The weather's influence on office workers' vitality

Research into the relationship between daylight intensity and physical activity of office workers.

B.A.S. Fok
TU/e
Eindhoven, Netherlands
b.a.s.fok@student.tue.nl

J. Schutselaars
TU/e
Eindhoven, Netherlands
j.schutselaars@student.tue.nl

N.J. Buhling
TU/e
Eindhoven, Netherlands
n.j.buhling@student.tue.nl

W.J.D. Rentes
TU/e
Eindhoven, Netherlands
w.j.d.rentes@student.tue.nl

ABSTRACT

This paper explores the influence of the presence of daylight on the vitality of office workers. This is done by recording the physical activity from five office workers at the municipality of Ede for over a period of three weeks. The activity data is then compared to local weather data about the daylight condition provided by the Royal Netherlands Meteorological Institute (KNMI). As a result, there is not enough confidence to conclude on a clear correlation between the activity of office workers and the amount and intensity of daylight.

INTRODUCTION

The weather, with all of its aspects, is something that is always around us. It is part of our everyday lives and, consciously or unconsciously, it affects the decisions we make and the things we do. Research shows that the weather affects our mood (Spasova, 2012), our productivity (Lee, Gino, & Staats, 2014) and even our health (Patz, Engelberg, & Last, 2000). However, questions still remain, how and when these effects come into play, for example, is still largely unclear.

A group for whom this can be especially relevant is office workers. In modern day western societies, a lot of people spend the majority of their time in office environments where they mostly sit in a chair behind a desk. This work environment has been proven not to be beneficial for their vitality (Hendriksen, Bernaards, Steijn, & Hildebrandt, 2016). Physical inactivity has been shown to be related to higher risks of cardiovascular diseases, diabetes mellitus, several types of cancer, obesity, hypertension, bone and joint diseases, and depression (Warburton, 2006). Research points out the beneficial effect of exposure to daylight on office workers (Mills, Tomkins, & Schlangen, 2007). It is therefore plausible that the amount of natural daylight influences the amount of physical activity and thereby the vitality of office workers. If vitality and weather are indeed linked in this way, it could inform design choices in the future and policies could be changed accordingly to have more beneficial effects on the workers' health and vitality. This leads to the following research question:

What effect does the presence and intensity of daylight have on the physical activity of office workers?

RELATED WORK

Research shows a strong correlation between exposure to daylight and vitality (Mills, Tomkins, & Schlangen, 2007). As daylight is strongly dictated by weather conditions, it is plausible that weather can influence vitality.

In a study by Feinglass et al. (Feinglass et al., 2011), the relation between weather and physical activity was investigated. The set up of this research was similar to this research, activity was also tracked with an accelerometer and this data was compared to weather data. The main difference is that Feinglass focussed on people with arthritis, a disease which causes painful inflammation and stiffness of the joints. Therefore, that research is not applicable to the normal office workers.

Other research shows that there is a correlation between the exposure to daylight of office workers and their overall health and sleep quality (Boubekri, Cheung, Reid, Wang, & Zee, 2014). From a total group of 49 participants, one group was working in a windowless environment, where the other group was working with significantly higher exposure to daylight. As a result, the office workers with more exposure to daylight scored higher on a well-being test as well as on a sleep quality test. To conclude, the researchers suggest that architecturally there should be more emphasis on daylight exposure.

METHOD

For this study, weather quality regarding daylight was compared to the activity of five office workers between the ages of 20 and 60 who worked at the municipality of Ede. The activity data was acquired with the help of Mi Bands. These smart wearables are equipped with accelerometers able to record the amount of steps participants take during the day. Four of the participants wore a Mi Band 3. The fifth participant wore a Mi Band 2, which has the same type of sensors and output as the Mi Band 3. All participants were asked to wear the Mi Bands from the moment they start to commute to work until the moment they arrive back home. For privacy and usability reasons, the data recorded between 20:00 and 06:00 will be deleted in the data cleaning process in python.

The resulting activity data from the Mi Bands will be compared to the weather at the time of the recordings. This data was acquired from the online database provided by the Royal Netherlands Meteorological Institute (KNMI). From the hourly recordings of the weather station in Deelen, which is the nearest weather station to Ede, four data types were selected to represent the weather's daylight conditions. These are the duration of sunshine, hourly global radiation, horizontal vision and cloud coverage.

Before all data can be analysed, it needs to be cleaned up. The activity data is recorded per minute and the weather data per hour. Therefore, all activity data will be summarized to hourly data points, so it is comparable to the weather data. Not every participant has the same activity level in general, it is not useful to compare the number of steps with each other. Since this study is about a relative effect of daylight on activity, the step counts are normalized by giving every hour a score between 0 and 1. In which 0 is the least amount of steps recorded and 1 is the most amount of steps recorded. Later on, the mean for all the participants is calculated to have a general activity score.

The same method will be applied to the weather data. The four data types within the weather get a normalized score from 0 to 1, based on their maximum and minimum values and effect on the daylight conditions. This score represents the amount of daylight, where a score of zero represents the day with the least amount of daylight of all observed data, and a score of one represents the day with the most amount of daylight.

Lastly, these scores are then compared to the step count of the participants which are also normalized to create an activity score from 0 to 1.

With the normalised scores, an R-squared test will be performed. Therefore, first a scatter plot will be created of the data and then a regression line will be calculated with the according to R-squared value. With the regression line and the value, a conclusion can be drawn. The following hypothesis was tested: the activity of office workers increases when the daylight intensity increases. The alternative hypothesis will be that there is no correlation between activity and daylight.

In addition to the quantitative data analysis, a small interview with the participants is held. Within this interview, the participant is asked if there were special days, problem and their thoughts about the weather. This will help to find systematic and transient noise in the data.

Ethical and legal aspects

All participants in our research were thoroughly informed about their role in the study and the data that was gathered about them. They will be asked to sign a consent form and are free to quit the study at any moment in time. When a participant quits, all collected data from this person will be deleted. Moreover, the participants were each assigned a unique identification number so that their names were not included as metadata in the datasets. The data in this study was gathered using an open source mobile application, Gadgetbridge (Gadgetbridge, n.a.). All data collected is stored locally within the app on the synchronised device and is not shared with any server or company to respect the privacy of the participants.

FAIR principles

During the research, activity data from participants were gathered. This data was handled with great care in order to respect the privacy of the participants. All data was anonymised and safely stored in the Canvas (Canvas, n.d.) environment. Within this environment, validated persons can acquire the data and establish the validity of the data. This makes the data findable and accessible to the right people.

The data analysis was done on the researchers' computers, all secured with passwords. After the analysis, the raw data was removed from these computers and only stored in Canvas to prevent data leaks. The raw data will be stored in a standard CSV format to make it interoperable as well as reusable for other researchers (Wilkinson, Dumontier, Aalbersberg, Appleton, Axton, Baak, ... & Bouwman, 2016).

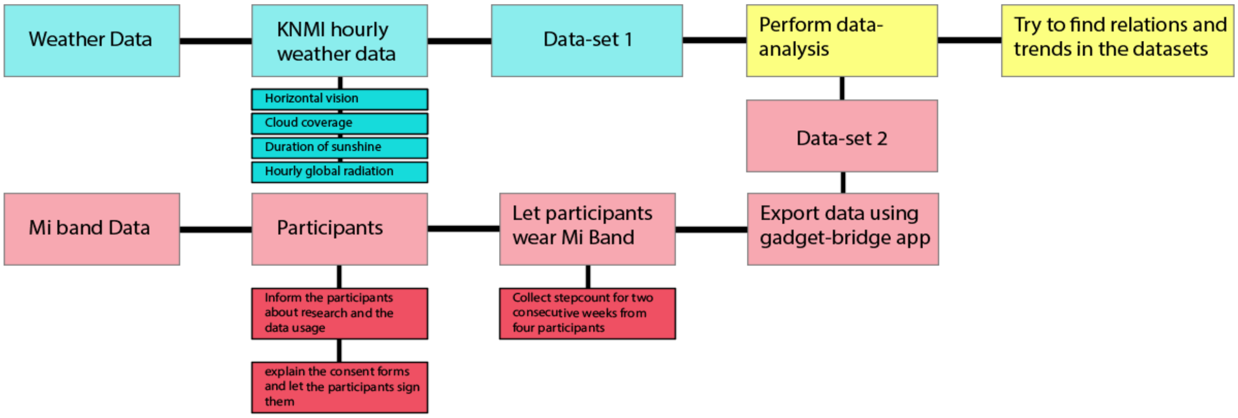

Figure 1: flow chart of data gathering and processing

DATA ANALYSIS

The data analysis consists of three parts, preparing and cleaning the data, normalizing all data and creating scores and lastly visualizing the data and performing statistical tests. The flow of the analysis process is visualised in figure 1. All data can be found on the Canvas files section of team 24. The python notebook can be found in the appendix as well as on Canvas.

Data cleaning and preparation

Cleaning and preparing the weather data provided by the KNMI was relatively simple. The data was well structured and only contained the subjects and days needed. Besides renaming the data types for an easier interpretation, the only cleaning needed was to drop the first hours in the dataset to synchronise the starting points of the activity and the weather data.

