Where should you live in San Francisco?

Choosing a neighobrhood with Zillow Data

By Collin Ching

```
library(knitr)

opts_chunk$set(warning=FALSE,message=FALSE)
```

Moving to San Francisco would be awesome except for the cost of rent.

In this project, I explore neighborhoods through Zillow data to find rental opportunities in San Francisco. The following analysis was scripted in R, and analysis is neighborhood-based.

Credit goes to Ken Steif and Keith Hassel for their great tutorial for exploring home prices in San Francisco. I used their ggplot themes for my graphics.

```
## load libraries and local files
options(scipen="99")

library(cowplot)
library(data.table)
library(broom)
library(tidyverse)
library(ggmap)
library(ggrepel)
library(grid)
library(gridExtra)
library(maptools)
library(scales)
library(sf)
source("../workflow/functions.R")

## smoothed median home price dataset
zhvi <- read.csv("../data/zillow/Neighborhood_Zhvi_AllHomes.csv",stringsAsFactors=FALSE)
## smoothed median neighborhood rent dataset
zri <- read.csv("../data/zillow/Neighborhood_Zri_AllHomesPlusMultifamily.csv",stringsAsFactors=FALSE)
## smoothed median rent per square foot dataset
zri_sqft <- read.csv("../data/zillow/Neighborhood_ZriPerSqft_AllHomes.csv",stringsAsFactors=FALSE)
## ratio of estimated home value to 12*monthly rent, renters would want this to be smaller
price_to_rent <- read.csv("../data/zillow/Neighborhood_PriceToRentRatio_AllHomes.csv",stringsAsFactors=
## sales-to-list ratio: tells you if market is favoring buyers
## time-on-market: the amount of time that homes are selling on the market

## shapefile of SF neighborhoods
sf_neighborhoods <- readShapePoly("../sf_neighborhoods/sf_neighborhoods")
```

