Spatial Analysis and Mapping Workshop

Zack W Almquist (University of Minnesota)

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R spatial data handling and GIS activities

- Roger Bivand's book *Applied Spatial Data Analysis with R*
- Contains tools for handling many (most?) different spatial data formats
- Contains tools for managing standard GIS activities such as plotting and overlays
- Contains tools for for statistical spatial analysis
- Contains tools for reading shape and raster files

The UScensus2000-suite of Packages

UScensus packages in R

- 13 packages
  - UScensus1990{blkgrp}
  - UScensus2000{block, blockgroup, tract, cdp}
  - UScensus2010{block, blockgroup, tract, county, cdp}
- 3 packages of helper functions
- 10 packages of polygon/shapefiles and demographic data
- All data from US Census Bureau's SF1 files and TigerLine Shapefiles

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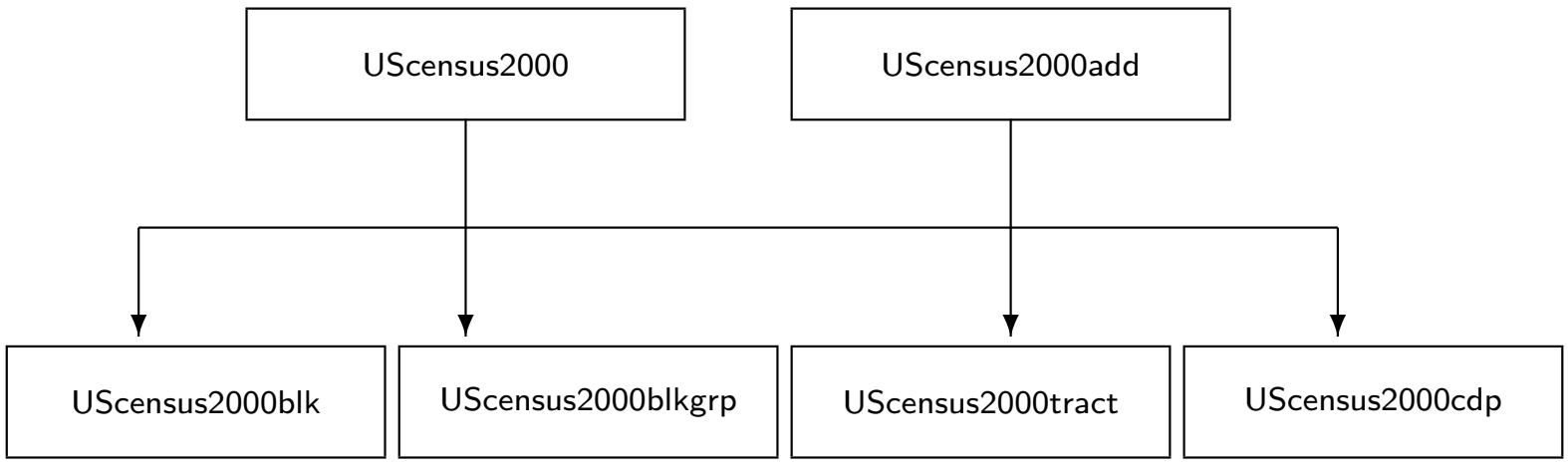
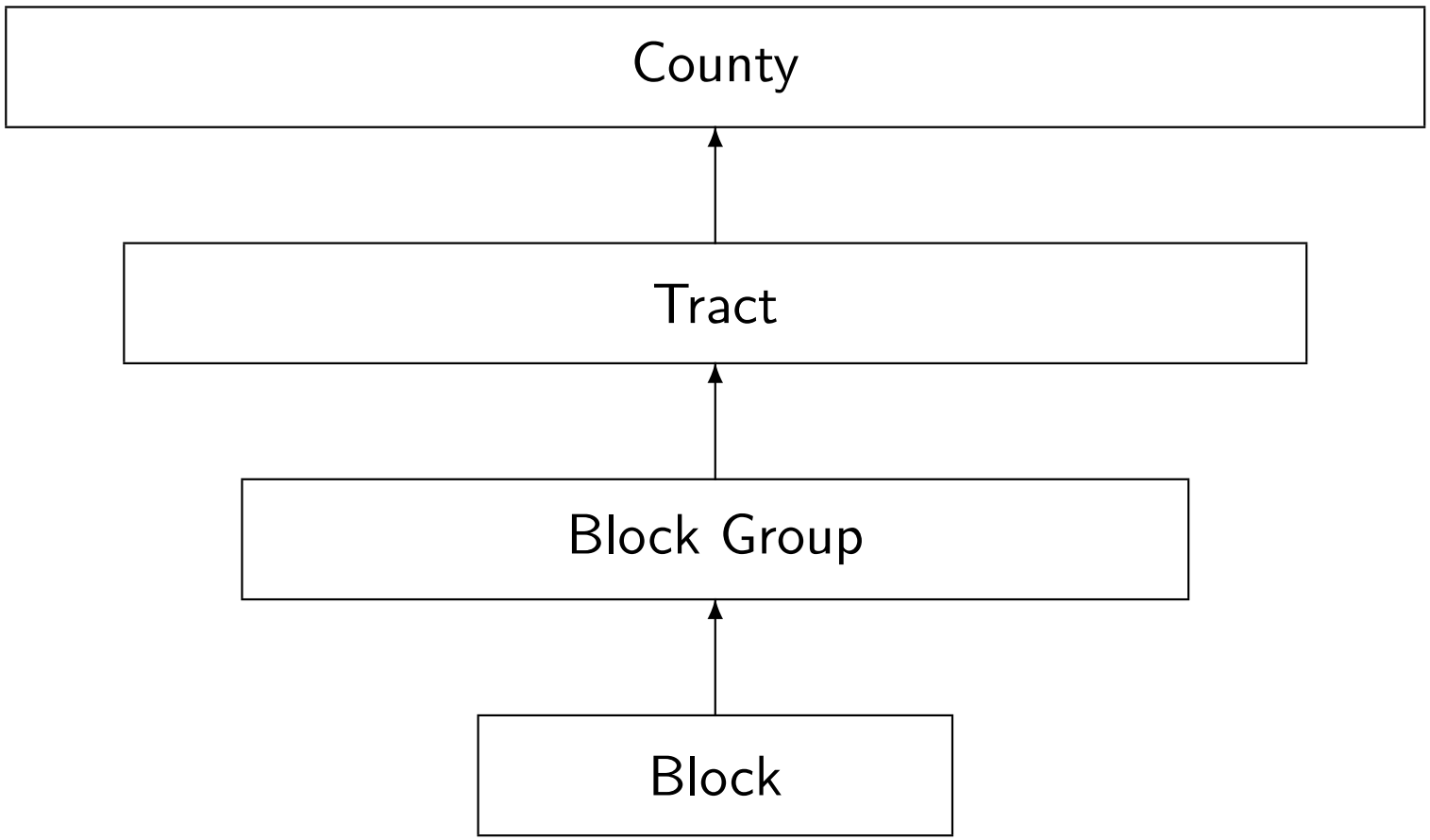
Structure of the UScensus2000 Packages



