

Data Quality Management of Black Box Monitored Driving Behaviors in a Sleep Apnea Study

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Outline

- What is Sleep Apnea
- Study Details
 - Goals of summer research
- Mean and S.D. Function
 - Correlation and Linear Regression
- Merge Data with Sunrise/Sunset Data
 - Percent of Drive Time in Dark/Daylight
- Daily Latitude and Longitude Plots
 - Visualization of Specific Day's Drive
- Distance From Home
 - Percent of time driven close to home
- Statistical Analysis
- Conclusions

Sleep Apnea

- Pauses in breathing or shallow breathing while sleeping
 - Duration of each pause: a few seconds to a few minutes
 - Common occurrence: 5 -30 x per hour
- Result: poor sleep quality
- One of the leading causes of daytime drowsiness

Obstructive Sleep Apnea

- Most common type of sleep apnea
- Occurs in all types of individuals but more common in those who are overweight
- The airway collapses and becomes blocked during sleep
 - The blockage inhibits air during the inhalation process and carbon dioxide during the exhalation process
 - The lack of air causes a decrease in blood oxygen levels which signals the brain to wake the individual in order to reopen the airway

Risks of Untreated Sleep Apnea

- Increased risk of
 - High blood pressure
 - Heart attack
 - Stroke
 - Obesity
 - Diabetes
 - Heart failure
 - Arrhythmias (irregular heartbeats)
 - **Driving accidents**
- Treatments:
 - Lifestyle changes
 - Mouthpieces
 - Surgery
 - Breathing devices

The Driving Study

- Researchers in the Neuroergonomics Division at the University of Iowa are outfitting patients cars with “black box” devices
 - Measure and record driving data for 3 months of driving per subject
 - 7 subjects
 - Examples of gathered data:
 - Latitude
 - Longitude
 - Driving speed
 - 3-dimensional acceleration

The Driving Study



Data Example

```
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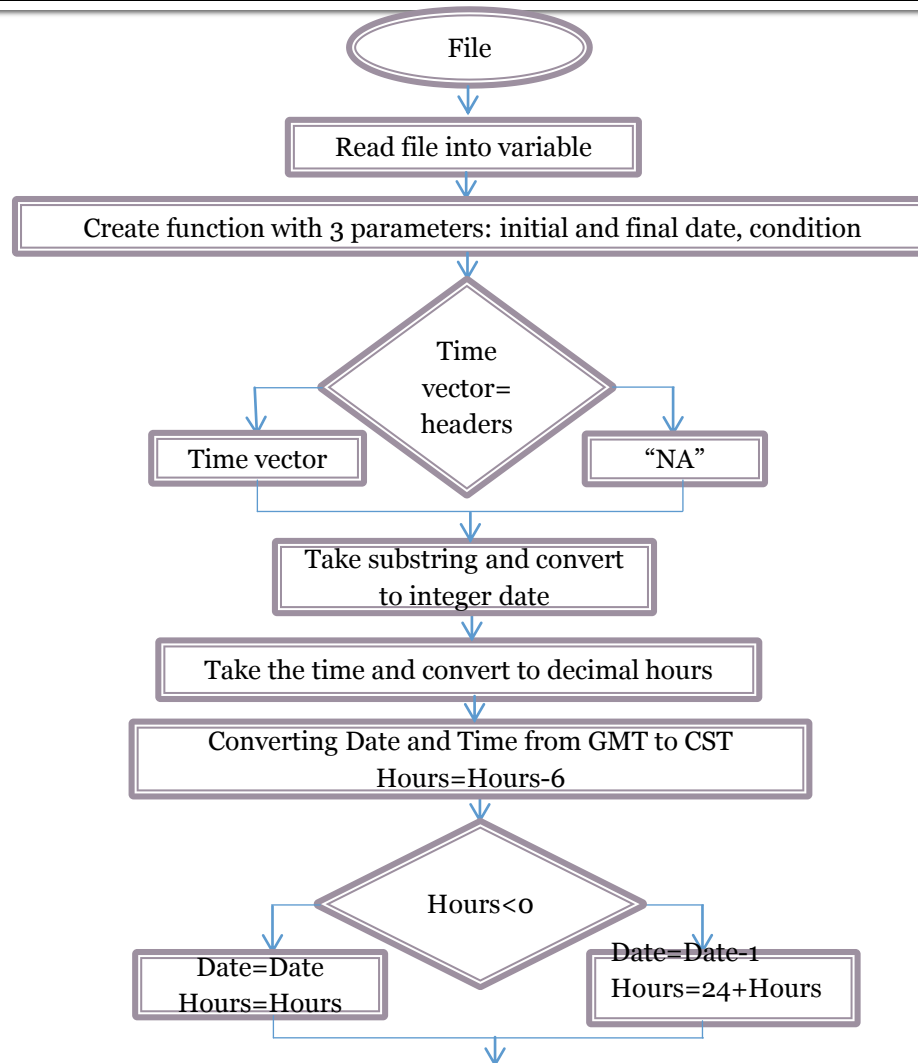

Goals of our Summer Research

- Describe the driving habits of the first several participants in this study
- Find and resolve data quality control issues which have arisen so far in this study
- Understand how driving habits are affected by weather conditions and other environmental factors
- Develop programming templates which can be used in future analyses as other drivers are enrolled into the studies

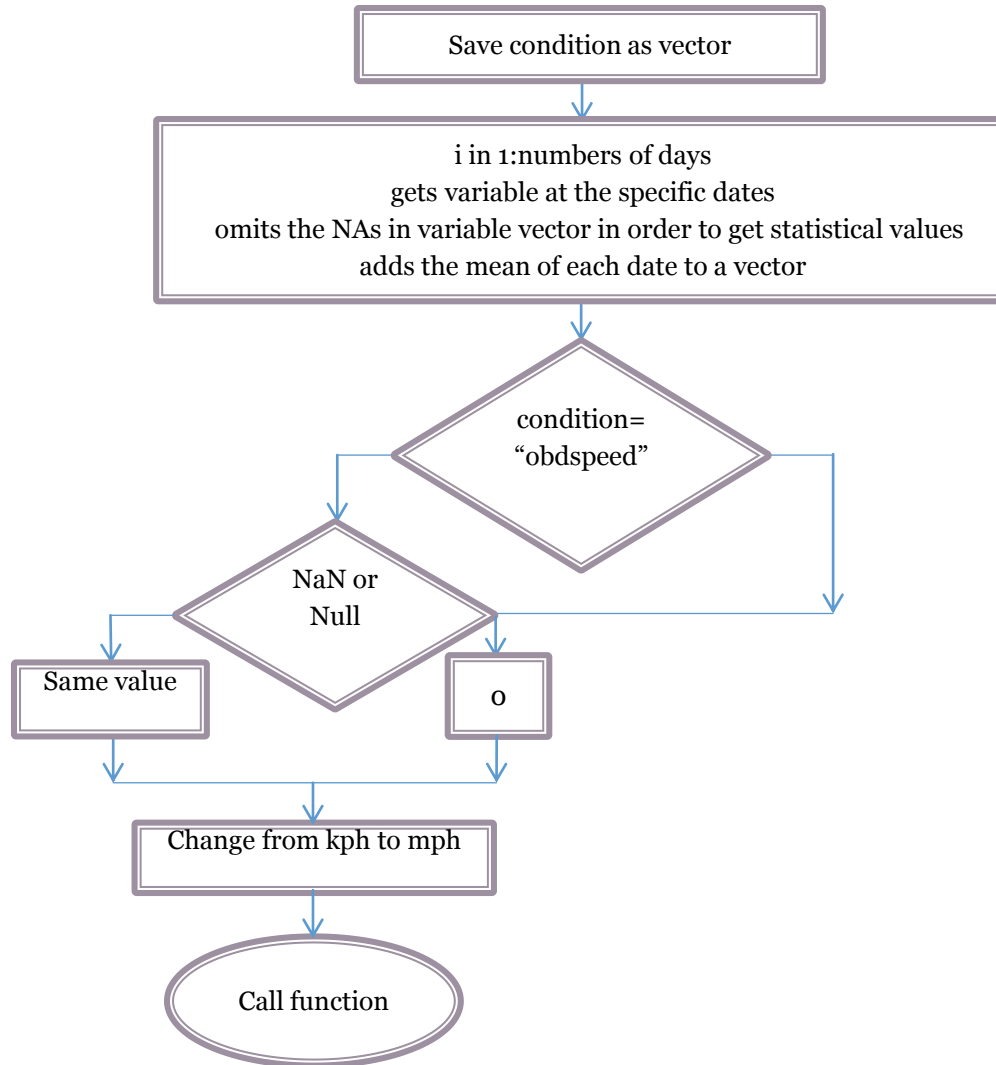
Mean & S.D. Function

- Used R statistical software to read in data and perform data reduction at the day level.
