Data Wrangling Project

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### Step 1: Load CDC environmental datasets

* Data for counties of interest was queried from <http://wonder.cdc.gov/EnvironmentalData.html>
* County coordinates from <https://www.census.gov/geo/maps-data/data/gazetteer.html>
* Each environmental data type was downloaded in its own tab-delimited file and a dataset was created for each file.

setwd("C:/Projects/springboard-wrangling")  
airtemp <- read.delim("../data/Air Temperature.txt")  
precip <- read.delim("../data/Precipitation.txt")  
sunlight <- read.delim("../data/Sunlight.txt")  
surfacetemp <- read.delim("../data/Surface Temperature.txt")  
particulate <- read.delim("../data/Particulate Matter.txt")  
coordinates <- read.delim("../data/County Coordinates.txt")

### Step 2: Manage NA's

* **dplyr** package loaded for wrangling functions.

library(dplyr)

* Missing numeric values from certain columns in original files were populated with the string "Missing".
* "Missing" strings were converted to NA using **type.convert** function.

airtemp <- mutate(airtemp, heat\_index =   
 type.convert(as.character(Avg.Daily.Max.Heat.Index..F.),   
 na.strings = "Missing"))   
  
surfacetemp <- mutate(surfacetemp, day\_surface\_temp =   
 type.convert(as.character(  
 Avg.Day.Land.Surface.Temperature..F.),   
 na.strings = "Missing"),  
 night\_surface\_temp = type.convert(as.character(  
 Avg.Night.Land.Surface.Temperature..F.),   
 na.strings = "Missing"))

Note: The same result could have been accomplished using **gsub** function:

airtemp <- mutate(airtemp, heat\_index = as.numeric(gsub("Missing",   
NA, as.character((airtemp$Avg.Daily.Max.Heat.Index..F.)))))

### Step 3: Load and reshape monthly ERSST data measuring El Nino / La Nina effects

* Data source: <http://www.cpc.noaa.gov/products/analysis_monitoring/ensostuff/ensoyears.shtml>

el\_nino <- read.csv("../data/el\_nino.csv")  
el\_nino <- rename(el\_nino, year = Year, "1" = DJF, "2" = JFM, "3" = FMA,  
 "4" = MAM, "5" = AMJ, "6" = MJJ, "7" = JJA, "8" = JAS,  
 "9" = ASO, "10" = SON, "11" = OND, "12" = NDJ)

* Gather monthly data into single column using **tidyr** package

el\_nino2 <- tidyr::gather(el\_nino, "month", "ersst", 2:13)  
el\_nino2 <- mutate(el\_nino2, month = as.integer(el\_nino2$month))

### Step 4: Join data into a single tidy dataset

joindat <- left\_join(airtemp, precip)

## Joining by: c("Notes", "County", "County.Code", "Year", "Year.Code", "Month", "Month.Code", "Day.of.Month", "Day.of.Month.Code", "Day.of.Year", "Day.of.Year.Code")

joindat <- left\_join(joindat, sunlight)

## Joining by: c("Notes", "County", "County.Code", "Year", "Year.Code", "Month", "Month.Code", "Day.of.Month", "Day.of.Month.Code", "Day.of.Year", "Day.of.Year.Code")

joindat <- left\_join(joindat, surfacetemp)

## Joining by: c("Notes", "County", "County.Code", "Year", "Year.Code", "Month", "Month.Code", "Day.of.Month", "Day.of.Month.Code", "Day.of.Year", "Day.of.Year.Code")

joindat <- left\_join(joindat, particulate)

## Joining by: c("Notes", "County", "County.Code", "Year", "Year.Code", "Month", "Month.Code", "Day.of.Month", "Day.of.Month.Code", "Day.of.Year", "Day.of.Year.Code")

joindat <- left\_join(joindat, coordinates)

## Joining by: c("County", "County.Code")

joindat <- left\_join(joindat, el\_nino2, by = c("Year" = "year", "Month.Code" = "month"))

Date variable created by concatenating year, month, and day columns and coverting to date class.

joindat <- mutate(joindat, date = as.Date(paste(joindat$Year.Code,   
 joindat$Month.Code,   
 joindat$Day.of.Month.Code,   
 sep="-")))

Select statement used to assign concise variable names in common format to columms of interest.