Organization of the US Census



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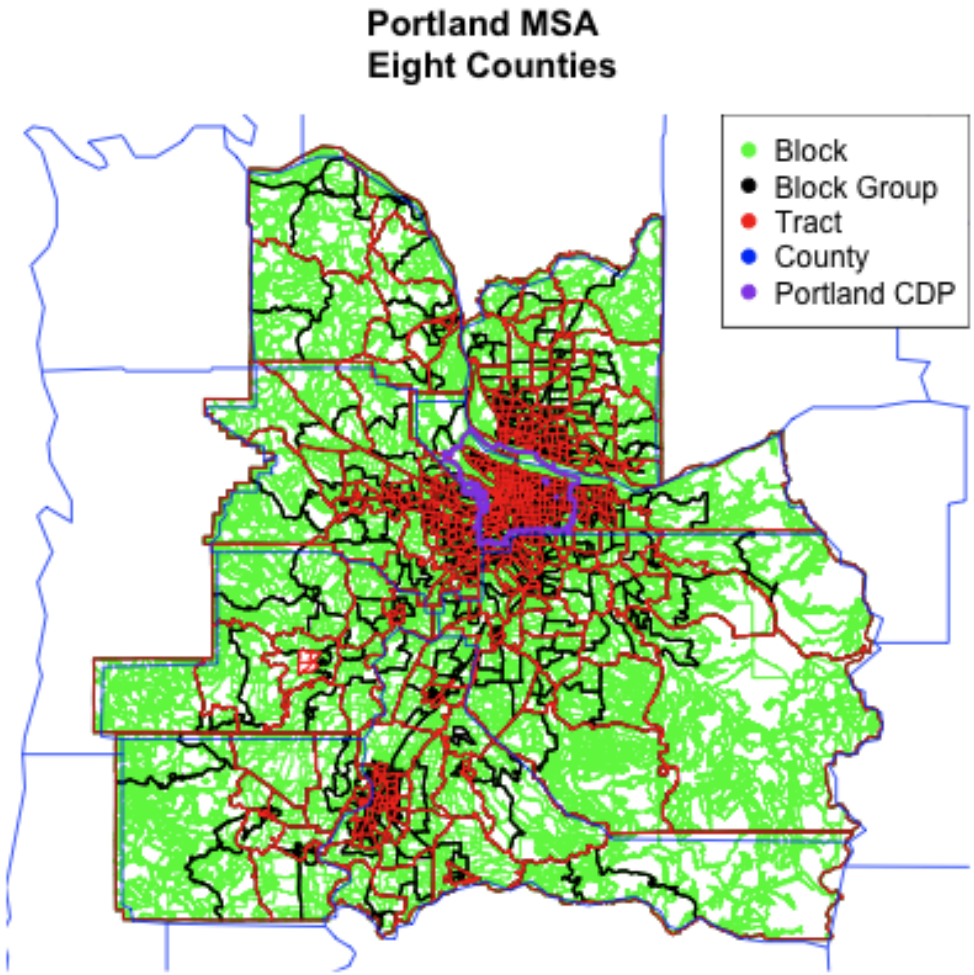


Available Data

Via The Comprehensive R Archive Network (CRAN)
http://cran.r-project.org/

- Tract (UScensus2000tract)
- Census Designated Place (UScensus2000cdp)
- UScensus2010

Available Data

Via R-Forge
https://r-forge.r-project.org/R/?group_id=2022

- Block, Block Group, Tract, County, CDP (UScensus2000 and UScensus2010)