The activity data needed more cleaning and preparation. First of all, all data points before and after the period of the study were deleted. Then all data outside the hours of 06:00 and 20:00 were deleted, as it is not relevant. All activity data was stored per minute and as the weather data is stored with hourly precision, all activity data needed to be summed up for the corresponding hours. Lastly, when a participant was not active for a whole day (which means the participant had forgotten to wear the Mi Band, was ill or had a day off), this day was deleted for that particular participant. The short qualitative questionnaires were used to validate these occurrences. Later on, further cleaning in data was performed by looking for situations when none of the participants was active at the start and at the end of a day, so when none of the participants was commuting to work or all arrived home.

Normalising data

Not every participant has the same level of physical activity throughout the day To be able to compare the data, all activity data per participant was normalised between 0 and 1. Where 0 is the lowest recorded value and 1 is the highest recorded value. This ensures that the relative differences in activity can be compared between participants instead of absolute differences. A mean value was then calculated for all the participants and that value was normalized again between 0 and 1. It was also hard to define when the weather is good or bad, so the weather was also normalised in a score. This was done by first creating normalised scores for every data type, then summing up the scores from the four data types, and lastly normalising the summed scores into a final weather score. Finally, this process resulted in a table with a column with a score from 0 to 1 describing the step count of each participant and a column with a similar score describing the quality of the weather. These scores could then easily be tested for possible correlations.

Data visualisation and statistical tests

After all the data was prepared, it was ready to be visualised and for a statistical test to be performed to search for a correlation. As the first visualisation, a graph of the raw step count was created. Within this graph, activity patterns are visible and it verifies if the participants were varyingly active (see Figure 2). As another graph, the normalized activity score for every participant and the normalised weather score are displayed(see Figure 3), so a first total overview of the two data types is created. Then a graph with the mean activity score and the weather score was created if there is a correlation between the daylight and the activity of office workers it could be visible in this graph (see Figure 4).

To be able to test for a correlation, a scatterplot of all data points was made with a linear regression line (see Figure 5). Also, an R-squared test is performed on this scatterplot.

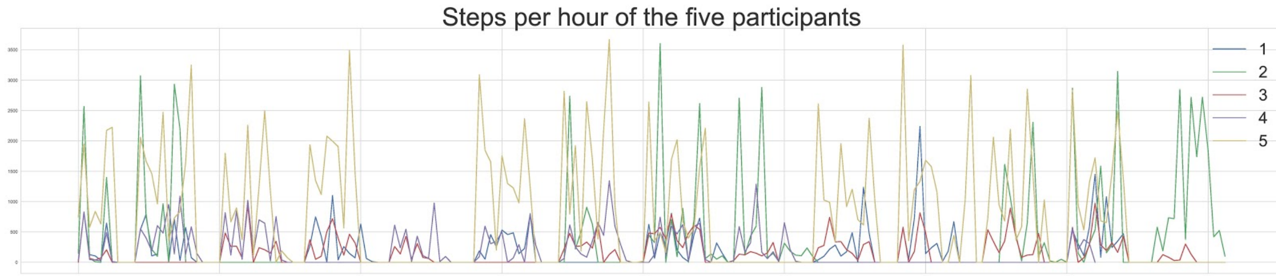

Figure 2: Graph of the steps per hour of the five participants

RESULTS

Detailed graphs can be found in Appendix I.

As we created a graph with the step count of all the participants (figure 2), we can see that all participants were variously active during the test period. Also, a large difference between the activity of the office workers can be noticed. Throughout the test period of three weeks, 14 work days because of Whitsun Monday, there were only three days where all the participants wore the Mi Bands. Because of the total of five participants, on each day there are at least three of four active participants.

As the next step in the analysis, the normalised scores for the activity and weather are created and plotted (figure 3). As visible, the lines are very turbulent and with six different lines crossing each other the graph is difficult to interpret.

In the next graph, the normalized mean value of the activity of all participants is plotted together with the normalized value of the weather (figure 4). This graph represents more clearly the relation between the presence and intensity of daylight and the participants' activity.

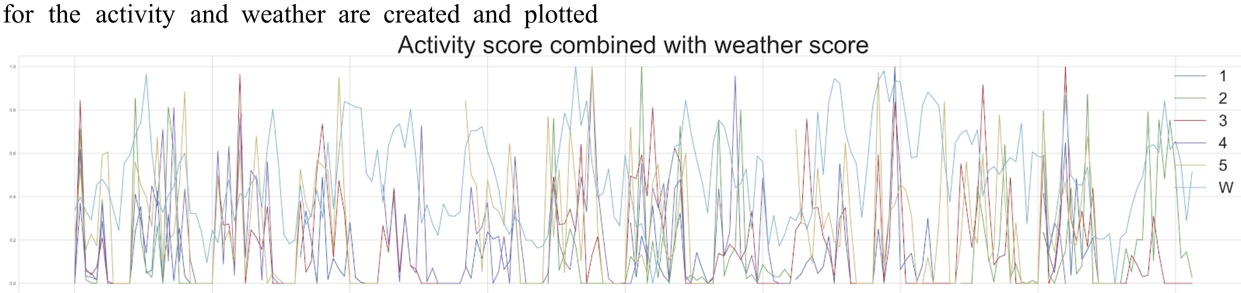

Figure 3: Graph of the activity scores per participant and the weather score (W)