- Two functions structured similarly
 - Calculates the Mean or Standard Deviation of any of the data parameters

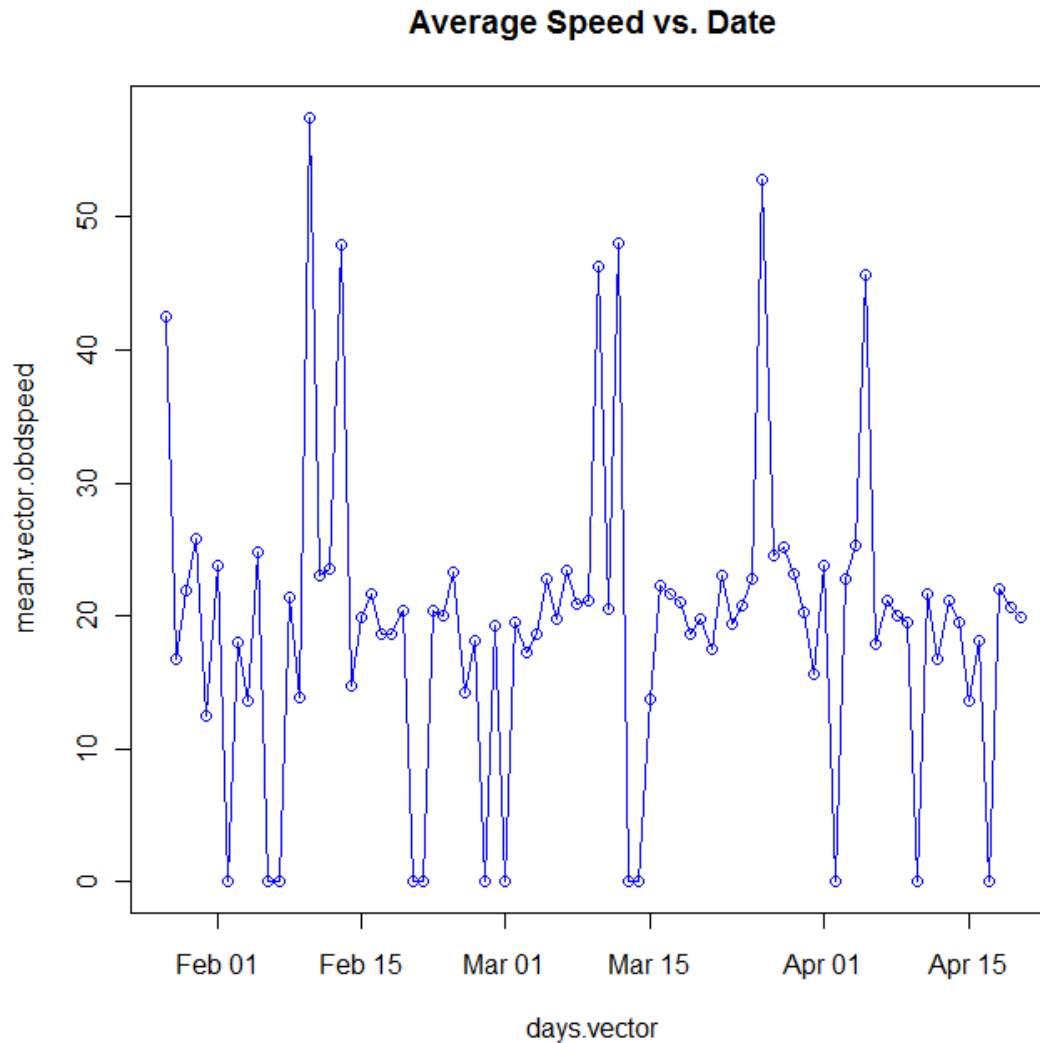
Mean & S.D. Function



Cont. Mean & S.D. Function

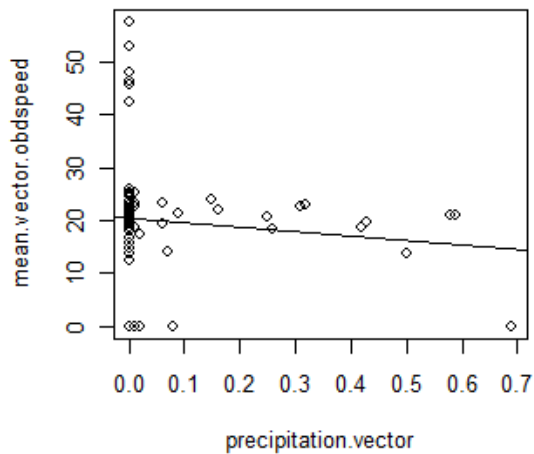


Mean & S.D. Function



Mean & S.D. Function

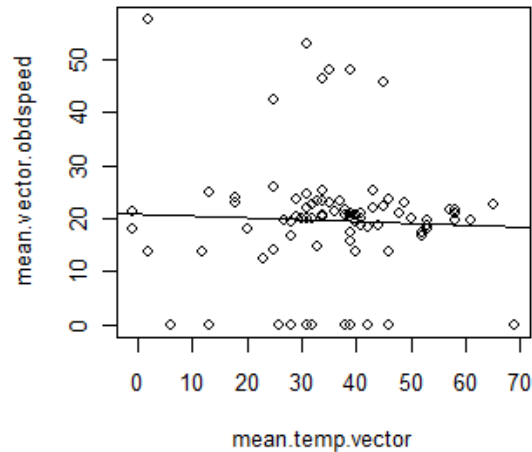
Average Speed with Precipitation (MPH)



Correlation

-0.1072122

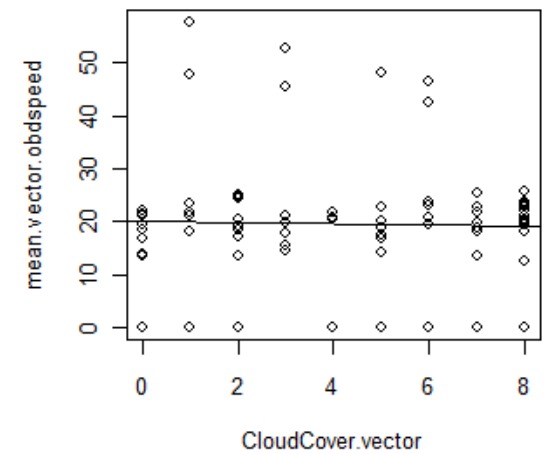
Average Speed with Temperature (MPH)



Correlation