Data processing

```
## tidy data
zhvi.sf <- zhvi[zhvi$City=="San Francisco",]
```

```
zhvi.sf <- gather(zhvi.sf,date,zhvi,8:ncol(zhvi.sf)) %>%
    mutate(date=str_sub(date,start=2),
           year=str_sub(date,1,4),
           month=str_sub(date,-2,-1)) %>%
    rename(neighborhood=RegionName) %>%
    select(neighborhood,year,month,zhvi)

zri.sf <- zri[zri$City=="San Francisco",]
zri.sf <- zri.sf %>%
    gather(date,zri,8:ncol(zri.sf)) %>%
    mutate(date=str_sub(date,start=2),
           year=str_sub(date,1,4),
           month=str_sub(date,-2,-1)) %>%
    rename(neighborhood=RegionName,city=City) %>%
    select(neighborhood,year,month,zri)

zri_sqft.sf <- zri_sqft[zri_sqft$City=="San Francisco",]
zri_sqft.sf <- zri_sqft.sf %>%
    gather(date,zri_sqft,8:ncol(zri_sqft)) %>%
    mutate(date=str_sub(date,start=2),
           year=str_sub(date,1,4),
           month=str_sub(date,-2,-1)) %>%
    rename(neighborhood=RegionName) %>%
    select(neighborhood,year,month,zri_sqft)

price_to_rent.sf <- price_to_rent[price_to_rent$City=="San Francisco",]
price_to_rent.sf <- price_to_rent.sf %>%
    gather(date,price_to_rent,8:ncol(price_to_rent.sf)) %>%
    mutate(date=str_sub(date,start=2),
           year=str_sub(date,1,4),
           month=str_sub(date,-2,-1)) %>%
    rename(neighborhood=RegionName) %>%
    select(neighborhood,year,month,price_to_rent)

#names(zhvi.sf)
#names(zri.sf)
#names(zri_sqft.sf)
#names(price_to_rent.sf)

sf_housing <- left_join(zhvi.sf,zri.sf,by=c("neighborhood","year","month")) %>%
    left_join(.,zri_sqft.sf,by=c("neighborhood","year","month")) %>%
    left_join(.,price_to_rent.sf,by=c("neighborhood","year","month"))

sf_housing$year <- as.integer(sf_housing$year)
sf_housing$month <- as.integer(sf_housing$month)

#############################################################
# Make points dataset for geom_polygon()
# Rename neighborhoods in Zillow data to match shapefiles
## extract neighborhood names from spatial object
neighb_pts <- tidy(sf_neighborhoods,region="nbrhood") ## converts to a data frame
neighb_pts <- neighb_pts %>%
    rename(neighborhood=id) %>%
```

```
    select(long,lat,neighborhood)
names(neighb_pts)[1:2] <- c("lat","long") ## lat and long were switched in original data

## check unique neighborhoods in sf_housing
#length(unique(sf_housing$neighborhood))
## these are the neighborhoods in sf_housing that don't show up in neighborhood shapefile
#setdiff(unique(sf_housing$neighborhood),unique(neighb_pts$neighborhood))

## match neighborhood names between datasets
#length(setdiff(unique(neighb_pts$neighborhood),unique(sf_housing$neighborhood)))
## 61 neighborhoods in ZHVI dataset, with 11 neighborhoods mismatched
sf_housing$neighborhood[sf_housing$neighborhood=="Buena Vista"] <- "Buena Vista Park/Ashbury Heights"
sf_housing$neighborhood[sf_housing$neighborhood=="Financial District"] <- "Financial District/Barbary C
sf_housing$neighborhood[sf_housing$neighborhood=="Haight"] <- "Haight Ashbury"
sf_housing$neighborhood[sf_housing$neighborhood=="Lake"] <- "Lake Street"
sf_housing$neighborhood[sf_housing$neighborhood=="Lakeshore"] <- "Lake Shore"
sf_housing$neighborhood[sf_housing$neighborhood=="Laurel Heights"] <- "Jordan Park / Laurel Heights"
sf_housing$neighborhood[sf_housing$neighborhood=="Mission"] <- "Mission Dolores"
sf_housing$neighborhood[sf_housing$neighborhood=="Panhandle"] <- "North Panhandle"
sf_housing$neighborhood[sf_housing$neighborhood=="Seacliff"] <- "Sea Cliff"
sf_housing$neighborhood[sf_housing$neighborhood=="St. Francis Wood"] <- "Saint Francis Wood"
sf_housing$neighborhood[sf_housing$neighborhood=="Upper Market"] <- "Twin Peaks"
## still some missing, but we're limited to our data

############################
## Add districts to dataset
presidio <- c("Presidio",
              "Sea Cliff",
              "Presidio Heights",
              "Pacific Heights",
              "Cow Hollow",
              "Marina",
              "Lake Street")

nob_hill <- c("Russian Hill",
              "North Beach",
              "Nob Hill",
              "Telegraph Hill",
              "North Waterfront",
              "Financial District/Barbary Coast",
              "Downtown")

avenues <- c("Lincoln Park",
             "Outer Richmond",
             "Central Richmond",
             "Inner Richmond",
             "Golden Gate Park",
             "Outer Sunset",
             "Central Sunset",
             "Outer Parkside",
             "Parkside",
             "Pine Lake Park",
             "Inner Sunset")
```

```
twinpeaks <- c("Lake Shore",
               "Stonestown",
               "Merced Manor",
               "Lakeside",
               "Ingleside Terrace",
               "Merced Heights",
               "Balboa Terrace",
               "Mount Davidson Manor",
               "Westwood Park",
               "Westwood Highlands",
               "Sunnyside",
               "Miraloma Park",
               "Diamond Hiehgts",
               "Twin Peaks",
               "Midtown Terrace",
               "Golden Gate Heights",
               "Forest Knolls",
               "Forest Hill",
               "Forest Hills Extension",
               "West Portal",
               "Saint Francis Wood",
               "Sherwood Forest",
               "Monterey Heights",
               "Mount Davidson Manor",
               "Inner Parkside",
               "Clarendon Heights")

castro <- c("Noe Valley",
            "Eureka Valley / Dolores Heights",
            "Corona Heights",
            "Diamond Heights",
            "Glen Park",
            "Duboce Triangle")

mission <- c("Bernal Heights","Inner Mission","Mission Dolores")

southeast <- c("Mission Terrace",
               "Ingleside",
               "Ingleside Heights",
               "Outer Mission",
               "Oceanview",
               "Crocker Amazon",
               "Excelseior",
               "Portola",
               "Silver Terrace",
               "Bayview",
               "Bayview Heights",
               "Visitacion Valley",
               "Little Hollywood",
               "Candlestick Point",
               "Hunters Point",
               "Central Waterfront/Dogpatch",
               "Potrero Hill",
```