Available Data

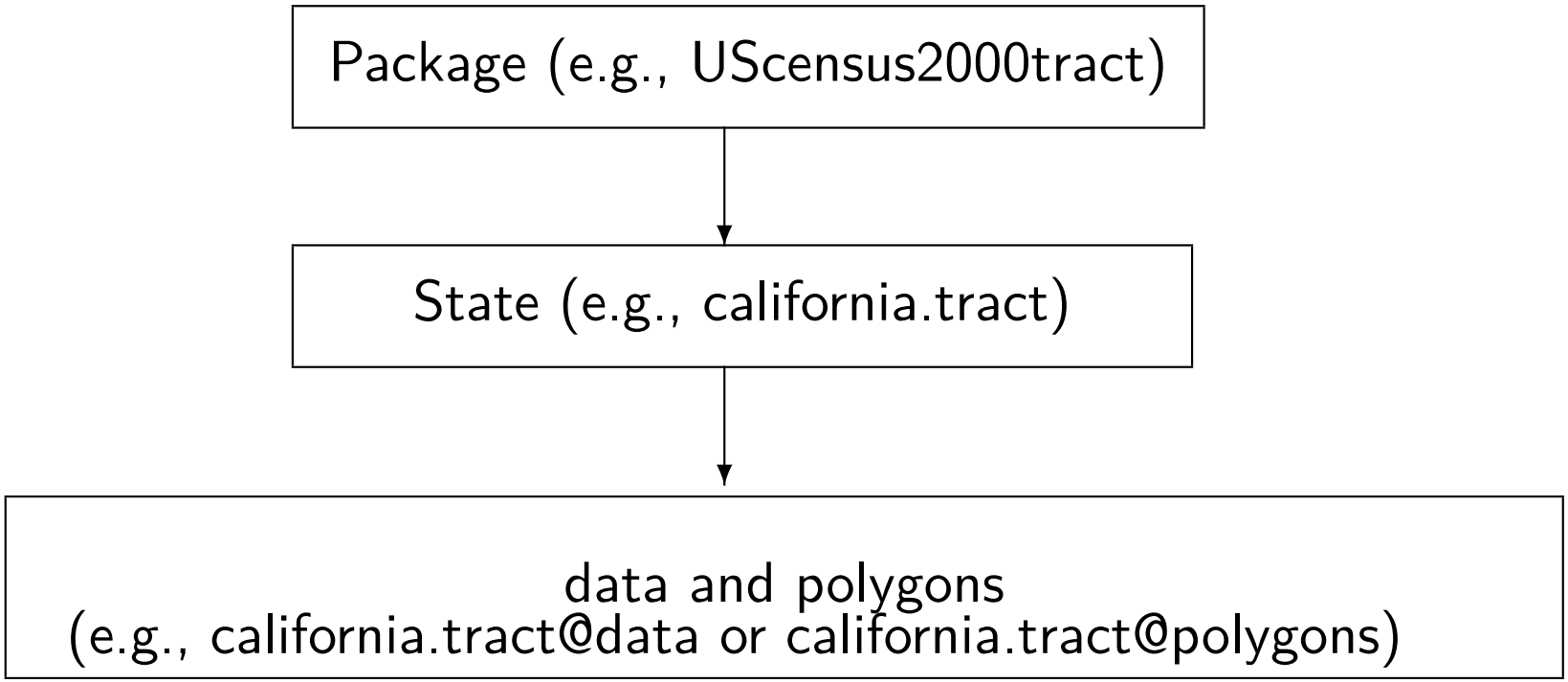
Via NCASD Lab
http://lakshmi.calit2.uci.edu/census2000/

- Block (UScensus1990blkgrp)
- Block (UScensus2000blk and UScensus2010blk)

Installation

```
install.packages("UScensus2010", repos = "http://R-Forge.R-project.org")
install.packages("UScensus2010county", repos = "http://R-Forge.R-project.org")
install.packages("UScensus2010tract", repos = "http://R-Forge.R-project.org")
install.packages("UScensus2010cdp", repos = "http://R-Forge.R-project.org")
```

Structure of the UScensus2000 Data-Packages



- All data is stored as SpatialPolygonsDataframe object
- data is a data.frame object with **ID** (factors) and **demographic** (numeric) values
- polygons is a list of the spatial data

Loading the Data

```
library(UScensus2000)
data(california.tract)
summary(as(california.tract, "SpatialPolygons"))
```

```
## Object of class SpatialPolygons
## Coordinates:
##           min        max
## r1 -124.40959 -114.13443
## r2   32.53416   42.00952
## Is projected: FALSE
## proj4string :
## [+proj=longlat +datum=NAD83 +ellps=GRS80
## +towgs84=0,0,0]
```

