R for Data Analysis and Visualization

ECON 396 (Fall 2017)
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6.1 Data

The data for this class will come from the National Oceanic and Atmospheric Administration (NOAA) U.S. Wind Climatology datasets (https://www.ncdc.noaa.gov/societal-impacts/wind/).

Download the files for both the u-component and the v-component of the wind data. To open these files in R, we'll need to install the ncdf4 package, which provides an interface to Unidata's netCDF data file format:

```
install.packages(c("ncdf4", "ncdf4.helpers", "PCICt"))
```

Let's load up the u-component file first:

```
library(ncdf4)

uwnd_nc <- nc_open("data/uwnd.sig995.2017.nc")
uwnd_nc
```

```
## File data/uwnd.sig995.2017.nc (NC_FORMAT_NETCDF4_CLASSIC):
##
##      2 variables (excluding dimension variables):
##         float uwnd[lon,lat,time]
##             long_name: mean Daily u-wind at sigma level 995
##             units: m/s
##             precision: 2
##             least_significant_digit: 1
##             GRIB_id: 33
##             GRIB_name: UGRD
##             var_desc: u-wind
##             dataset: NCEP Reanalysis Daily Averages
##             level_desc: Surface
##             statistic: Mean
##             parent_stat: Individual Obs
##             missing_value: -9.96920996838687e+36
##             valid_range: -102.199996948242
##              valid_range: 102.199996948242
##             actual_range: -26.9250011444092
##              actual_range: 29.8999996185303
##         double time_bnds[nbnds,time]
##
##      4 dimensions:
```

```
##         lat  Size:73
##             units: degrees_north
##             actual_range: 90
##              actual_range: -90
##             long_name: Latitude
##             standard_name: latitude
##             axis: Y
##         lon  Size:144
##             units: degrees_east
##             long_name: Longitude
##             actual_range: 0
##              actual_range: 357.5
##             standard_name: longitude
##             axis: X
##         time  Size:198   *** is unlimited ***
##             long_name: Time
##             delta_t: 0000-00-01 00:00:00
##             standard_name: time
##             axis: T
##             units: hours since 1800-01-01 00:00:0.0
##             avg_period: 0000-00-01 00:00:00
##             coordinate_defines: start
##             actual_range: 1902192
##              actual_range: 1906920
##         nbnds  Size:2
##
##     7 global attributes:
##         Conventions: COARDS
##         title: mean daily NMC reanalysis (2014)
##         history: created 2013/12 by Hoop (netCDF2.3)
##         description: Data is from NMC initialized reanalysis
## (4x/day).  These are the 0.9950 sigma level values.
##         platform: Model
##         References: http://www.esrl.noaa.gov/psd/data/gridded/data.ncep.reanalysis.html
##         dataset_title: NCEP-NCAR Reanalysis 1
```

Let's store the uwnd observations in the netCDF file for the u-component:

```
## packages for getting nice time variables from the netCDF file
library(ncdf4.helpers)
library(PCICt)
## general data munging packages
library(dplyr)
library(tibble)

uwnd <- ncvar_get(uwnd_nc, "uwnd")
uwnd_time <- nc.get.time.series(uwnd_nc, v = "uwnd", time.dim.name = "time")
uwnd_lon <- ncvar_get(uwnd_nc, "lon")
uwnd_lat <- ncvar_get(uwnd_nc, "lat")
nc_close(uwnd_nc)

uwnd_df <- uwnd %>%
  as.data.frame.table(responseName = "uwnd", stringsAsFactors = FALSE) %>%
  rename(a = Var1, b = Var2, c = Var3) %>%
  cbind.data.frame(expand.grid(uwnd_lon, uwnd_lat, uwnd_time)) %>%
```

```
  rename(lon = Var1, lat = Var2, time = Var3) %>%
  select(lon, lat, time, uwnd) %>%
  as.tibble()
uwnd_df
```

```
## # A tibble: 2,081,376 × 4
##      lon   lat        time        uwnd
##    <dbl> <dbl> <S3: PCICt>       <dbl>
## 1    0.0    90  2017-01-01 -2.29999971
## 2    2.5    90  2017-01-01 -1.99999964
## 3    5.0    90  2017-01-01 -1.69999957
## 4    7.5    90  2017-01-01 -1.34999967
## 5   10.0    90  2017-01-01 -1.02499962
## 6   12.5    90  2017-01-01 -0.72499961
## 7   15.0    90  2017-01-01 -0.39999962
## 8   17.5    90  2017-01-01 -0.04999962
## 9   20.0    90  2017-01-01  0.27500039
## 10  22.5    90  2017-01-01  0.60000038
## # ... with 2,081,366 more rows
```