-0.03794425

Average Speed with Cloud Cover (MPH)

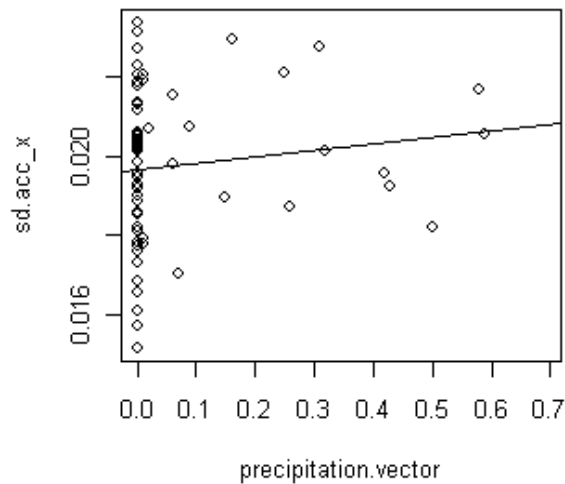


Correlation

-0.02142638

Mean & S.D. Function

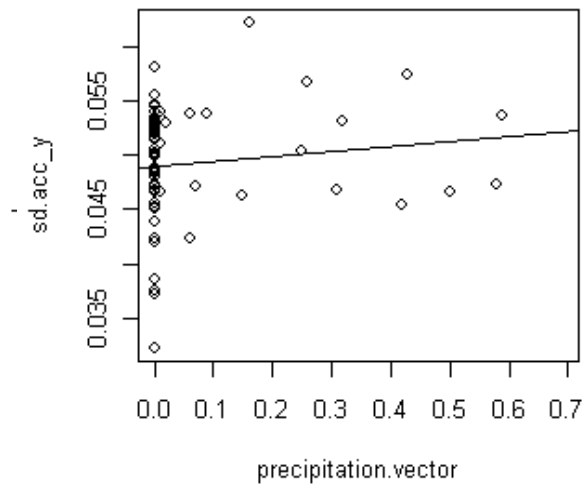
Acceleration X vs. Precipitation



Correlation

0.1277237

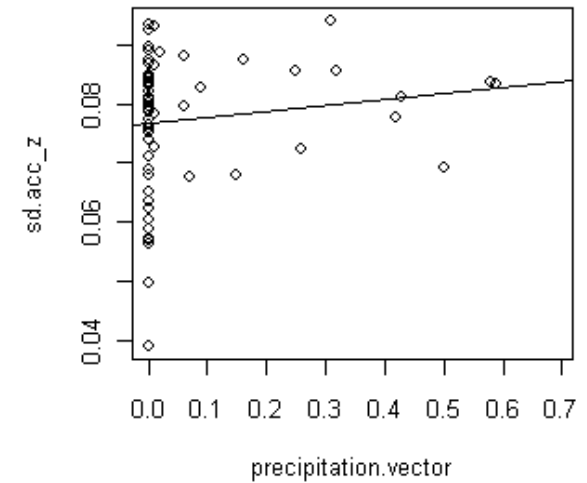
Acceleration Y vs. Precipitation



Correlation

0.1249988

Acceleration Z vs. Precipitation



Correlation

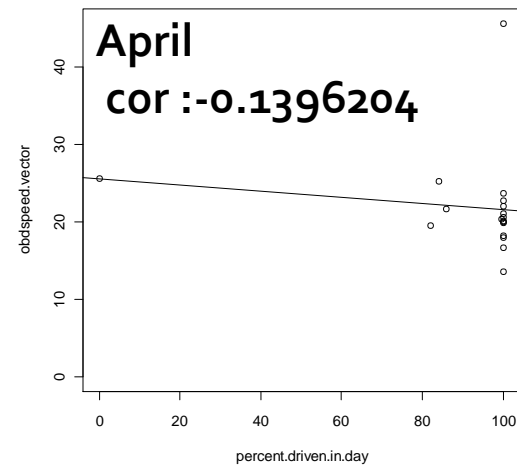
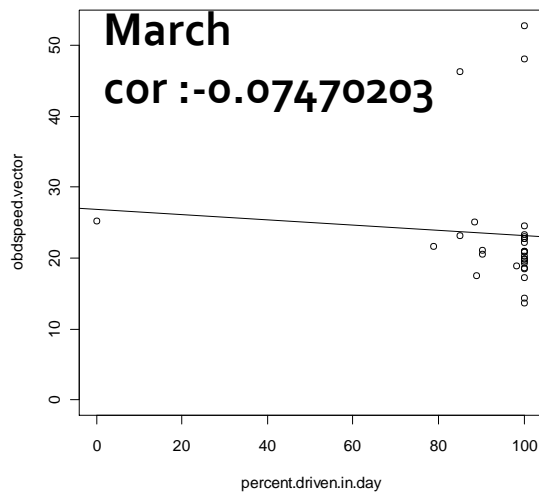
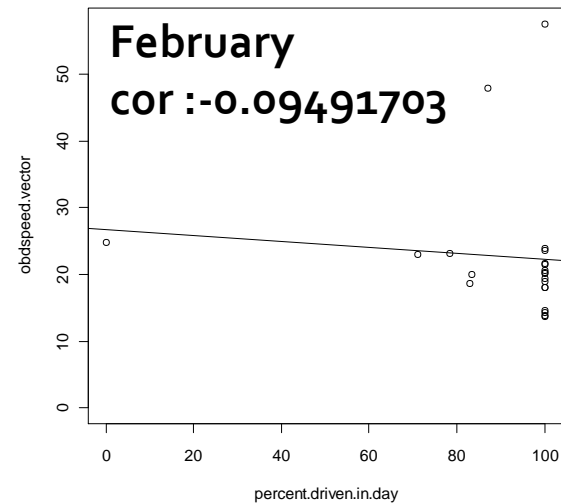