Loading the Data

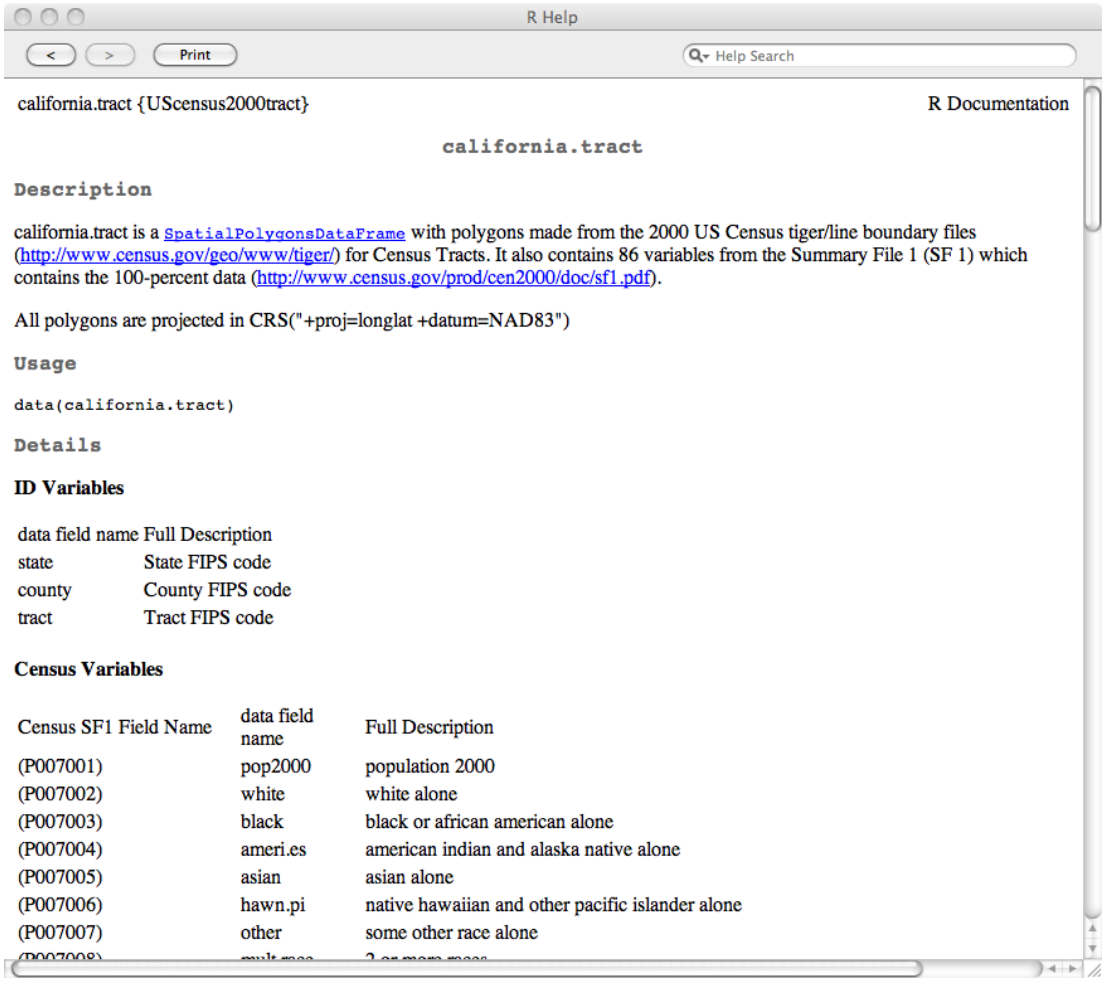
```
names(california.tract)
```

```
##  [1] "fips"           "state"          "county"
##  [4] "tract"          "pop2000"        "white"
##  [7] "black"          "ameri.es"       "asian"
## [10] "hawn.pi"        "other"          "mult.race"
## [13] "hispanic"       "not.hispanic.t" "nh.white"
## [16] "nh.black"       "nh.ameri.es"    "nh.asian"
## [19] "nh.hawn.pi"     "nh.other"       "hispanic.t"
## [22] "h.white"        "h.black"        "h.american.es"
## [25] "h.asian"        "h.hawn.pi"      "h.other"
## [28] "males"          "females"        "age.under5"
## [31] "age.5.17"       "age.18.21"      "age.22.29"
## [34] "age.30.39"      "age.40.49"      "age.50.64"
## [37] "age.65.up"      "med.age"        "med.age.m"
## [40] "med.age.f"      "households"     "ave.hh.sz"
## [43] "hsehld.1.m"     "hsehld.1.f"     "marhh.chd"
## [46] "marhh.no.c"     "mhh.child"      "fhh.child"
## [49] "hh.units"       "hh.urban"       "hh.rural"
## [52] "hh.occupied"    "hh.vacant"      "hh.owner"
## [55] "hh.renter"      "hh.1person"     "hh.2person"
## [58] "hh.3person"     "hh.4person"     "hh.5person"
## [61] "hh.6person"     "hh.7person"     "hh.nh.white.1p"
## [64] "hh.nh.white.2p" "hh.nh.white.3p" "hh.nh.white.4p"
## [67] "hh.nh.white.5p" "hh.nh.white.6p" "hh.nh.white.7p"
## [70] "hh.hisp.1p"     "hh.hisp.2p"     "hh.hisp.3p"
## [73] "hh.hisp.4p"     "hh.hisp.5p"     "hh.hisp.6p"
## [76] "hh.hisp.7p"     "hh.black.1p"    "hh.black.2p"
## [79] "hh.black.3p"    "hh.black.4p"    "hh.black.5p"
## [82] "hh.black.6p"    "hh.black.7p"    "hh.asian.1p"
## [85] "hh.asian.2p"    "hh.asian.3p"    "hh.asian.4p"
## [88] "hh.asian.5p"    "hh.asian.6p"    "hh.asian.7p"
```

Help

```
help(california.tract)
```

Help



california.tract {UScensus2000tract} R Documentation

california.tract

Description

california.tract is a SpatialPolygonsDataFrame with polygons made from the 2000 US Census tiger/line boundary files (http://www.census.gov/geo/www/tiger/) for Census Tracts. It also contains 86 variables from the Summary File 1 (SF 1) which contains the 100-percent data (http://www.census.gov/prod/cen2000/doc/sf1.pdf).