envdat <- select(joindat,  
 county = County,  
 latitude = Latitude,  
 longitude = Longitude,  
 year = Year,  
 month = Month.Code,  
 day\_of\_yr = Day.of.Year,  
 date,  
 max\_air\_temp = Avg.Daily.Max.Air.Temperature..F.,  
 min\_air\_temp = Avg.Daily.Min.Air.Temperature..F.,  
 heat\_index,  
 precip = Avg.Daily.Precipitation..mm.,  
 sunlight = Avg.Daily.Sunlight..KJ.m².,  
 day\_surface\_temp,  
 night\_surface\_temp,  
 particulate\_matter = Avg.Fine.Particulate.Matter..µg.m³.,  
 ersst  
 )

Growing degree units (GDUs), also known as growing degree days, were calculated by taking the average of the daily maximum and minimum temperatures compared to a base temperature, T(base), as follows:

GDU = ((T(max) + T(min)) / 2) - T(base)

where T(max) is equal to the maximum daily temperature but not greater than a defined upper limit and T(min) is equal to the maximum daily temperature but not less than the base temperature. The upper limit and base in this project were set to 50°F and 86°F (10°C and 50°C), respectively, typical values for corn.

Accumulated GDUs (AGDUs) were calculated using the **cumsum** function grouped by county and year and ordered by date. AGDUs provide a standard measure of accumulated heat during a growing season. The maturity of a plant variety is often expressed in AGDUs after planting, rather than days, since days to maturity vary by location and season.

References:  
<http://en.wikipedia.org/wiki/Growing_degree-day>  
<http://agron-www.agron.iastate.edu/Courses/agron212/Calculations/GDD.htm>

envdat <- mutate(envdat, gdu = ifelse(max\_air\_temp < 50, 0,  
 (((ifelse(max\_air\_temp > 86, 86, max\_air\_temp)   
 + ifelse(min\_air\_temp < 50, 50, min\_air\_temp)) / 2) - 50)))  
  
envdat <- transform(envdat, agdu = ave(gdu, paste(county, year),   
 FUN = cumsum))  
  
# Save results for future use  
write.table(envdat, "../data/envdat.txt", sep = "\t")

### Step 5: Summarize and view data

summary(envdat)

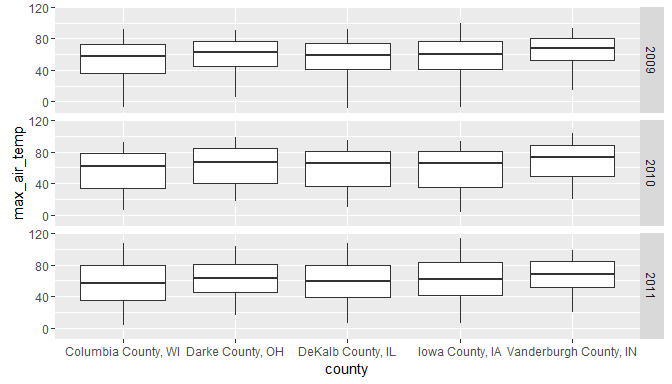
## county latitude longitude   
## Columbia County, WI :7305 Min. :38.02 Min. :-92.06   
## Darke County, OH :7305 1st Qu.:40.13 1st Qu.:-89.33   
## DeKalb County, IL :7305 Median :41.68 Median :-88.77   
## Iowa County, IA :7305 Mean :41.04 Mean :-88.47   
## Vanderburgh County, IN:7305 3rd Qu.:41.89 3rd Qu.:-87.59   
## Max. :43.47 Max. :-84.62   
##   
## year month day\_of\_yr date   
## Min. :1992 Min. : 1.000 Min. : 1.0 Min. :1992-01-01   
## 1st Qu.:1996 1st Qu.: 4.000 1st Qu.: 92.0 1st Qu.:1996-12-31   
## Median :2001 Median : 7.000 Median :183.0 Median :2001-12-31   
## Mean :2001 Mean : 6.523 Mean :183.1 Mean :2001-12-31   
## 3rd Qu.:2006 3rd Qu.:10.000 3rd Qu.:274.0 3rd Qu.:2006-12-31   
## Max. :2011 Max. :12.000 Max. :366.0 Max. :2011-12-31   
##   
## max\_air\_temp min\_air\_temp heat\_index precip   
## Min. :-16.81 Min. :-34.48 Min. : 78.40 Min. : 0.000   
## 1st Qu.: 41.12 1st Qu.: 28.58 1st Qu.: 84.10 1st Qu.: 0.000   
## Median : 62.17 Median : 43.37 Median : 88.35 Median : 0.100   
## Mean : 59.32 Mean : 42.48 Mean : 90.22 Mean : 2.754   
## 3rd Qu.: 78.13 3rd Qu.: 58.40 3rd Qu.: 94.80 3rd Qu.: 1.900   
## Max. :114.08 Max. : 84.07 Max. :128.49 Max. :133.900   
## NA's :28356   
## sunlight day\_surface\_temp night\_surface\_temp particulate\_matter  
## Min. : 1450 Min. : -8.23 Min. :-26.27 Min. : 0.00   
## 1st Qu.: 8334 1st Qu.: 47.97 1st Qu.: 24.80 1st Qu.: 8.30   
## Median :14337 Median : 71.75 Median : 42.29 Median :12.03   
## Mean :14768 Mean : 63.88 Mean : 39.20 Mean :13.14   
## 3rd Qu.:20725 3rd Qu.: 81.42 3rd Qu.: 55.77 3rd Qu.:16.56   
## Max. :30876 Max. :108.53 Max. : 77.10 Max. :55.30   
## NA's :28644 NA's :28042 NA's :20090   
## ersst gdu agdu   
## Min. :-1.60000 Min. : 0.000 Min. : 0.00   
## 1st Qu.:-0.70000 1st Qu.: 0.000 1st Qu.: 83.41   
## Median : 0.00000 Median : 6.185 Median :1275.78   
## Mean :-0.02597 Mean : 9.547 Mean :1577.38   
## 3rd Qu.: 0.50000 3rd Qu.:18.200 3rd Qu.:2916.39   
## Max. : 2.30000 Max. :35.035 Max. :4957.62   
##