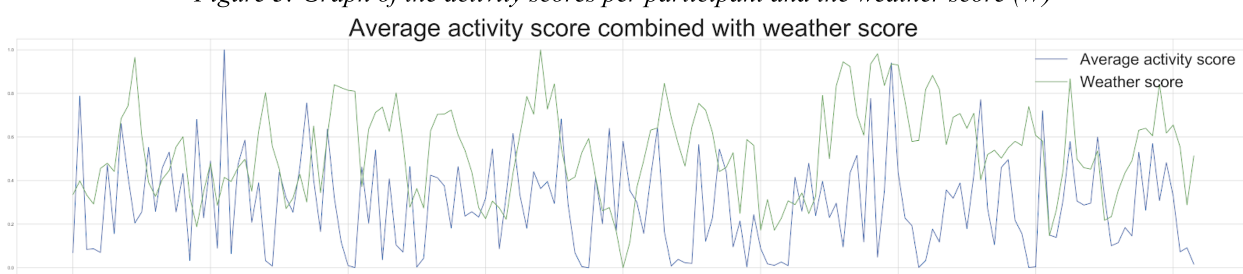

Figure 4: Graph of the average activity score and the weather score

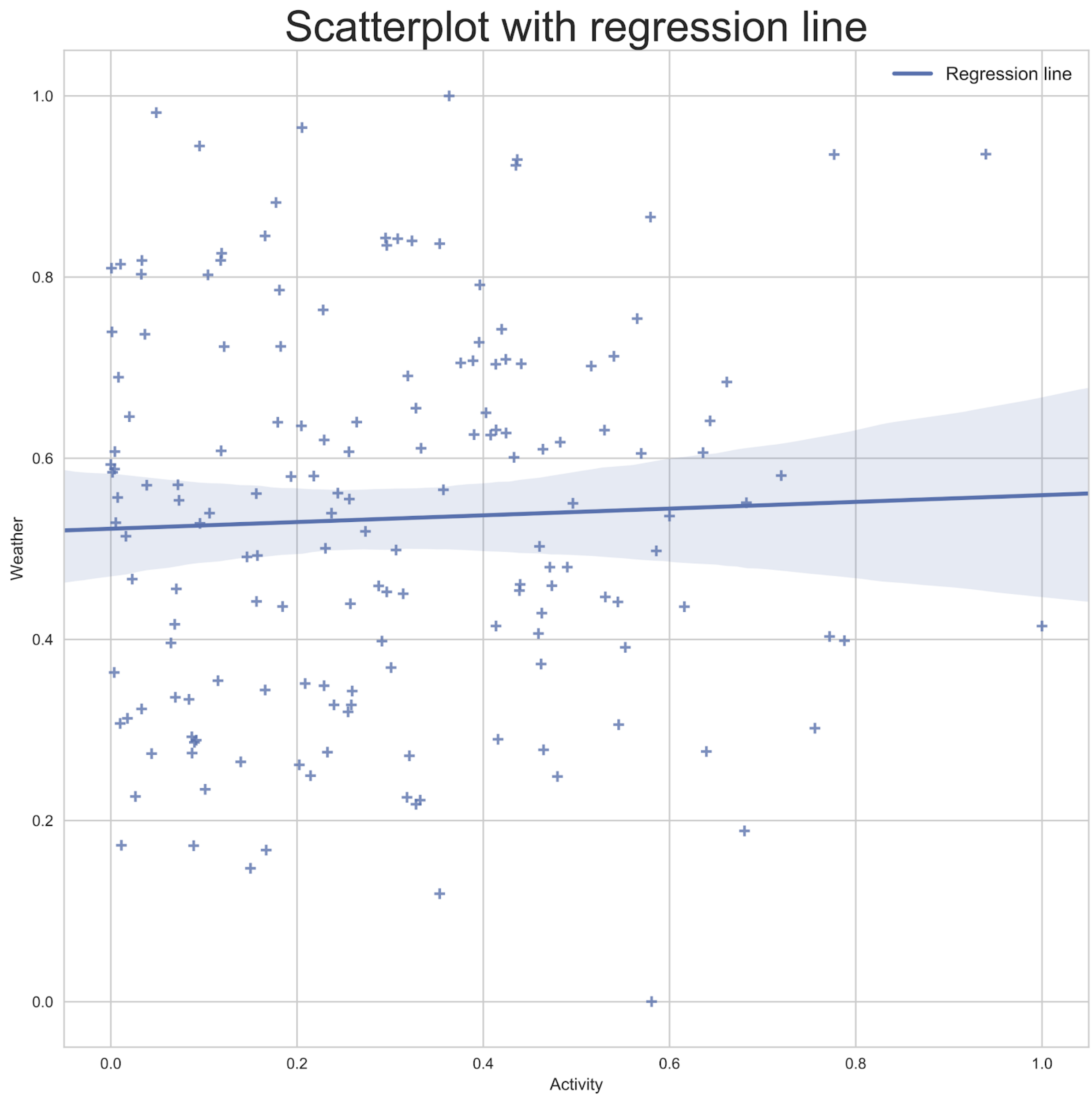

Figure 5: Scatter plot of the activity and weather scores with a regression line

Statistical test

Scatterplots are a good method to explore the correlation between the two factors. All data points are plotted on axis, with the weather score on the y-axis and the activity score on the x-axis. As visible, the cloud of data points does not suggest a clear correlation (figure 5). To be sure, a regression line is calculated. The line is almost horizontal, which means that the weather is of no, or very little, influence on the activity of office workers. However, the calculated R-squared value of 57,6% confirms that the data points are too scattered to be able to draw a conclusion.

Interviews

At the end of the test period, small interviews with the participants were held. With these interviews, it would be easier to identify and elucidate noise.

Out of these interviews, we can conclude that there were no technical failures. The Mi Bands did their job and the synchronisation with the central phone also went successfully. Except for one participant who was ill for a couple of days there were no injuries that could affect activity. Furthermore, most people indicated that the weather was not of a large influence on their active choices to go for a walk or not. They had routines in which they worked. This is also visible in the step count data, for some participants there is a recurring summit in activity during lunch breaks when they or walk to the canteen or to the city centre to buy some food. Lastly, the type of transportation used to commute is from significant influence on the data. One participant walked to work which is clearly visible as to peaks. Another participant commuted on a motorcycle, during the journey the Mi Band recognised a lot of steps, which is probably systemic noise.

DISCUSSION

Surprisingly, this study did not find a positive correlation between the activity of office workers and the presence and intensity of daylight. This is in contradiction to previous work (Boubekri et al., 2014) which shows that exposure to daylight can have positive effects on the well being of office workers.

This might be caused by the fact that office workers have to finish their work or are working according to a fixed schedule or their personal routines, which does not give them the ability to decide when to take a walk based on the weather. In the interviews, the participants also mentioned that they just follow their routines and schedule without taking the weather into account.

It can also be that the weather's daylight condition is not an important factor of the local weather in the decision process of going for an extra walk for office workers. There might be other factors that have more influence on the activity of office workers such as the time of the day, temperature or rain.

Limitations

A sample size of five people and a data collecting period of three weeks is very limited and makes it hard to draw scientifically significant conclusions. For the purpose of the course Making Sense of Sensors this does not matter as the goal is to get acquainted with the process of data collection, ethical and legal principles and setting up a research, however if the goal was to make significant conclusions and contribute to the academic community, a much higher sample size and a longer period of time would be highly advised.

Another limitation has to do with the hardware, the Mi Bands record steps data with an accelerometer without GPS or gyroscope to make it more accurate. In one occasion this caused systemic noise in the data gathering process. The fifth participant commuted to and from work on a motorcycle every day, during the commute approximately 3000 steps were recorded which are not taken. Which resulted in approximately 6000 recorded that were not taken in reality. For now, it was not possible to filter this data because we decided to also take the commuting into account and we do not exactly know when the commuting ends on the way to work, or start on the way back home.

The second participant was ill for a period of time during the research. However, as mentioned earlier, the backup source of data enabled the study to always have enough active participants during the day.

CONCLUSION

In the introduction and related work section, we mentioned that previous work suggests positive effects of the weather and daylight exposure on various health-related factors. This led to the investigation of the following research question:

What effect does the presence and intensity of daylight have on the physical activity of office workers?

With this study, we aimed to find a relation between daylight conditions and the activity of office workers working at the same location. After analyzing the results, it can be concluded that there is no statistically significant correlation between the two. To conclude, this research suggests that there is no correlation between the amount and intensity of daylight and the activity of office workers, however, the amount of data is not sufficient, with an R-squared value of 57,6%, to conclude that this is the case.

FUTURE OPTIONS

This research could suggest an investigation of new research topics. It may be that the differences in daylight within this study were too small. Other research could be done on the long-term effect between winter and summer, with longer and shorter periods of daylight. Or the difference between office workers working in a room with exposure to daylight through for example windows, and office workers that are isolated from daylight exposure.

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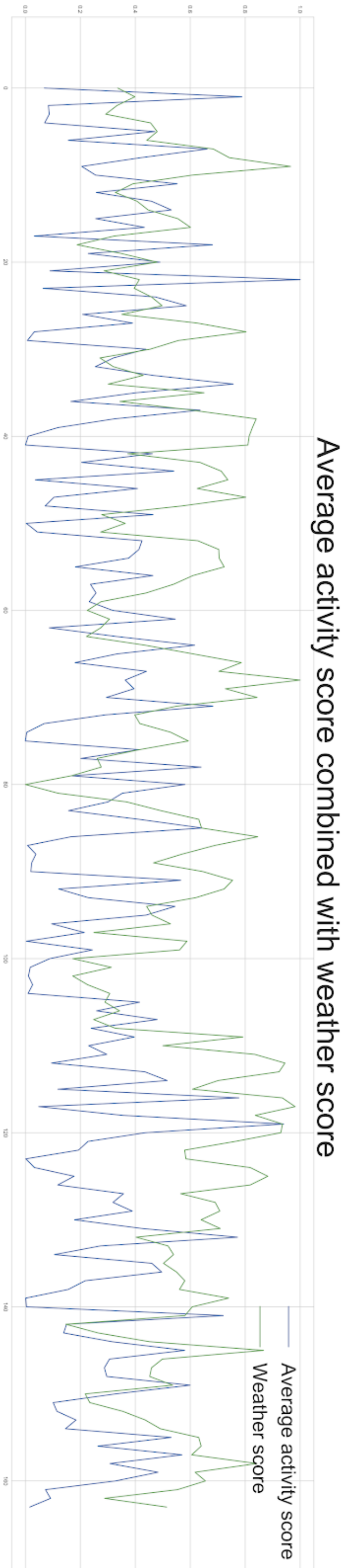
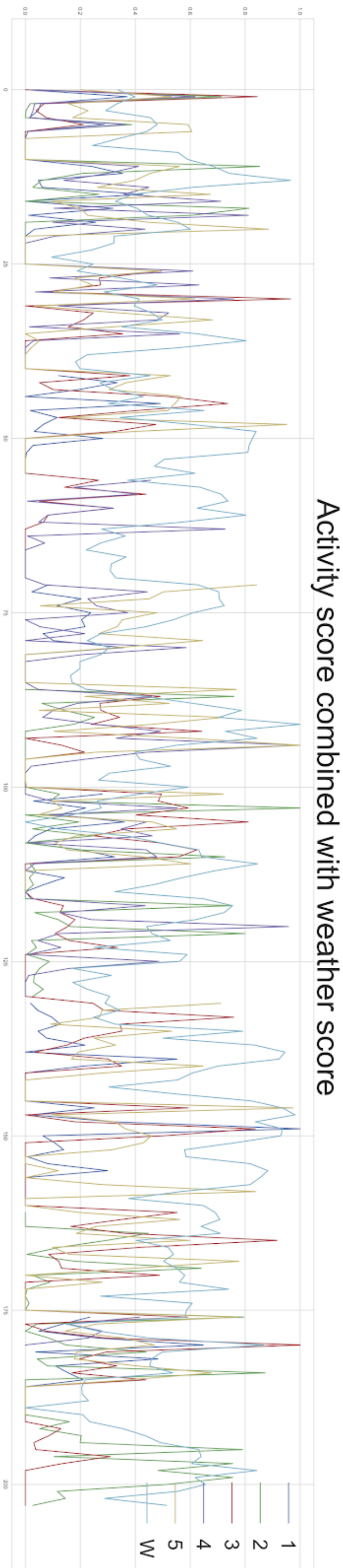
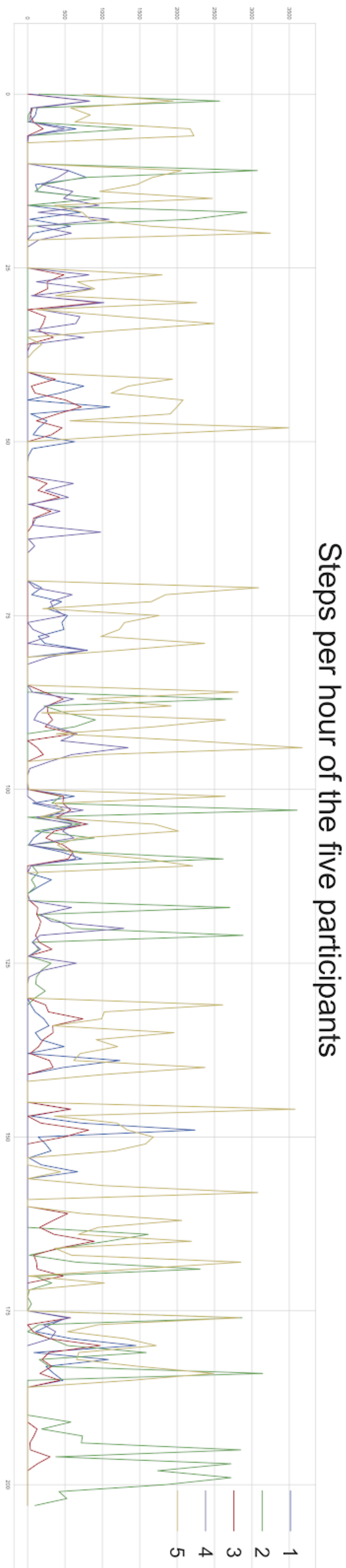
APPENDIX