All polygons are projected in CRS("+proj=longlat +datum=NAD83")

Usage

```
data(california.tract)
```

Details

ID Variables

data field name	Full Description
state	State FIPS code
county	County FIPS code
tract	Tract FIPS code

Census Variables

Census SF1 Field Name	data field name	Full Description
(P007001)	pop2000	population 2000
(P007002)	white	white alone
(P007003)	black	black or african american alone
(P007004)	ameri.es	american indian and alaska native alone
(P007005)	asian	asian alone
(P007006)	hawn.pi	native hawaiian and other pacific islander alone
(P007007)	other	some other race alone
(P007008)	mult.race	2 or more races

Examples

Useful Functions in the UScensus2000 Package

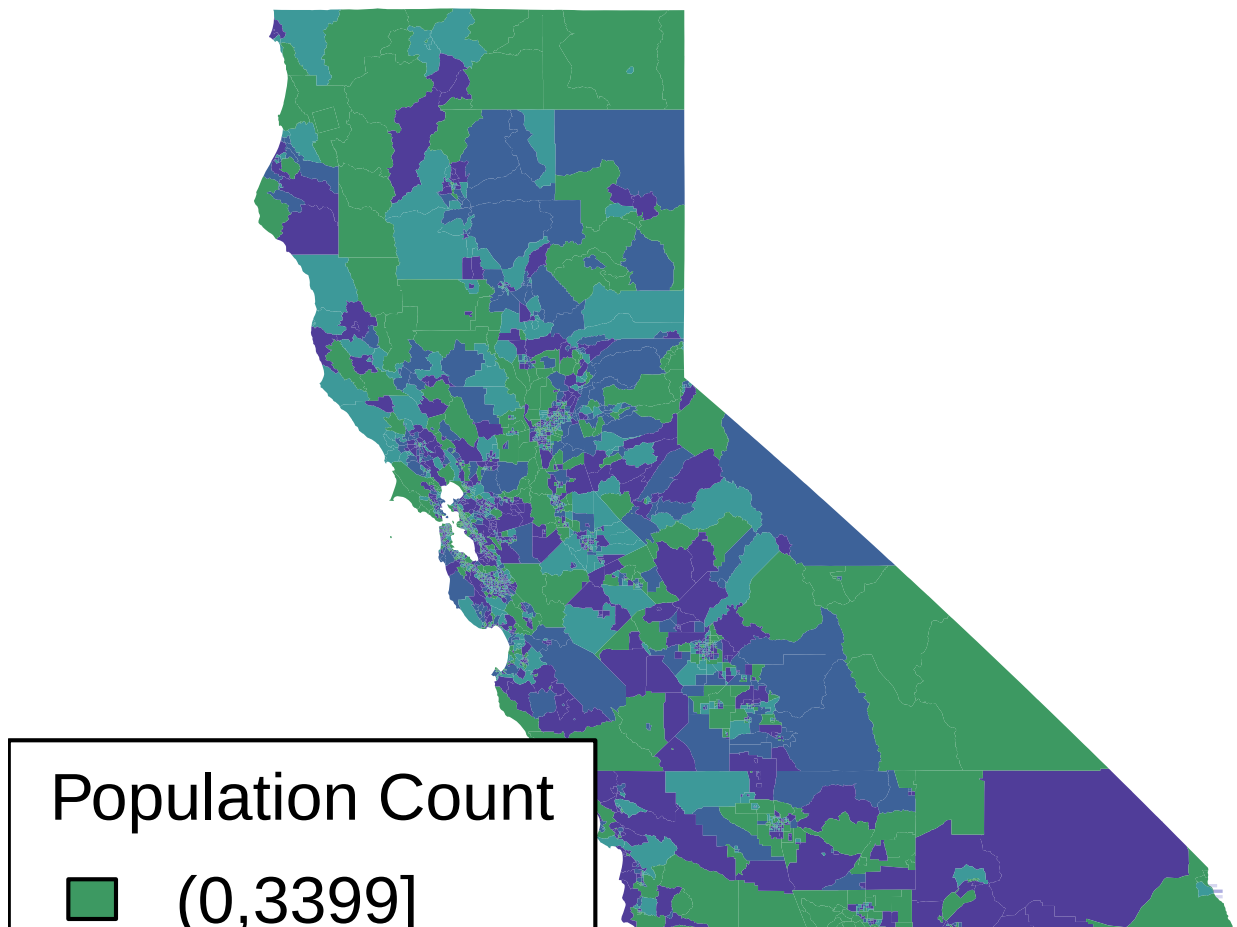
UScensus2000

Functions

- choropleth()
- county()
- MSA()
- city()
- poly.clipper()
- demographics()

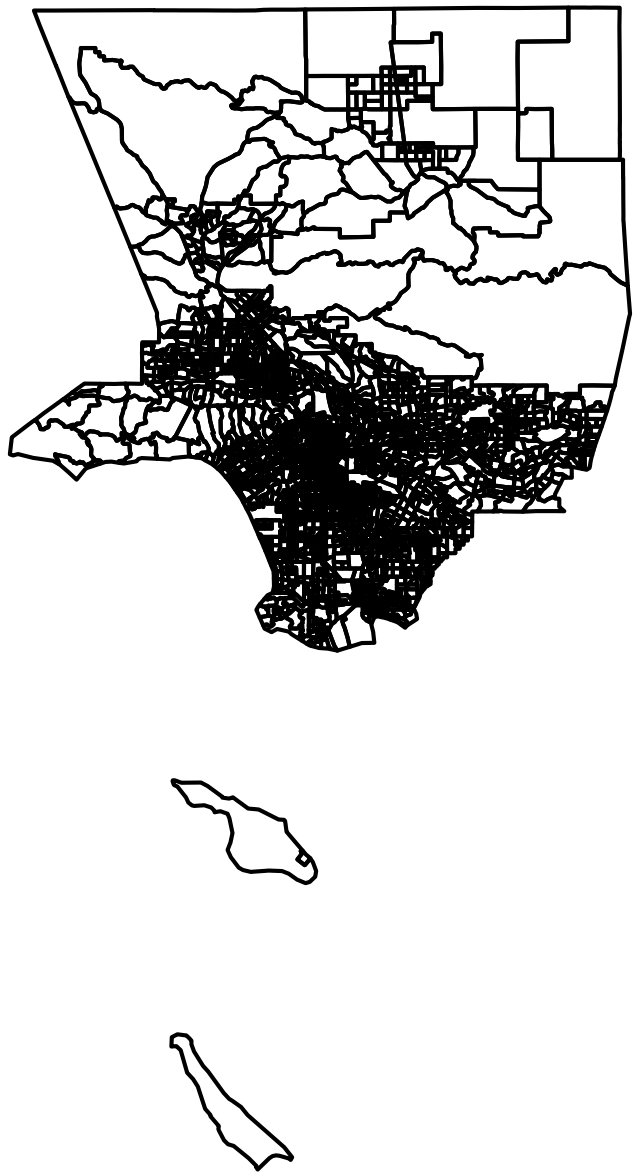
Choropleth Maps

```
UScensus2000::choropleth(california.tract, main = "2000 US Census Tracts \n California",
    border = "transparent")
```