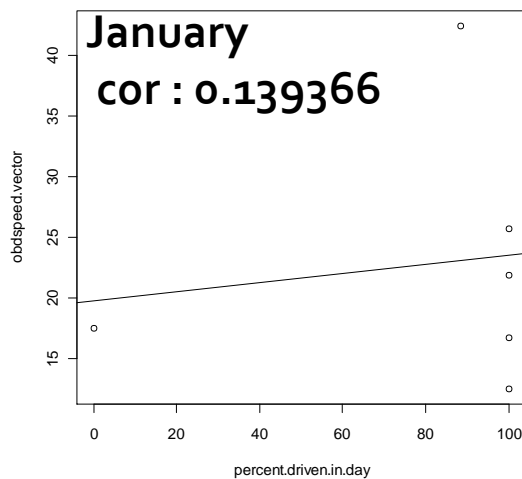
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Merge Data with Sunrise/Sunset

- Read daily sunrise and sunset times for Jan. 1-Jun. 30, 2011 from the U. S. Naval Observatory
- Categorizes each data entry as occurring during the day (sunrise to sunset) or night (sunset to sunrise)
- Analyze correlation between speed and percent driven in day

Merge Data with Sunrise/Sunset

Percent Driven In Day vs. Speed

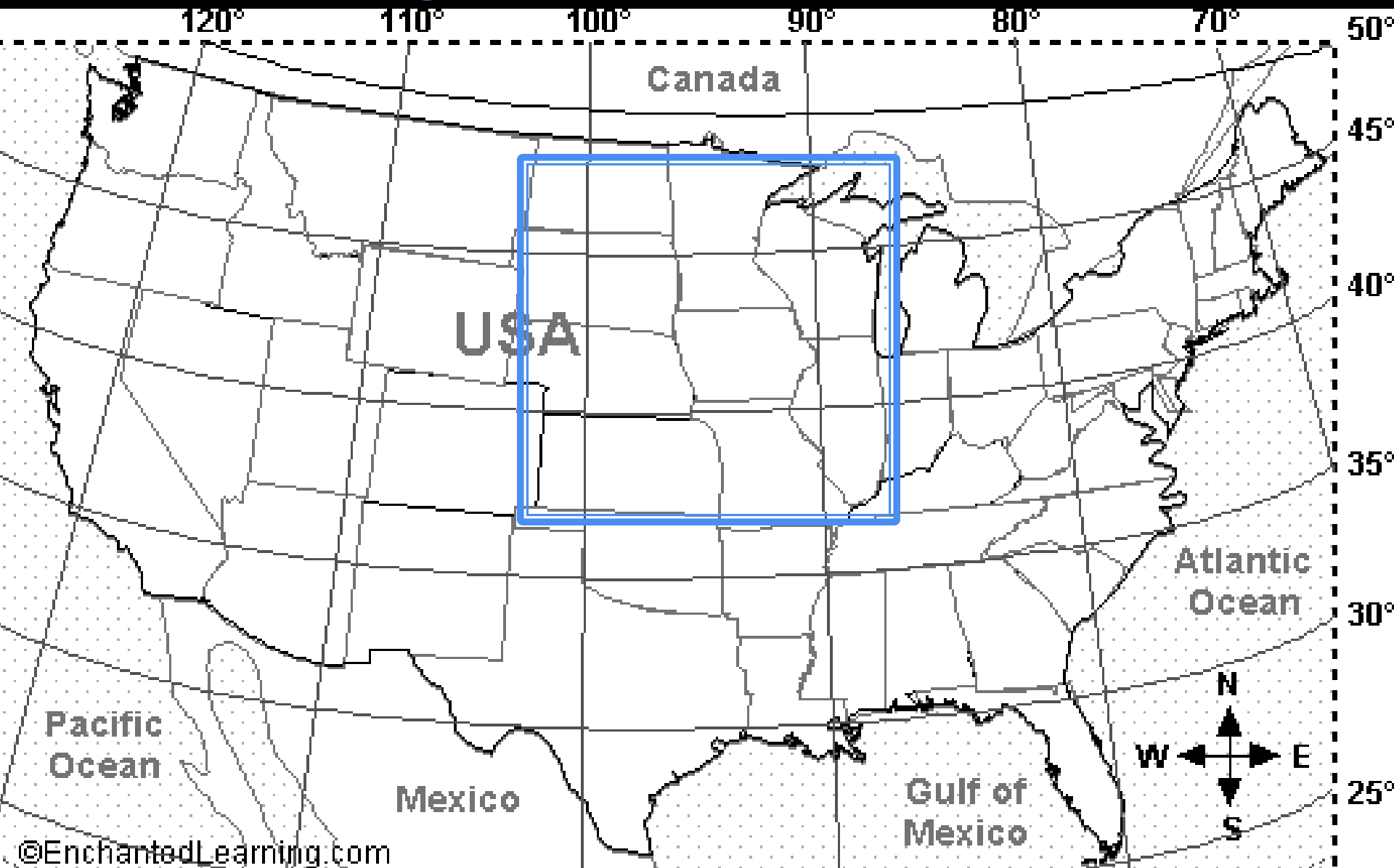


Latitude and Longitude Plots

- Plots the route of a test subject for one day
- Omits data entries for which latitude and/or longitude
 - is not available
 - is inaccurate (0 or other implausible values)

Latitude and Longitude Plots

EnchantedLearning.com



Latitude and Longitude Plots

- **Pseudo Code**

Function: Read table.

Receive the date.

Save latitude, longitude and time to three different variables.

Change dates to integer format.

Change time to decimal format.