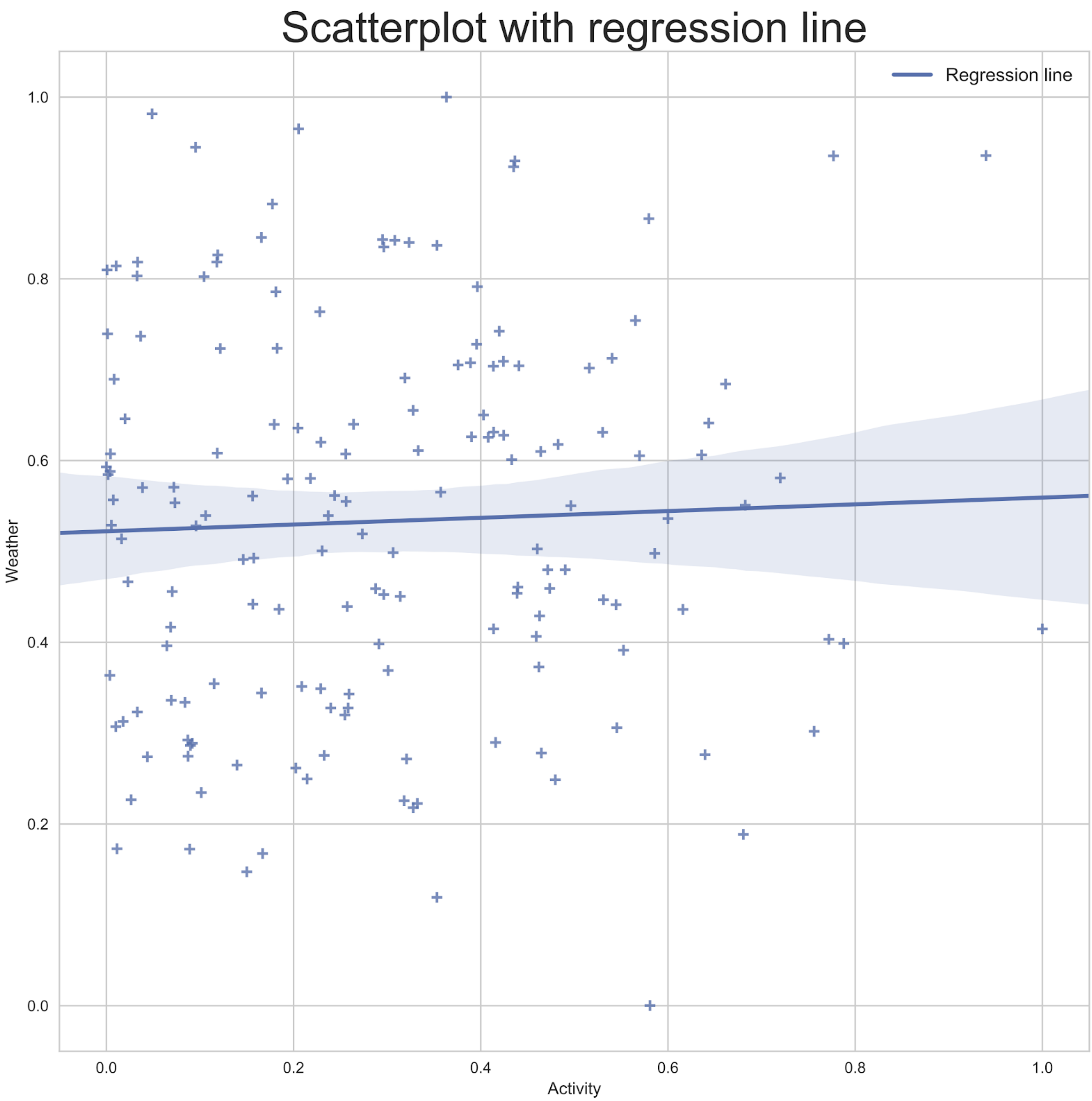
I. Detailed graphs
II. Interview results: Qualitative questions (Dutch)
III. Data analysis: Python notebook
IV. Consent forms

I. DETAILED GRAPHS








Scatterplot with regression line
Regression line
Weather
Activity
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0

II. INTERVIEW RESULTS: QUALITATIVE QUESTIONS (DUTCH)

Questions and results of the qualitative interviews at the end of the study, held in dutch.

Vragen onderzoek afronding Ede: #1

Waren en bijzondere dagen in de metingen? (Buitendagen met werk, bandje deed gek?)

-

Waren er andere praktische problemen tijdens het onderzoek?

-

Hoe komt u naar uw werk toe? En is dat variabel op basis van het weer?

Auto en dan een stukje wandelen

Wat doet u normaal op een dag qua wandelen lopen?

Soms tussen de middag naar buiten, wel met de trap

Hoe heeft u het weer de afgelopen tijd ervaren?

Niet actief tegengehouden door het weer

Heeft u het idee dat u actiever of inactiever was dan normaal? Waardoor?

Zou kunnen dat iets minder actief, geen herinneringen van de fitbit.

Vragen onderzoek afronding Ede: #2

Waren en bijzondere dagen in de metingen? (Buitendagen met werk, bandje deed gek?)

Geen extra actieve dagen, afgelopen vrijdag 21 juni veel stappen maar niet naar het werk

Waren er andere praktische problemen tijdens het onderzoek?

-

Hoe komt u naar uw werk toe? En is dat variabel op basis van het weer?

Wandelend, alleen als het erg hard regent met de bus

Wat doet u normaal op een dag qua wandelen lopen?

Nee, alleen binnen, naar het restaurant

Hoe heeft u het weer de afgelopen tijd ervaren?

Het was lekker weer

Heeft u het idee dat u actiever of inactiever was dan normaal? Waardoor?

Gewoon normale activiteit

Vragen onderzoek afronding Ede: #3

Waren en bijzondere dagen in de metingen? (Buitendagen met werk, bandje deed gek?)

Vrijdag werk vanuit thuis en de mi band wel omgehad, ook de honden uitgelaten.

Waren er andere praktische problemen tijdens het onderzoek?

-

Hoe komt u naar uw werk toe? En is dat variabel op basis van het weer?

Op de fiets

Wat doet u normaal op een dag qua wandelen lopen?

In het weekend wel veel lopen met de honden; naar de printer en de lunch

Hoe heeft u het weer de afgelopen tijd ervaren?

Weer is niet echt beperkend geweest, alleen met harde regen

Heeft u het idee dat u actiever of inactiever was dan normaal? Waardoor?

Geen verandering, normaal

Vragen onderzoek afronding Ede: #4

Waren en bijzondere dagen in de metingen? (Buitendagen met werk, bandje deed gek?)

Een dag met veel heen en weer tussen gebouw, veel rondlopen

Waren er andere praktische problemen tijdens het onderzoek?

Goede batterij

Hoe komt u naar uw werk toe? En is dat variabel op basis van het weer?

Met de auto, klein stukje lopen

Wat doet u normaal op een dag qua wandelen lopen?

Rondje over de afdeling, soms een broodje in de stad

Hoe heeft u het weer de afgelopen tijd ervaren?

Een dag met regen en maar moest toch heen en weer lopen, niet tegengehouden

Heeft u het idee dat u actiever of inactiever was dan normaal? Waardoor?

Normaal

Vragen onderzoek afronding Ede: #5 Pim

Waren en bijzondere dagen in de metingen? (Buitendagen met werk, bandje deed gek?)

Dag 8, 13 juni met de trein in plaats van met de auto naar het werk

Waren er andere praktische problemen tijdens het onderzoek?

-

Hoe komt u naar uw werk toe? En is dat variabel op basis van het weer?

Met de motor, nauwelijks

Wat doet u normaal op een dag qua wandelen lopen?

Koffie en lunch halen, vergaderingen naar andere gebouwen

Hoe heeft u het weer de afgelopen tijd ervaren?

Vanwege onweer soms een iets andere planning

Heeft u het idee dat u actiever of inactiever was dan normaal? Waardoor?