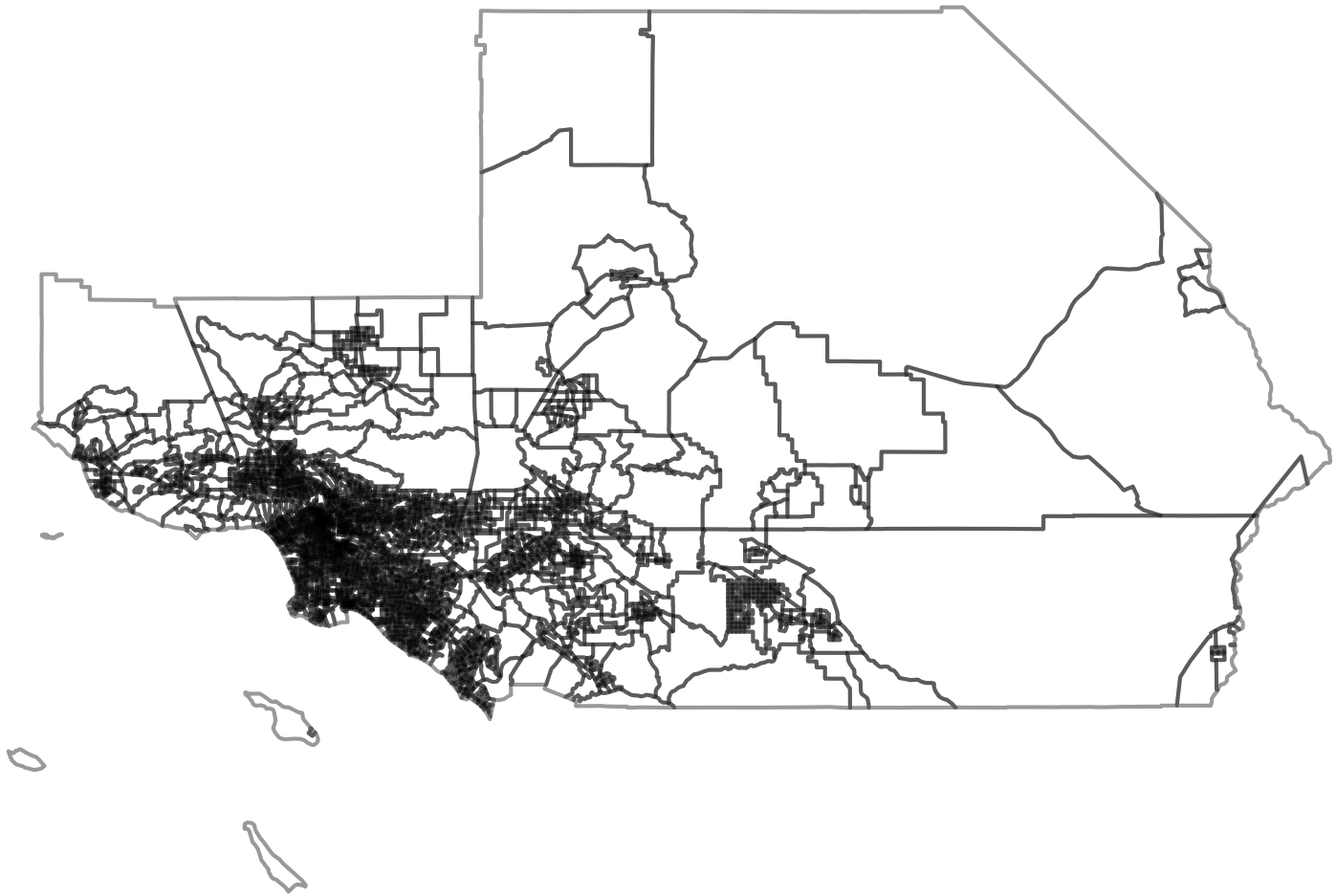
county

```
la.county <- county(name = "los angeles", state = "ca", level = "tract")
plot(la.county)
```