Convert time from GMT to CST.

Define hour = hour - 6

 If (hour < 0), Date - 1 and 24 + hour

 Else, Date, hour

Find the position of the desired date.

Create vector "Skip" of the positions for the empty latitude and longitude spaces and o coordinates.

If (length(Skip) != 0), remove the members of Skip from the original latitude vector and save the resulting vector.

 Else, save the latitude vector.

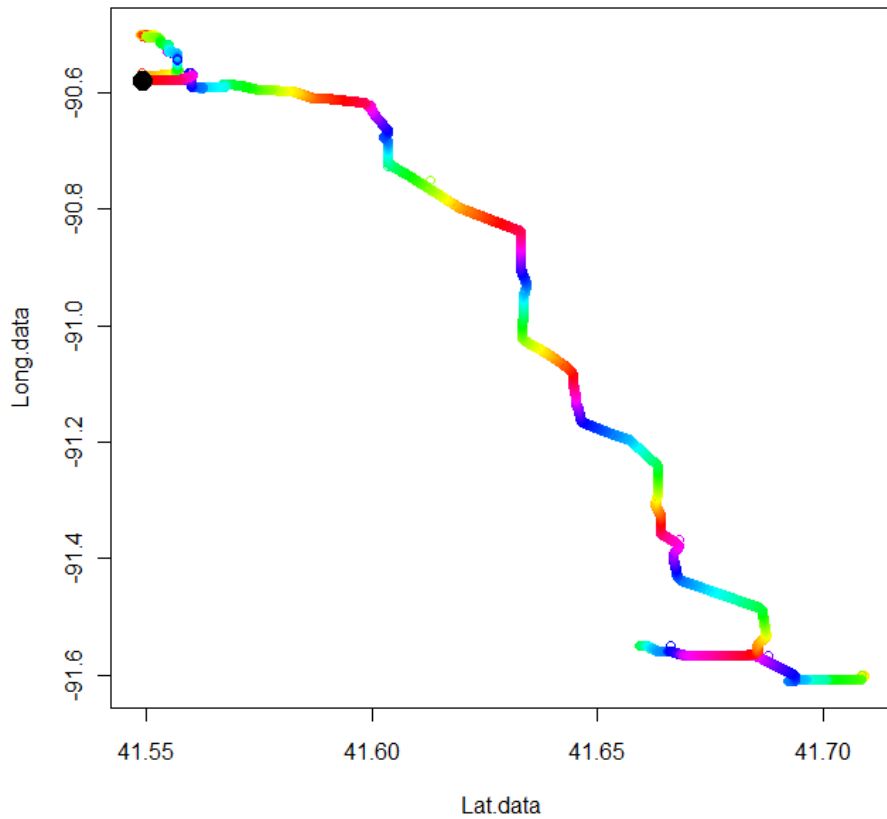
Do the same check with longitude vector.