Normaal

KNMI Data Analysis

Defining good and bad weather conditions

In this notebook, KNMI w eather data from w eather station Deelen w ill be imported and the duration of sunshine, hourly global radiation, horizontal vision and cloud coverage w ill be analysed from monday 03/06/2019 untill 07/06/2019. The goal is to end up w ith a score from 1-10 representing the w eather quality based on light. This w ill be done by looking at the maximum and minimum value per data type and mapping all hourly data values to this 1-10 scale. Then, by using factors that identify each data type's amount of influence on the w eather quality, a general number can be assigned to every timestamp that represents the w eather quality at that moment.

Data source: https://projects.knmi.nl/klimatologie/uurgegevens/selectie.cgi (https://projects.knmi.nl/klimatologie/uurgegevens/selectie.cgi)

In [1]:
```
file_KNMI = './Dataset/KNMI_20190621_hourly.csv'
file_STEPS = './Dataset/Export_24_juni.csv'
```

In [2]:
```
import numpy as np
import pandas as pd
from sklearn import preprocessing
import seaborn as sns
import datetime

import statsmodels.api as sm
import matplotlib.pyplot as plt
from statsmodels.sandbox.regression.predstd import wls_prediction_std
```

```
C:\ProgramData\Anaconda3\lib\site-packages\statsmodels\compat\pandas.p
y:56: FutureWarning: The pandas.core.datetools module is deprecated and
will be removed in a future version. Please use the pandas.tseries modul
e instead.
  from pandas.core import datetools
```

Data Types

YYYYMMDD = datum (YYYY=jaar MM=maand DD=dag);

HH = tijd (HH=uur UT.12 UT=13 MET 14 MEZT. Uurvak 05 loopt van 04.00 UT tot 5.00 UT)

SQ = Duur van de zonneschijn (in 0.1 uren) per uurvak berekend uit globale straling (-1 for <0.05 uur)

Q = Globale straling (in J/cm2) per uurvak

VV = Horizontaal zicht tijdens de w aarneming (0=minder dan 100m, 1=100-200m, 2=200-300m ... 49=4900-5000m, 50=5-6km, 56=6-7km, 57=7-8km ... 79=29-30km, 80=30-35km, 81=35-40km ... 89=meer dan 70km)

N = Bew olking (bedekkingsgraad van de bovenlucht in achtsten) tijdens de w aarneming (9=bovenlucht onzichtbaar)

In [3]:
```
df_KNMI = pd.read_csv(file_KNMI, sep=';')
df_KNMI.head()
```

Out[3]:

	STN	YYYYMMDD	HH	SQ	Q	VV	N
0	275	20190603	12	0	117	80	8
1	275	20190603	13	1	160	80	8
2	275	20190603	14	0	109	81	8
3	275	20190603	15	0	86	76	8
4	275	20190603	16	4	144	78	8

Cleaning, editing, renaming

In [4]:
```
# Deleting all leading spaces from column names
df_KNMI.columns = df_KNMI.columns.str.lstrip()
```

In [5]:
```
# Station number is not necessary, so can be dropped out
df_KNMI.drop('STN',1,inplace=True)
```

In [6]:
```
# Converting 'YYYYMMDD' to string so we can change it to a datetime object
df_KNMI['YYYYMMDD'] = df_KNMI['YYYYMMDD'].apply(str)

# Converting it to a datetime object
df_KNMI['YYYYMMDD'] = pd.to_datetime(df_KNMI['YYYYMMDD'])

# Renaming 'YYYYMMDD' to 'Date'
df_KNMI.rename(columns = {'YYYYMMDD' : 'Date'}, inplace = True)
```

In [7]:
```
# Renaming 'HH' to 'Hour'
df_KNMI.rename(columns = {'HH' : 'Hour'}, inplace = True)

# Renaming the columns to more clearly describe the data
df_KNMI.rename(columns = {'SQ' : 'SQ: Duration sunshine'}, inplace = True)
df_KNMI.rename(columns = {'Q' : 'Q: Global radiation'}, inplace = True)
df_KNMI.rename(columns = {'VV' : 'VV: Horizontal vision'}, inplace = True)
df_KNMI.rename(columns = {'N' : 'N: Cloud coverage'}, inplace = True)

df_KNMI.head()
```

Out[7]:

	Date	Hour	SQ: Duration sunshine	Q: Global radiation	VV: Horizontal vision	N: Cloud coverage
0	2019-06-03	12	0	117	80	8
1	2019-06-03	13	1	160	80	8
2	2019-06-03	14	0	109	81	8
3	2019-06-03	15	0	86	76	8
4	2019-06-03	16	4	144	78	8

Defining max & min

In [8]:
```
max_duration_of_sunshine = df_KNMI['SQ: Duration sunshine'].max() # =10
min_duration_of_sunshine = df_KNMI['SQ: Duration sunshine'].min() # =1

max_global_radiation = df_KNMI['Q: Global radiation'].max() # =311
min_global_radiation = df_KNMI['Q: Global radiation'].min() # =2

max_horizontal_vision = df_KNMI['VV: Horizontal vision'].max() # =83
min_horizontal_vision = df_KNMI['VV: Horizontal vision'].min() # =45

max_cloud_coverage = df_KNMI['N: Cloud coverage'].max() # =8
min_cloud_coverage = df_KNMI['N: Cloud coverage'].min() # =0
```

Creating the weather data type scores by normalizing the data recordings

In [9]:
```
# Create S_SQ, where S_SQ are the 'scores' as floats for 'SQ: Duration sun
shine'
S_SQ = df_KNMI[['SQ: Duration sunshine']].values.astype(float)

# Create a minimum and maximum processor object
min_max_scaler = preprocessing.MinMaxScaler()

# Create an object to transform the data to fit minmax processor
S_SQ_scaled = min_max_scaler.fit_transform(S_SQ)

# Run the normalizer on the dataframe
df_KNMI['S_SQ'] = pd.DataFrame(S_SQ_scaled)
```

Repeat for the rest of the data types...

In [10]:
```
S_Q = df_KNMI[['Q: Global radiation']].values.astype(float)
min_max_scaler = preprocessing.MinMaxScaler()
S_Q_scaled = min_max_scaler.fit_transform(S_Q)
df_KNMI['S_Q'] = pd.DataFrame(S_Q_scaled)
```

In [11]:
```
S_VV = df_KNMI[['VV: Horizontal vision']].values.astype(float)
min_max_scaler = preprocessing.MinMaxScaler()
S_VV_scaled = min_max_scaler.fit_transform(S_VV)
df_KNMI['S_VV'] = pd.DataFrame(S_VV_scaled)
```

In [12]:
```
S_N = df_KNMI[['N: Cloud coverage']].values.astype(float)
min_max_scaler = preprocessing.MinMaxScaler()
S_N_scaled = min_max_scaler.fit_transform(S_N)
df_KNMI['S_N'] = pd.DataFrame(S_N_scaled)

# Because a high score for cloud coverage has a negative influence on the
percieved weather quality,
# where all other data types are positive with higher scores, the score fo
r cloud coverange (S_N)
# will be inverted by doing 1.0 - S_N

df_KNMI['S_N'] = [1-x for x in df_KNMI['S_N']]

df_KNMI.head()
```

Out[12]:

	Date	Hour	SQ: Duration sunshine	Q: Global radiation	VV: Horizontal vision	N: Cloud coverage	S_SQ	S_Q	S_VV	S_N
0	2019-06-03	12	0	117	80	8	0.0	0.367089	0.950000	0.0
1	2019-06-03	13	1	160	80	8	0.1	0.503165	0.950000	0.0
2	2019-06-03	14	0	109	81	8	0.0	0.341772	0.966667	0.0
3	2019-06-03	15	0	86	76	8	0.0	0.268987	0.883333	0.0
4	2019-06-03	16	4	144	78	8	0.4	0.452532	0.916667	0.0

Creating the weather scores based on each weather data type's factor

In [13]:
```
# Here we set the factors that determine the impact of each weather data t
ype on the weather quality
# These will be based on qualitative data gathered from our participants
Duration_of_sunshine_factor = 1
Global_radiation_factor = 1
Horizontal_vision_factor = 1
Cloud_coverage_factor = 1
```

In [14]:
```
# Multiplying the scores times their factor
df_factored_scores = pd.DataFrame()
df_factored_scores['F_S_SQ'] = df_KNMI[['S_SQ']].multiply(Duration_of_suns
hine_factor)
df_factored_scores['F_S_Q'] = df_KNMI[['S_Q']].multiply(Global_radiation_f
actor)
df_factored_scores['F_S_VV'] = df_KNMI[['S_VV']].multiply(Horizontal_visio
n_factor)
df_factored_scores['F_S_N'] = df_KNMI[['S_N']].multiply(Cloud_coverage_fac
tor)

# Summing all the scores in a new column
df_factored_scores['Sum'] = df_factored_scores['F_S_SQ'] + df_factored_sco
res['F_S_Q'] + df_factored_scores['F_S_VV'] + df_factored_scores['F_S_N']

df_factored_scores.head(2)
```

Out[14]:

	F_S_SQ	F_S_Q	F_S_VV	F_S_N	Sum
0	0.0	0.367089	0.95	0.0	1.317089
1	0.1	0.503165	0.95	0.0	1.553165

In [15]:
```
# Now we normalize these added scores to create the weather score with a s
cale from 0-1
Weather_score = df_factored_scores[['Sum']].values.astype(float)
min_max_scaler = preprocessing.MinMaxScaler()
Weather_score_scaled = min_max_scaler.fit_transform(Weather_score)
df_factored_scores['Weather score (0-1)'] = pd.DataFrame(Weather_score_sca
led)
df_factored_scores['Weather score (0-1)'] = df_factored_scores['Weather sc
ore (0-1)'].multiply(1)

df_factored_scores.head(2)
```

Out[15]:

	F_S_SQ	F_S_Q	F_S_VV	F_S_N	Sum	Weather score (0-1)
0	0.0	0.367089	0.95	0.0	1.317089	0.336098
1	0.1	0.503165	0.95	0.0	1.553165	0.398593

Final dataframe with weather score

In [16]:
```
df_KNMI['Weather score'] = df_factored_scores['Weather score (0-1)']
df_KNMI.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 204 entries, 0 to 203
Data columns (total 11 columns):
Date                     204 non-null datetime64[ns]
Hour                     204 non-null int64
SQ: Duration sunshine    204 non-null int64
Q: Global radiation      204 non-null int64
VV: Horizontal vision    204 non-null int64
N: Cloud coverage        204 non-null int64
S_SQ                     204 non-null float64
S_Q                      204 non-null float64
S_VV                     204 non-null float64
S_N                      204 non-null float64
Weather score            204 non-null float64
dtypes: datetime64[ns](1), float64(5), int64(5)
memory usage: 17.6 KB
```

In [17]:
```
def hr_func(ts):
    return ts.hour
```

In [18]:
```
df_steps = pd.read_csv(file_STEPS)
df_steps['TIMESTAMP'] = pd.to_datetime(df_steps['TIMESTAMP'],unit='s')
df_steps.drop('RAW_KIND',1,inplace=True)
df_steps.drop('RAW_INTENSITY',1,inplace=True)
df_steps.drop('HEART_RATE',1,inplace=True)
df_steps['Date'] = df_steps['TIMESTAMP'].dt.date
df_steps['Date'] = df_steps['Date'].astype('str')
df_steps['Hour'] = df_steps['TIMESTAMP'].apply(hr_func)
df_steps['WeekDay'] = df_steps['TIMESTAMP'].dt.weekday
df_steps = df_steps[['Date', 'Hour', 'WeekDay', 'TIMESTAMP','DEVICE_ID', '
STEPS']]
df_steps = df_steps[df_steps['WeekDay'] < 5].reset_index(drop=True)
df_steps = df_steps[df_steps['Date'] != '2019-06-10'].reset_index(drop=Tru
e)
df_steps.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 93881 entries, 0 to 93880
Data columns (total 6 columns):
Date         93881 non-null object
Hour         93881 non-null int64
WeekDay      93881 non-null int64
TIMESTAMP    93881 non-null datetime64[ns]
DEVICE_ID    93881 non-null int64
STEPS        93881 non-null int64
dtypes: datetime64[ns](1), int64(4), object(1)
memory usage: 4.3+ MB
```

In [19]:
```
df_steps = df_steps.groupby(['DEVICE_ID','Date','Hour'],as_index=False).ag
g({'STEPS': 'sum'})
df_steps = df_steps[df_steps['Hour'] > 5]
df_steps = df_steps[df_steps['Hour'] < 21]
df_steps.reset_index(drop=True)
df_steps.head()
```

Out[19]:

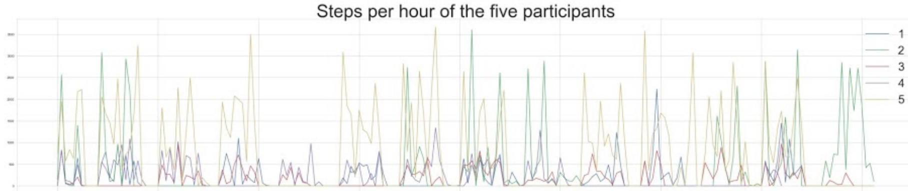
	DEVICE_ID	Date	Hour	STEPS
0	1	2019-06-03	10	11
1	1	2019-06-03	11	830
2	1	2019-06-03	12	126
3	1	2019-06-03	13	105
4	1	2019-06-03	14	33

In [20]:
```
#Split the dataframe for every participant
df_steps_1 = df_steps[df_steps['DEVICE_ID'] == 1].reset_index(drop=True)
df_steps_2 = df_steps[df_steps['DEVICE_ID'] == 2].reset_index(drop=True)
df_steps_3 = df_steps[df_steps['DEVICE_ID'] == 3].reset_index(drop=True)
df_steps_4 = df_steps[df_steps['DEVICE_ID'] == 4].reset_index(drop=True)
df_steps_5 = df_steps[df_steps['DEVICE_ID'] == 5].reset_index(drop=True)
```

In [21]:
```
# Start visualizing
```

In [22]:
```
%matplotlib inline
import matplotlib.pyplot as plt
plt.style.use('seaborn-whitegrid')
import numpy as np
import matplotlib.pyplot as plt
import matplotlib.style as style
```

In [23]:
```
fig = plt.figure(figsize=(50,10))
ax = plt.axes()
ax.plot(df_steps_1['STEPS']);
ax.plot(df_steps_2['STEPS']);
ax.plot(df_steps_3['STEPS']);
ax.plot(df_steps_4['STEPS']);
ax.plot(df_steps_5['STEPS']);
plt.legend(['1','2','3', '4', '5'], fontsize=36);
plt.title('Steps per hour of the five participants', fontsize=56, loc='cen
ter')
plt.savefig("Steps per hour of the five participants.pdf", bbox_inches='ti
ght')
```



In [24]:
```
# Dataframe with activity score
```

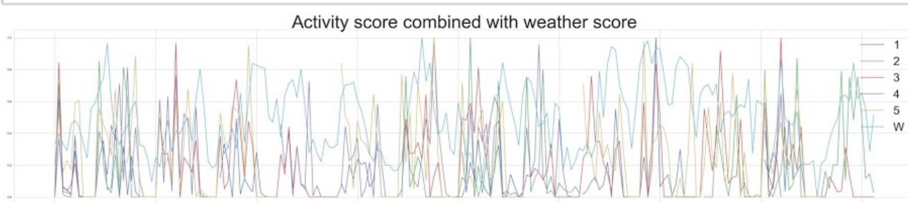
In [25]:
```
df1 = df_steps_1[['STEPS']].values.astype(float)
min_max_scaler = preprocessing.MinMaxScaler()
df1 = min_max_scaler.fit_transform(df1)
df_steps_1['Score'] = pd.DataFrame(df1)

df2 = df_steps_2[['STEPS']].values.astype(float)
min_max_scaler = preprocessing.MinMaxScaler()
df2 = min_max_scaler.fit_transform(df2)
df_steps_2['Score'] = pd.DataFrame(df2)

df3 = df_steps_3[['STEPS']].values.astype(float)
min_max_scaler = preprocessing.MinMaxScaler()
df3 = min_max_scaler.fit_transform(df3)
df_steps_3['Score'] = pd.DataFrame(df3)

df4 = df_steps_4[['STEPS']].values.astype(float)
min_max_scaler = preprocessing.MinMaxScaler()
df4 = min_max_scaler.fit_transform(df4)
df_steps_4['Score'] = pd.DataFrame(df4)

df5 = df_steps_5[['STEPS']].values.astype(float)
min_max_scaler = preprocessing.MinMaxScaler()
df5 = min_max_scaler.fit_transform(df5)
df_steps_5['Score'] = pd.DataFrame(df5)
```

In [26]:
```
#Change step count values to NaN for non active days
df_steps_day_1 = df_steps_1.groupby(['DEVICE_ID','Date'],as_index=False).a
gg({'STEPS': 'sum'})
day_filter_1 = df_steps_day_1[df_steps_day_1['STEPS'] == 0].Date
df_steps_1['Active this day:'] = ~df_steps_1['Date'].isin(day_filter_1)
df_steps_1.loc[df_steps_1['Active this day:'] == False, 'Score'] = np.nan

df_steps_day_2 = df_steps_2.groupby(['DEVICE_ID','Date'],as_index=False).a
gg({'STEPS': 'sum'})
day_filter_2 = df_steps_day_2[df_steps_day_2['STEPS'] == 0].Date
df_steps_2['Active this day:'] = ~df_steps_2['Date'].isin(day_filter_2)
df_steps_2.loc[df_steps_2['Active this day:'] == False, 'Score'] = np.nan

df_steps_day_3 = df_steps_3.groupby(['DEVICE_ID','Date'],as_index=False).a
gg({'STEPS': 'sum'})
day_filter_3 = df_steps_day_3[df_steps_day_3['STEPS'] == 0].Date
df_steps_3['Active this day:'] = ~df_steps_3['Date'].isin(day_filter_3)
df_steps_3.loc[df_steps_3['Active this day:'] == False, 'Score'] = np.nan

df_steps_day_4 = df_steps_4.groupby(['DEVICE_ID','Date'],as_index=False).a
gg({'STEPS': 'sum'})
day_filter_4 = df_steps_day_4[df_steps_day_4['STEPS'] == 0].Date
df_steps_4['Active this day:'] = ~df_steps_4['Date'].isin(day_filter_4)
df_steps_4.loc[df_steps_4['Active this day:'] == False, 'Score'] = np.nan

df_steps_day_5 = df_steps_5.groupby(['DEVICE_ID','Date'],as_index=False).a
gg({'STEPS': 'sum'})
day_filter_5 = df_steps_day_5[df_steps_day_5['STEPS'] == 0].Date
df_steps_5['Active this day:'] = ~df_steps_5['Date'].isin(day_filter_5)
df_steps_5.loc[df_steps_5['Active this day:'] == False, 'Score'] = np.nan
```