Now we need to do the same for the v-component of the wind vectors. Since we know the lat, lon, and time dimensions are repeated, we can join directly to the previous data.frame:

```
vwnd_nc <- nc_open("data/vwnd.sig995.2017.nc")
vwnd <- ncvar_get(vwnd_nc, "vwnd")
vwnd_time <- nc.get.time.series(vwnd_nc, v = "vwnd", time.dim.name = "time")
vwnd_lon <- ncvar_get(vwnd_nc, "lon")
vwnd_lat <- ncvar_get(vwnd_nc, "lat")
nc_close(vwnd_nc)

wind <- vwnd %>%
  as.data.frame.table(responseName = "vwnd", stringsAsFactors = FALSE) %>%
  cbind.data.frame(uwnd_df) %>%
  rename(lon2 = Var1, lat2 = Var2, time2 = Var3) %>%
  select(lon, lat, time, vwnd, uwnd) %>%
  as.tibble()
wind
```

```
## # A tibble: 2,081,376 × 5
##      lon   lat        time     vwnd        uwnd
##    <dbl> <dbl> <S3: PCICt>    <dbl>       <dbl>
## 1    0.0    90  2017-01-01 7.150002 -2.29999971
## 2    2.5    90  2017-01-01 7.250002 -1.99999964
## 3    5.0    90  2017-01-01 7.350002 -1.69999957
## 4    7.5    90  2017-01-01 7.375001 -1.34999967
## 5   10.0    90  2017-01-01 7.475002 -1.02499962
## 6   12.5    90  2017-01-01 7.475002 -0.72499961
## 7   15.0    90  2017-01-01 7.525002 -0.39999962
## 8   17.5    90  2017-01-01 7.550002 -0.04999962
## 9   20.0    90  2017-01-01 7.550002  0.27500039
## 10  22.5    90  2017-01-01 7.525002  0.60000038
## # ... with 2,081,366 more rows
```