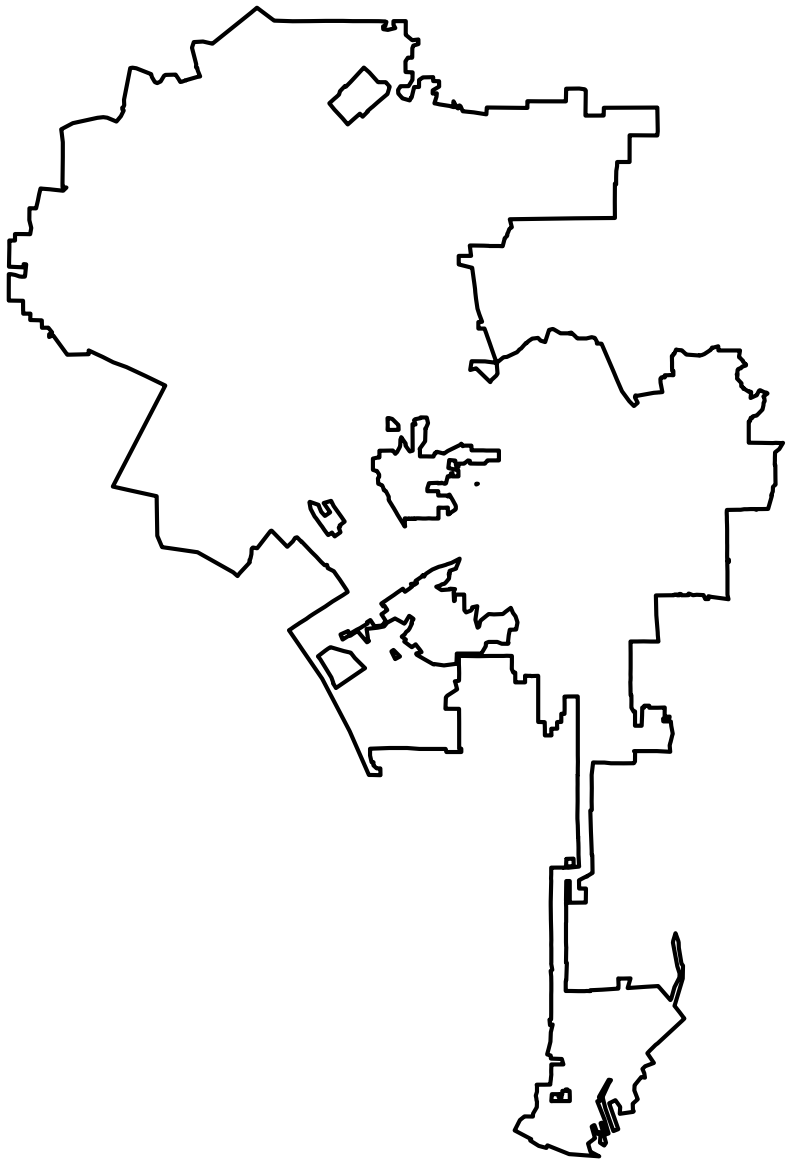
MSA

```
losangeles.msa <- MSA(msaname = "Los Angeles", state = "CA",
    level = "tract")
plot(losangeles.msa, border = rgb(0, 0, 0, 0.4))
```



City

```
losangeles <- city(name = "los angeles", state = "ca")
plot(losangeles)
```



demographics

```
laMSAarea <- demographics(dem = c("pop2000", "white", "black"),
    "CA", level = "msa", msaname = "Los Angeles")
laMSAarea
```

```
##                         fips pop2000   white  black
## san bernardino county 06071 1709434 1006960 155348
## ventura county        06111  753197  526721  14664
## los angeles county    06037 9519338 4637062 930957
## riverside county      06065 1545387 1013478  96421
## orange county         06059 2846289 1844652  47649
```

demographics

```
r ca.cdp <- demographics(dem = c("pop2000", "white", "black", "hh.units", "hh.vacant"), "CA",
level = "cdp") ## Alphabetic order the first 10 CDPs ca.cdp[order(rownames(ca.cdp))[1:10], ]
```

```
## pop2000 white black hh.units hh.vacant ## Acton 2390 2130 17 873 76 ## Adelanto 18130 9147
2377 5547 833 ## Agoura Hills 20537 17858 272 6993 119 ## Alameda 72259 41148 4488 31644 1418 ##
Alamo 15626 14119 74 5497 91 ## Albany 16444 10078 675 7248 237 ## Alhambra 85804 25758 1437
30069 958 ## Aliso Viejo 40166 31395 828 16608 461 ## Almanor 0 0 0 74 74 ## Alondra Park 8622
3584 1088 2933 103
```

rgdal

- Requires GDAL and proj4 packages (these must be installed at the OS level)
- A it of a pain, but worth it!
- rgdal allows one to read in ESRI shape files
- rgdal allows one to re-project spatial data

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- A it of a pain, but worth it!
- rgdal allows one to read in ESRI shape files
- rgdal allows one to re-project spatial data
- Let's do an example!

rgdal

```
library(rgdal)
UScounty <- readOGR(dsn = "data/co99_d00_shp", layer = "co99_d00",
    stringsAsFactors = FALSE)
```

```
## OGR data source with driver: ESRI Shapefile
## Source: "data/co99_d00_shp", layer: "co99_d00"
## with 3489 features
## It has 9 fields
```

```
proj4string(UScounty) <- " +proj=longlat +ellps=GRS80 +datum=NAD83 +no_defs +towgs84=0,0,0"
```