Check for additional latitude and longitude data that needs to be omitted due to errors in the collection of GPS data.

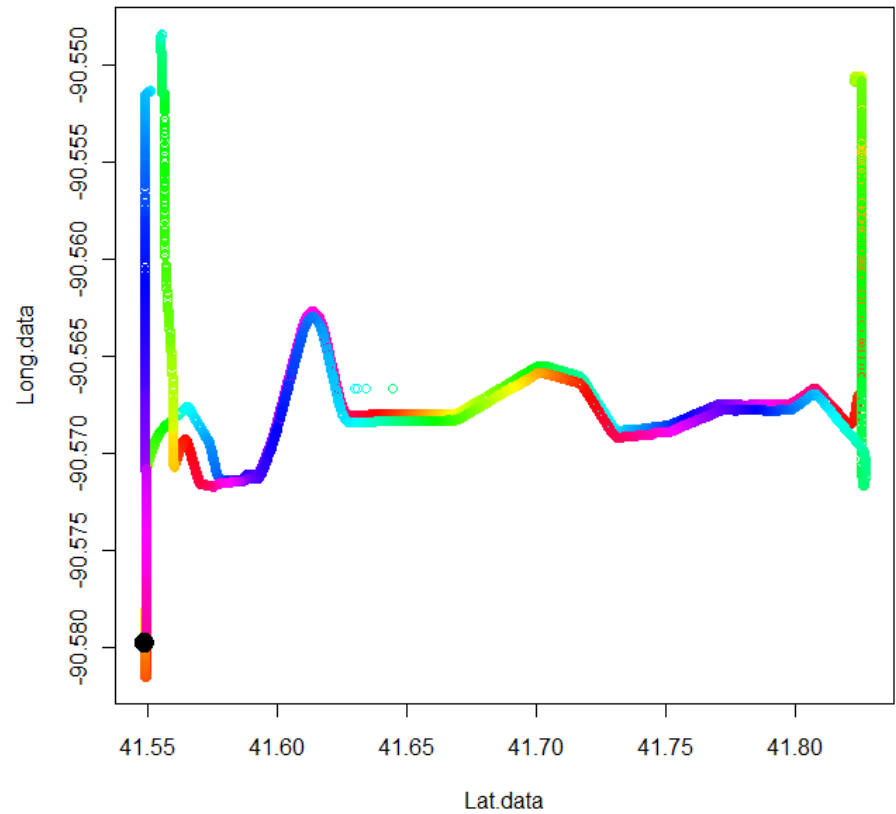
Plot latitude and longitude.

Latitude and Longitude Plots

Drive on Jan 27 2011



Drive on Feb 13 2011



Distance from Home

- Calculates the percentage of time subject drives “close to home”
- “Close to home” criteria is specified by user
- Uses Great Circle Distance to calculate distance from latitude and longitude data to home location
 - Great Circle Distance:
 - Shortest distance between any two points on the surface of a sphere
 - Measured along sphere’s surface rather than through sphere’s interior
- Omits data entries for which latitude and/or longitude
 - is not available
 - is inaccurate

Distance from Home

- **Pseudo Code**

Function, input parameters: home latitude, home longitude, and condition (2 miles)

Begins with the code that plots latitude and longitude

Calculate the great circle distance of each valid latitude and longitude entry

Categorizes each data entry as within or outside of condition

Counts number of entries within condition

Calculates percentage of driving time within (outside) condition

Returns data frame

Noteworthy Obstacles

- Storage space didn't have sufficient capacity to store data files
- GPS data not collected accurately (Latitude/Longitude)
- Tedious to concatenate files (Date/Time conversion error)
 - We used Command Prompt
- Processing (Files too large)

Acknowledgements

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