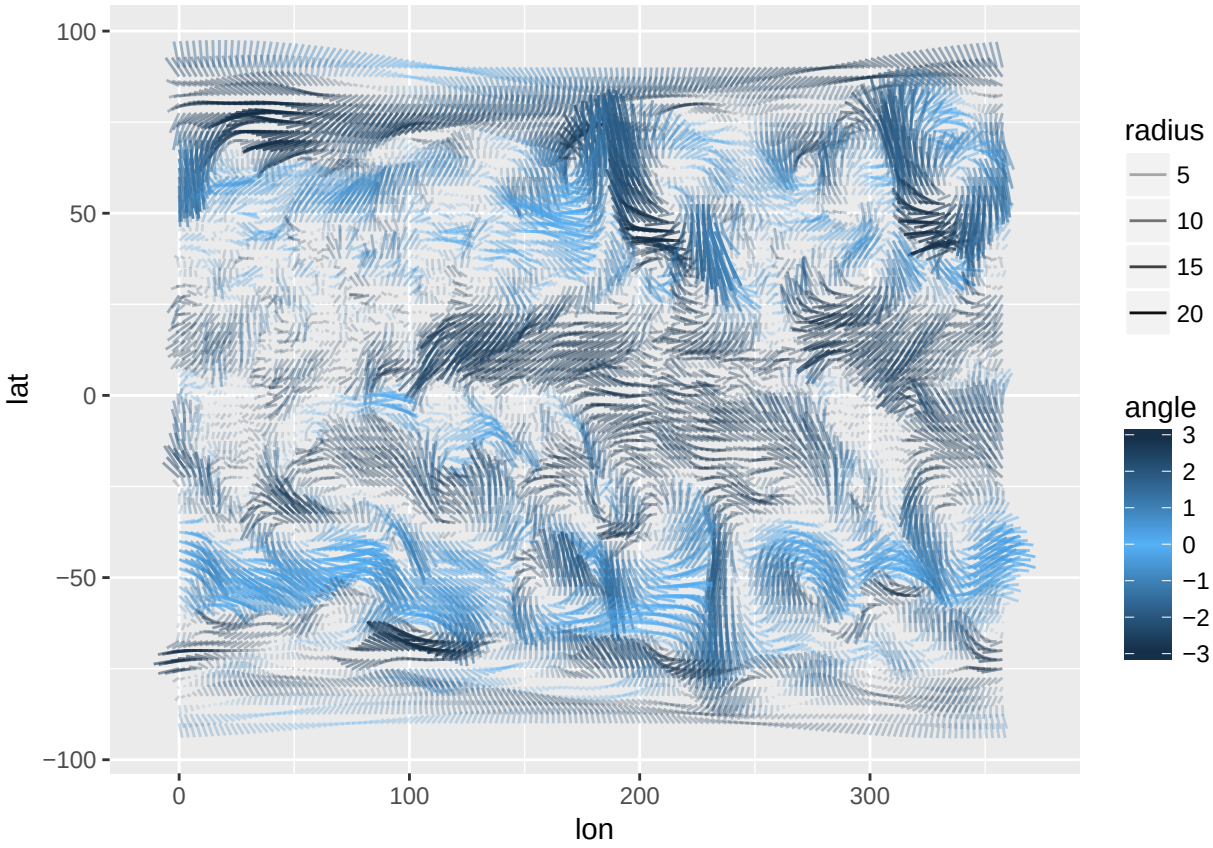
Otherwise, we would need to merge these data.frames to get `uwnd` and `vwnd` together with the following, which takes long time to run:

```
wind <- merge(uwnd_df, vwnd_df)
```

6.2 geom_spoke

To represent these wind vectors we'll use the `geom_spoke()`. We'll start just plotting wind patterns for January 1, 2017:

```
library(ggplot2)
wind <- wind %>%
  mutate(angle = atan2(vwnd, uwnd), radius = sqrt(uwnd^2 + vwnd^2), time = as.POSIXct(time))
wind %>%
  filter(time == as.POSIXct("2017-01-01", tz = "GMT")) %>%
  ggplot(aes(lon, lat)) +
  geom_spoke(aes(angle = angle, radius = radius, alpha = radius, color = angle)) +
  scale_color_gradient2(low = "#132B43", mid = "#56B1F7", high = "#132B43")
```



6.3 gganimate

The `gganimate` package lets us animate the above chart. If you want to be able to save animations as an mp4, you will need install `ffmpeg` (https://www.ffmpeg.org/download.html). You can install `gganimate` with `devtools`:

```
devtools::install_github("dgrtwo/gganimate")
```

```
library(gganimate)
f <- ggplot(wind, aes(lon, lat, angle = angle, radius = radius, alpha = radius, color = angle, frame = 
```

```
  geom_spoke() +
  scale_color_gradient2(low = "#132B43", mid = "#56B1F7", high = "#132B43")
gganimate(f)
```

Chapter 7

geom_area and geom_ribbon

Part II

Topics

Anscombe's Quartet

How to Judge Visualizations

Bibliography