rgdal

```
plot(UScounty)
```

rgdal: Translate to an equal area projection

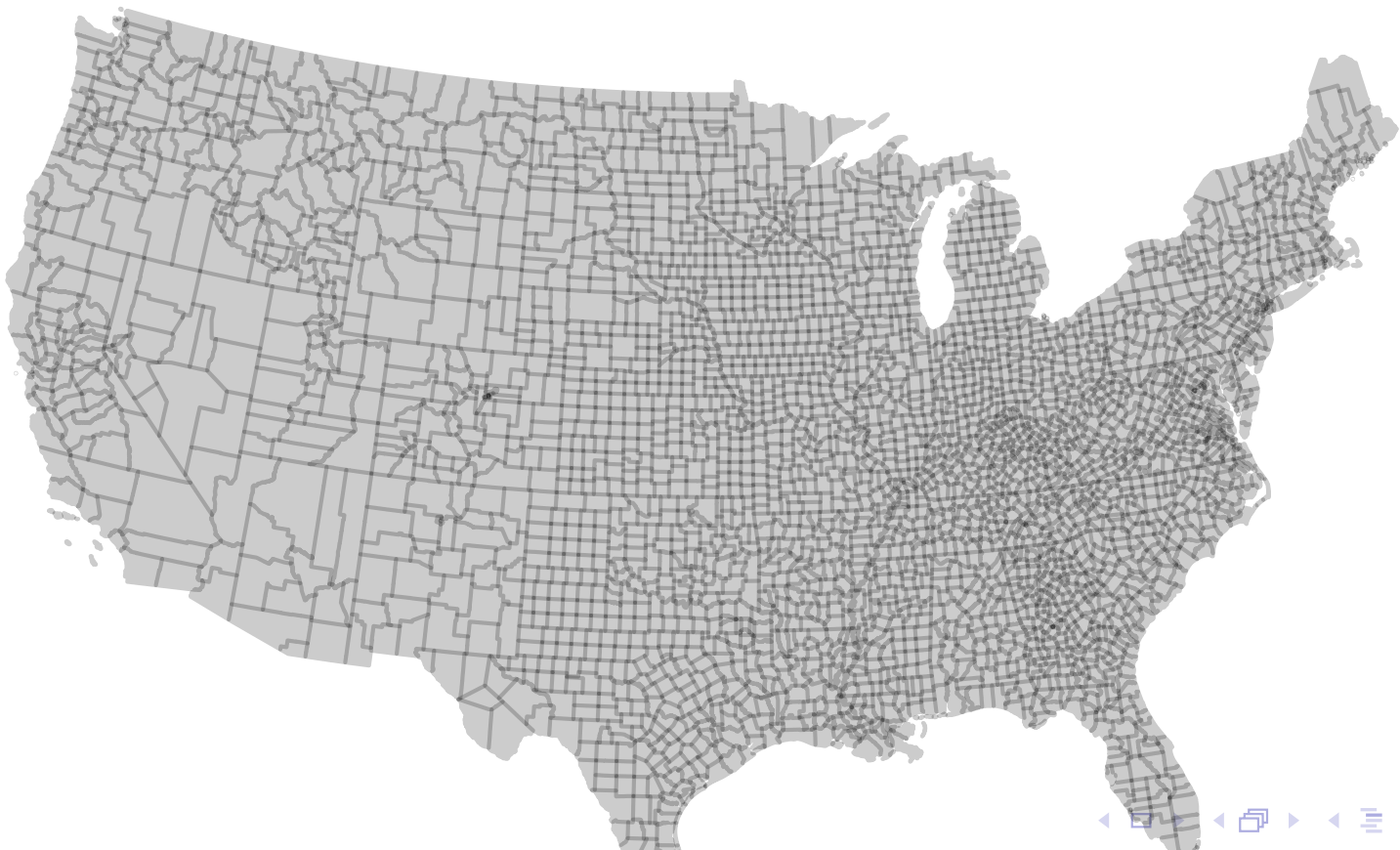
```
UScounty <- spTransform(UScounty, CRS(" +proj=aea +lat_1=29.5 +lat_2=45.5 +lat_0=23 +lon_0=-96 +x_0=0 +y_0
```

rgdal

```
library(UScensus2010)
data(countyfips)
UScounty$fips <- paste(UScounty$STATE, UScounty$COUNTY, sep = "")
ah.fips <- unique(substr(countyfips$fips[countyfips$statename %in%
    c("hawaii", "alaska")], 1, 2))
conUS <- UScounty[!UScounty$STATE %in% ah.fips, ]
alaska <- UScounty[UScounty$STATE == ah.fips[1], ]
hawaii <- UScounty[UScounty$STATE == ah.fips[2], ]
```

rgdal

```
par(mar = c(1, 1, 0, 0) + 0.1, mgp = c(0, 0.2, 0), tcl = -0.2)
plot(conUS, border = rgb(0, 0, 0, 0.2), col = rgb(0, 0, 0, 0.2))
par(fig = c(0.25, 2, 0.2, 2.1)/10, new = TRUE, mgp = c(0, 0.2,
    0), tcl = -0.2)
plot(alaska, border = rgb(0, 0, 0, 0.3), col = rgb(0, 0, 0, 0.2))
box()
par(fig = c(2.25, 4, 0.2, 2.1)/10, new = TRUE, mgp = c(0, 0.2,
    0), tcl = -0.2)
plot(hawaii, border = rgb(0, 0, 0, 0.3), col = rgb(0, 0, 0, 0.05))
box()
```



US Census API

- Access to US Demographics SF1, SF3 (1990, 2000) and ACS (2010)
- Much More Too!!
- `http://www.census.gov/data/developers/data-sets.html`
- Requires User Key (`http://api.census.gov/data/key_signup.html`)

Tutorials

- spatial-analysis-and-mapping-workshop.pdf
- Tutorial_ACS.pdf
- WorkBook.pdf