In [27]:
```
df_scores = pd.DataFrame({
    '1': df_steps_1['Score'],
    '2': df_steps_2['Score'],
    '3': df_steps_3['Score'],
    '4': df_steps_4['Score'],
    '5': df_steps_5['Score'],
})
df_scores['Mean score'] = df_scores.mean(axis=1)
df_scores.info()
```

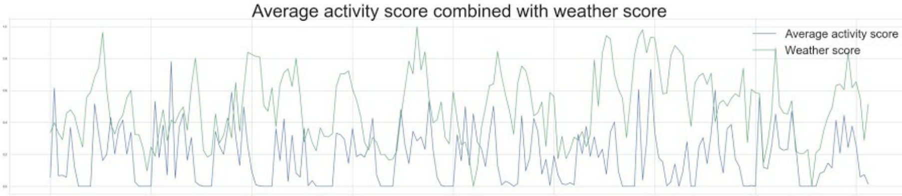
```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 204 entries, 0 to 203
Data columns (total 6 columns):
1             116 non-null float64
2             114 non-null float64
3             174 non-null float64
4             121 non-null float64
5             161 non-null float64
Mean score    204 non-null float64
dtypes: float64(6)
memory usage: 9.6 KB
```

In [28]:
```
fig = plt.figure(figsize=(50,10))
ax = plt.axes()
ax.plot(df_steps_1['Score']);ax.plot(df_steps_2['Score']);
ax.plot(df_steps_3['Score']);
ax.plot(df_steps_4['Score']);
ax.plot(df_steps_5['Score']);
ax.plot(df_KNMI['Weather score'])
plt.legend(['1', '2', '3', '4', '5', 'W'], fontsize=36, loc='upper right
');
plt.title('Activity score combined with weather score', fontsize=56, loc='
center')
plt.savefig("Activity score combined with weather score.pdf", bbox_inche
s='tight')
```



In [29]:
```
fig = plt.figure(figsize=(50,10))
ax = plt.axes()
ax.plot(df_scores['Mean score']);
ax.plot(df_KNMI['Weather score'])
plt.legend(['Average activity score', 'Weather score'], fontsize=36, loc='
upper right');
plt.title('Average activity score combined with weather score', fontsiz
e=56, loc='center')
plt.savefig("Average activity score combined with weather score.pdf", bbox
_inches='tight')
```

Average activity score combined with weather score

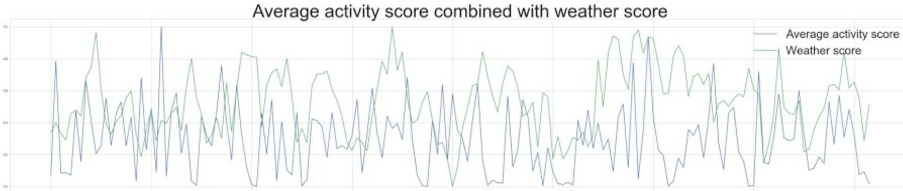


In [30]:
```
df_plot = pd.DataFrame({
    'Activity': df_scores['Mean score'],
    'Weather': df_KNMI['Weather score'],
})
df_plot = df_plot[(df_plot != 0).all(1)]
df_plot = df_plot.reset_index(drop=True)

df = df_plot[['Activity']].values.astype(float)
min_max_scaler = preprocessing.MinMaxScaler()
df = min_max_scaler.fit_transform(df)
df_plot['Activity'] = pd.DataFrame(df)

df_plot.info()
```

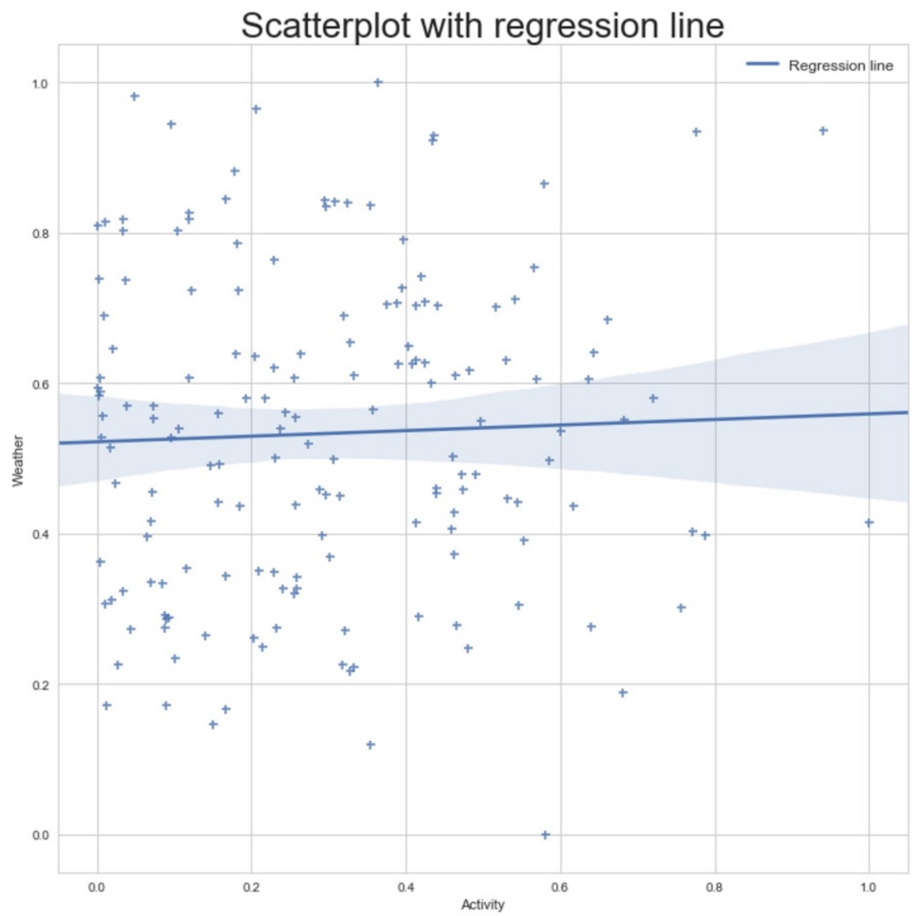
```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 164 entries, 0 to 163
Data columns (total 2 columns):
Activity    164 non-null float64
Weather     164 non-null float64
dtypes: float64(2)
memory usage: 2.6 KB
```

In [31]:
```
fig = plt.figure(figsize=(50,10))
ax = plt.axes()
ax.plot(df_plot['Activity']);
ax.plot(df_plot['Weather'])
plt.legend(['Average activity score', 'Weather score'], fontsize=36, loc='
upper right');
plt.title('Average activity score combined with weather score', fontsiz
e=56, loc='center')
plt.savefig("Average activity score combined with weather score_2.pdf", bb
ox_inches='tight')
```

Average activity score combined with weather score



In [32]:
```
fig = plt.figure(figsize=(12,12))
ax = sns.regplot(x=df_plot['Activity'],y=df_plot['Weather'],data=df_plot,
marker="+")

plt.legend(['Regression line'], fontsize=12);
plt.title('Scatterplot with regression line', fontsize=28, loc='center')
plt.savefig("Scatterplot with regression line.pdf", bbox_inches='tight')
```



In [33]:
```
y = df_plot['Weather']#.iloc[1:181]
X = df_plot['Activity']#.iloc[1:181]
est = sm.OLS(y, X)
est = est.fit()
est.summary()
```

Out[33]:

OLS Regression Results

Dep. Variable:	Weather	**R-squared:**	0.576
Model:	OLS	**Adj. R-squared:**	0.573
Method:	Least Squares	**F-statistic:**	221.4
Date:	Tue, 25 Jun 2019	**Prob (F-statistic):**	3.56e-32
Time:	11:09:48	**Log-Likelihood:**	-71.050
No. Observations:	164	**AIC:**	144.1
Df Residuals:	163	**BIC:**	147.2
Df Model:	1		
Covariance Type:	nonrobust		

	coef	**std err**	**t**	**P>|t|**	**[0.025**	**0.975]**
Activity	1.1879	0.080	14.878	0.000	1.030	1.346

Omnibus:	1.972	**Durbin-Watson:**	1.163
Prob(Omnibus):	0.373	**Jarque-Bera (JB):**	1.763
Skew:	-0.254	**Prob(JB):**	0.414
Kurtosis:	3.030	**Cond. No.**	1.00

IV. CONSENT FORMS

1

TU/e EINDHOVEN UNIVERSITY OF TECHNOLOGY

Making Sense of Sensors DAB100
Groep 24
Supervisie: prof.dr.ir. A.C. Brombacher

Onderzoek

De TU Eindhoven doet onderzoek naar bewegingspatronen en vitaliteit in het kader van het vak "Making Sense of Sensors" (vakcode DAB100). In dit onderzoek wordt er gekeken naar de activiteit van kantoormedewerkers, en in dit geval in relatie tot het weer. De activiteit data wordt vergeleken met data van het KNMI om daaruit mogelijke conclusies te halen.

