or not as strict regulations occurring in the summer months, for example people should be seated at all times at bars.
4th period: 2nd lockdown	November, December 2020	On the 7th of November the country was in lockdown again, with some differences than the previous one, for example primary schools remained opened and a month later some facilities, shops, hairdressers and others, were allowed to operate under strict safety measures.

Results 1/2

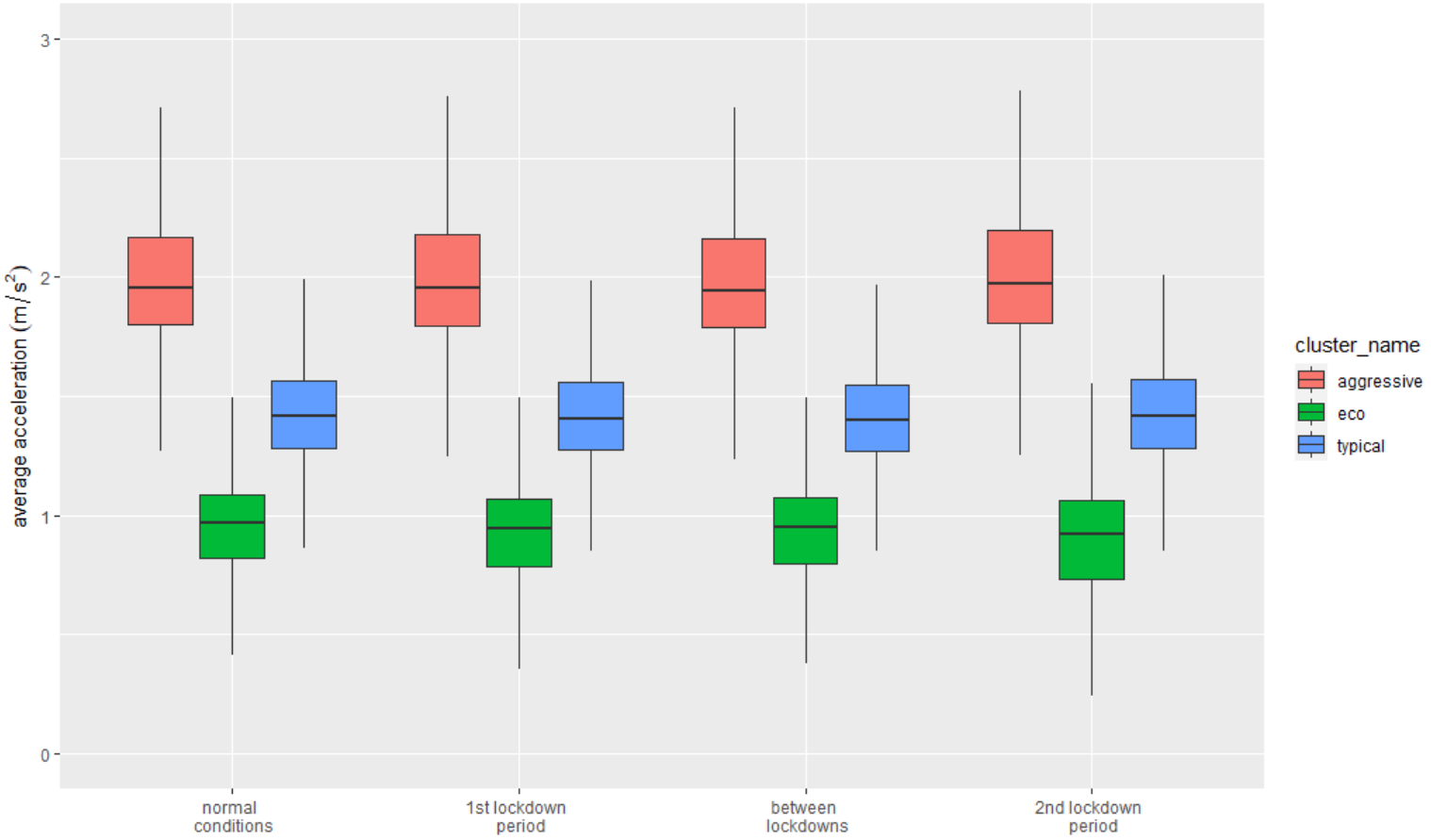
Distribution of trips of the 4 periods among the 3 profiles



- The percentage of the eco profile is observed to be gradually increasing, as the time passes.
- Significant increase of about 4% from one period to the other
- Typical and, secondarily, aggressive trips are decreasing
- Before/after the lockdowns:
  - Typical -5.5%
  - Eco +7%
  - Aggressive -1.5%

Results 2/2

Boxplots of trips' average acceleration per cluster and per time period



- Typical trips: similar accelerations during all periods
- Aggressive trips: lower average acceleration between the lockdowns
- Eco trips: mean value decreasing and higher deviation with time

Conclusions

- ✓ The effect of the COVID-19 lockdowns on driving behavior and especially eco-driving was investigated.
- ✓ First, we were able to detect three different driving profiles (eco, aggressive and typical) in a dataset of naturalistic driving data, using an unsupervised learning framework. Then, the distribution of the trips during the four defined time periods (before the lockdowns, during the first lockdown, between the two lockdowns, during the second lockdown) was estimated, in order to detect differences between them.
- ✓ While in the normal conditions, the typical trips were more than 50% of the total and 33% were eco, during 2020 and because of the new conditions connected with the pandemic, the percentage of eco (and also safer) trips increased to about 40%, while the aggressive ones had also a significant decline, from 15.5% to 13.9%.
- ✓ Results indicate that the new normal that was introduced by the government measures and is characterized by lower traffic volumes and less trips per person, because of the high percentage of teleworking and the closure of retail shops, restaurants, etc., has led drivers to drive in a smoother way and, thus, safer and ecologically friendlier.

Future research

- ✓ Analysis of trips conducted later (in 2021), in order to investigate whether the trend that was witnessed in 2020 continues and whether similar conclusions can be reached.
- ✓ Examination and deeper understanding of the reasons leading to the observed behavioral changes.
- ✓ Results of this study can be translated to specific measures that could lead to similar outcomes regarding the driving behavior, after the alleviation of all the pandemic-related measures and limitations.

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