Box plot and line graphs created using **ggplot2**.

library(ggplot2)

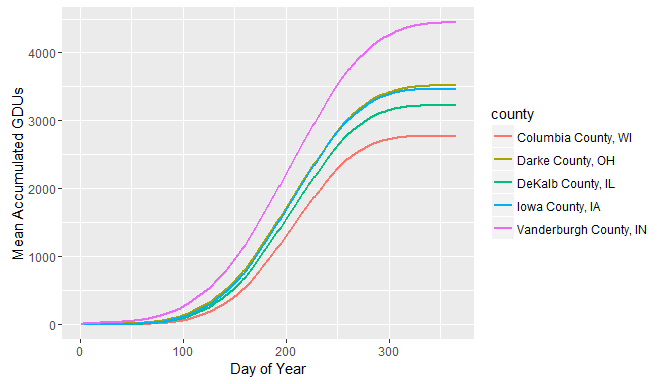
Differences in max air temp by year and county (2009-2011):

envdat\_3yr <- filter(envdat, year %in% c(2009, 2010, 2011))  
envdat\_3yr$year <- as.factor(envdat\_3yr$year)  
qplot(county, max\_air\_temp, data = envdat\_3yr, geom = "boxplot",   
 facets = year ~ .)



Differences in accumulated GDUs by county, across years:

county\_means <- envdat %>%  
 filter(day\_of\_yr != 366) %>% # exclude extra leap year day  
 group\_by(county, day\_of\_yr) %>%  
 summarize(agdu\_mean = mean(agdu))  
  
qplot(day\_of\_yr, agdu\_mean, data = county\_means, geom = "line", color = county,   
 xlab = "Day of Year", ylab = "Mean Accumulated GDUs") + geom\_line(size = 1.0)



Differences in accumulated GDUs by 5-year means, across counties:

envdat <- mutate(envdat, yr\_group = ifelse(year < 1997, "1992-1996",  
 ifelse(year < 2002, "1997-2001",  
 ifelse(year < 2007, "2002-2006",  
 "2007-2011"))))  
yr\_means <- envdat %>%  
 filter(day\_of\_yr != 366) %>% # exclude extra leap year day  
 group\_by(yr\_group, day\_of\_yr) %>%  
 summarize(agdu\_mean = mean(agdu))  
  
qplot(day\_of\_yr, agdu\_mean, data = yr\_means, geom = "line",   
 color = yr\_group, xlab = "Day of Year",   
 ylab = "Mean Accumulated GDUs") + geom\_line(size = 1.0)