Procedure

Gedurende het onderzoek is het de bedoeling dat u meewerkt aan data acquisitie in het kader van het bovengenoemd onderzoek. Hierbij is het de bedoeling dat u gewoon te werk gaat als altijd en daarbij de Mi Band vanaf het vertrek naar het werk tot het moment van thuiskomen om heeft. Tijdens het onderzoek wordt de activiteit gemeten aan de hand van het aantal stappen en alle data blijft lokaal en wordt niet gedeeld met andere onderzoeken.

Deelname aan deze onderzoeken is geheel vrijwillig. Als u van deelname aan het onderzoek af zou willen zien, om welke reden dan ook, kunt u dat op ieder moment doen. Als u aarzelt over deelname of vragen heeft over het onderzoek, kunt u die altijd stellen aan Bodi Fok (b.a.s.fok@student.tue.nl of +31623036305).

Bij dit onderzoek wordt gewerkt volgens de Code of Conduct van de TU Eindhoven. Het gedrag van de deelnemers kan voor onderzoeksdoeleinden worden geregistreerd. De verkregen gegevens worden altijd anoniem verwerkt, en de resultaten worden slechts op groepsniveau gerapporteerd.

Bij deze verklaar ik, (NAAM) Marjoltje Neekman dat ik deze werkwijze begrepen heb en ermee instem om deel te nemen aan het onderzoek van groep 24, vakcode DAB100 met als werktitel "De invloed van weer op de vitaliteit van kantoormedewerkers".

	3-6-2019.	Bodi
Handtekening participant	Datum	Handtekening onderzoeker

2

Making Sense of Sensors DAB100
Groep 24
Supervisie: prof.dr.ir. A.C. Brombacher

Onderzoek

De TU Eindhoven doet onderzoek naar bewegingspatronen en vitaliteit in het kader van het vak "Making Sense of Sensors" (vakcode DAB100). In dit onderzoek wordt er gekeken naar de activiteit van kantoormedewerkers, en in dit geval in relatie tot het weer. De activiteit data wordt vergeleken met data van het KNMI om daaruit mogelijke conclusies te halen.

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Gedurende het onderzoek is het de bedoeling dat u meewerkt aan data acquisitie in het kader van het bovengenoemd onderzoek. Hierbij is het de bedoeling dat u gewoon te werk gaat als altijd en daarbij de Mi Band vanaf het vertrek naar het werk tot het moment van thuiskomen om heeft. Tijdens het onderzoek wordt de activiteit gemeten aan de hand van het aantal stappen en alle data blijft lokaal en wordt niet gedeeld met andere onderzoeken.

Deelname aan deze onderzoeken is geheel vrijwillig. Als u van deelname aan het onderzoek af zou willen zien, om welke reden dan ook, kunt u dat op ieder moment doen. Als u aarzelt over deelname of vragen heeft over het onderzoek, kunt u die altijd stellen aan Bodi Fok (b.a.s.fok@student.tue.nl of +31623036305).

Bij dit onderzoek wordt gewerkt volgens de Code of Conduct van de TU Eindhoven. Het gedrag van de deelnemers kan voor onderzoeksdoeleinden worden geregistreerd. De verkregen gegevens worden altijd anoniem verwerkt, en de resultaten worden slechts op groepsniveau gerapporteerd.

Bij deze verklaar ik, (NAAM) Ton Meeuwissen dat ik deze werkwijze begrepen heb en ermee instem om deel te nemen aan het onderzoek van groep 24, vakcode DAB100 met als werktitel "De invloed van weer op de vitaliteit van kantoormedewerkers".

Handtekening participant

3-6-2019
Datum

Handtekening onderzoeker

3

Making Sense of Sensors DAB100
Groep 24
Supervisie: prof.dr.ir. A.C. Brombacher

Onderzoek

De TU Eindhoven doet onderzoek naar bewegingspatronen en vitaliteit in het kader van het vak "Making Sense of Sensors" (vakcode DAB100). In dit onderzoek wordt er gekeken naar de activiteit van kantoormedewerkers, en in dit geval in relatie tot het weer. De activiteit data wordt vergeleken met data van het KNMI om daaruit mogelijke conclusies te halen.

Procedure

Gedurende het onderzoek is het de bedoeling dat u meewerkt aan data acquisitie in het kader van het bovengenoemd onderzoek. Hierbij is het de bedoeling dat u gewoon te werk gaat als altijd en daarbij de Mi Band vanaf het vertrek naar het werk tot het moment van thuiskomen om heeft. Tijdens het onderzoek wordt de activiteit gemeten aan de hand van het aantal stappen en alle data blijft lokaal en wordt niet gedeeld met andere onderzoeken.

Deelname aan deze onderzoeken is geheel vrijwillig. Als u van deelname aan het onderzoek af zou willen zien, om welke reden dan ook, kunt u dat op ieder moment doen. Als u aarzelt over deelname of vragen heeft over het onderzoek, kunt u die altijd stellen aan Bodi Fok (b.a.s.fok@student.tue.nl of +31623036305).

Bij dit onderzoek wordt gewerkt volgens de Code of Conduct van de TU Eindhoven. Het gedrag van de deelnemers kan voor onderzoeksdoeleinden worden geregistreerd. De verkregen gegevens worden altijd anoniem verwerkt, en de resultaten worden slechts op groepsniveau gerapporteerd.

Bij deze verklaar ik, (NAAM) Richard Elschot dat ik deze werkwijze begrepen heb en ermee instem om deel te nemen aan het onderzoek van groep 24, vakcode DAB100 met als werktitel "De invloed van weer op de vitaliteit van kantoormedewerkers".

	3 juni 2015	
Handtekening participant	Datum	Handtekening onderzoeker

4

TU/e EINDHOVEN UNIVERSITY OF TECHNOLOGY

Making Sense of Sensors DAB100
Groep 24
Supervisie: prof.dr.ir. A.C. Brombacher

Onderzoek

De TU Eindhoven doet onderzoek naar bewegingspatronen en vitaliteit in het kader van het vak "Making Sense of Sensors" (vakcode DAB100). In dit onderzoek wordt er gekeken naar de activiteit van kantoormedewerkers, en in dit geval in relatie tot het weer. De activiteit data wordt vergeleken met data van het KNMI om daaruit mogelijke conclusies te halen.

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Deelname aan deze onderzoeken is geheel vrijwillig. Als u van deelname aan het onderzoek af zou willen zien, om welke reden dan ook, kunt u dat op ieder moment doen. Als u aarzelt over deelname of vragen heeft over het onderzoek, kunt u die altijd stellen aan Bodi Fok (b.a.s.fok@student.tue.nl of +31623036305).

Bij dit onderzoek wordt gewerkt volgens de Code of Conduct van de TU Eindhoven. Het gedrag van de deelnemers kan voor onderzoeksdoeleinden worden geregistreerd. De verkregen gegevens worden altijd anoniem verwerkt, en de resultaten worden slechts op groepsniveau gerapporteerd.

Bij deze verklaar ik, (NAAM) Almar Hutten dat ik deze werkwijze begrepen heb en ermee instem om deel te nemen aan het onderzoek van groep 24, vakcode DAB100 met als werktitel "De invloed van weer op de vitaliteit van kantoormedewerkers".

HUTTEN	3-6-2019	Bodi
Handtekening participant	Datum	Handtekening onderzoeker

5

Making Sense of Sensors DAB100
Groep 24
Supervisie: prof.dr.ir. A.C. Brombacher

Onderzoek

De TU Eindhoven doet onderzoek naar bewegingspatronen en vitaliteit in het kader van het vak "Making Sense of Sensors" (vakcode DAB100). In dit onderzoek wordt er gekeken naar de activiteit van kantoormedewerkers, en in dit geval in relatie tot het weer. De activiteit data wordt vergeleken met data van het KNMI om daaruit mogelijke conclusies te halen.

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Deelname aan deze onderzoeken is geheel vrijwillig. Als u van deelname aan het onderzoek af zou willen zien, om welke reden dan ook, kunt u dat op ieder moment doen. Als u aarzelt over deelname of vragen heeft over het onderzoek, kunt u die altijd stellen aan Bodi Fok (b.a.s.fok@student.tue.nl of +31623036305).

Bij dit onderzoek wordt gewerkt volgens de Code of Conduct van de TU Eindhoven. Het gedrag van de deelnemers kan voor onderzoeksdoeleinden worden geregistreerd. De verkregen gegevens worden altijd anoniem verwerkt, en de resultaten worden slechts op groepsniveau gerapporteerd.

Bij deze verklaar ik, (NAAM) Pim Fok dat ik deze werkwijze begrepen heb en ermee instem om deel te nemen aan het onderzoek van groep 24, vakcode DAB100 met als werktitel "De invloed van weer op de vitaliteit van kantoormedewerkers".

	3-Juni-2019	
Handtekening participant	Datum	Handtekening onderzoeker