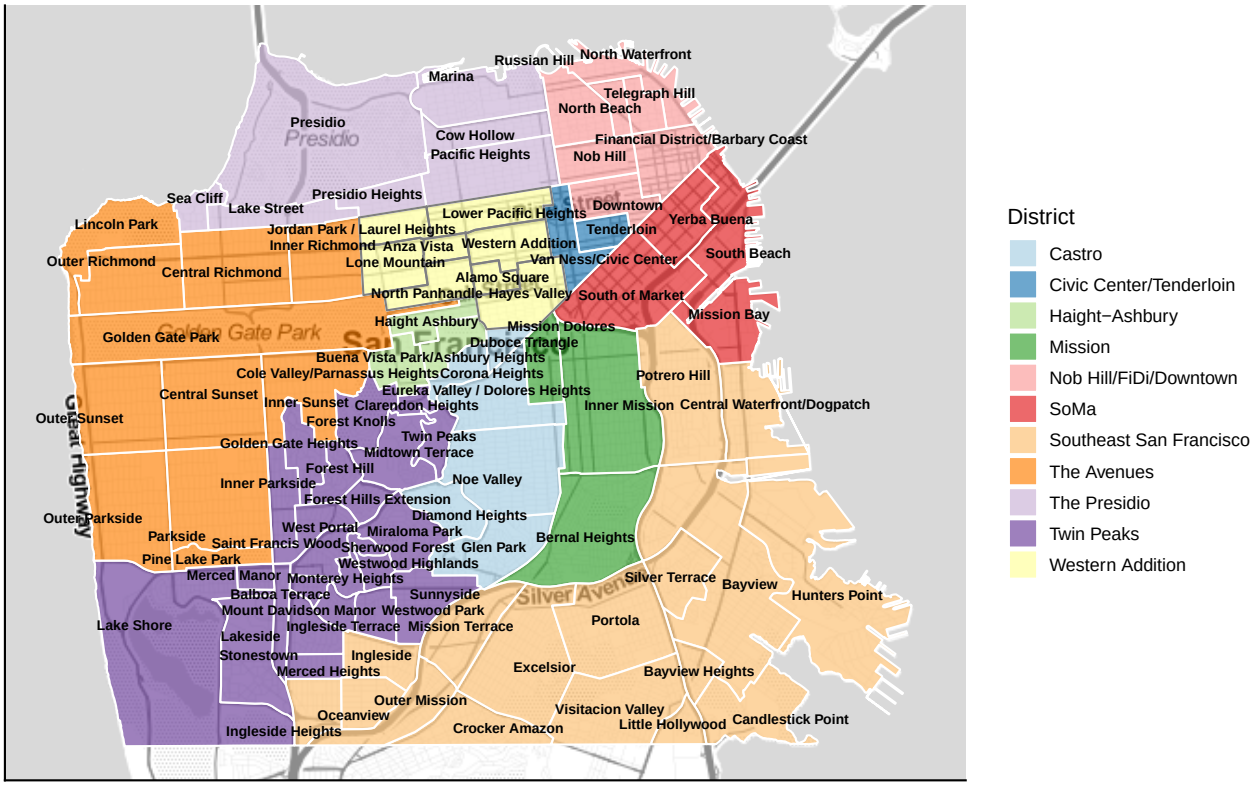
```
               "Excelsior")

soma <- c("Mission Bay","South of Market","South Beach","Yerba Buena")

haight <- c("Haight Ashbury",
            "Buena Vista Park/Ashbury Heights",
            "Cole Valley/Parnassus Heights")

tenderloin <- c("Tenderloin","Van Ness/Civic Center")

western_addition <- c("Anza Vista",
                      "Lower Pacific Heights",
                      "Hayes Valley",
                      "Alamo Square",
                      "Western Addition",
                      "North Panhandle",
                      "Jordan Park / Laurel Heights",
                      "Lone Mountain")

neighb_pts$district[neighb_pts$neighborhood %in% western_addition] <- "Western Addition"
neighb_pts$district[neighb_pts$neighborhood %in% avenues] <- "The Avenues"
neighb_pts$district[neighb_pts$neighborhood %in% twinpeaks] <- "Twin Peaks"
neighb_pts$district[neighb_pts$neighborhood %in% presidio] <- "The Presidio"
neighb_pts$district[neighb_pts$neighborhood %in% nob_hill] <- "Nob Hill/FiDi/Downtown"
neighb_pts$district[neighb_pts$neighborhood %in% castro] <- "Castro"
neighb_pts$district[neighb_pts$neighborhood %in% mission] <- "Mission"
neighb_pts$district[neighb_pts$neighborhood %in% southeast] <- "Southeast San Francisco"
neighb_pts$district[neighb_pts$neighborhood %in% soma] <- "SoMa"
neighb_pts$district[neighb_pts$neighborhood %in% haight] <- "Haight-Ashbury"
neighb_pts$district[neighb_pts$neighborhood %in% tenderloin] <- "Civic Center/Tenderloin"

##############################
## Aggregate sf_housing by year
sf_housing.yearly <- sf_housing %>%
    group_by(neighborhood,year) %>%
    summarize(zhvi=mean(zhvi,na.rm=TRUE),
              zri=mean(zri,na.rm=TRUE),
              zri_sqft=mean(zri_sqft,na.rm=TRUE),
              price_to_rent=mean(price_to_rent,na.rm=TRUE))

#names(sf_housing)
#names(sf_housing.yearly)

##########################################################
## Join neighborhood points with descriptive statistics
#names(sf_housing)
#names(neighb_pts)
sf_housing_pts <- right_join(neighb_pts,sf_housing,by="neighborhood")
sf_housing_pts.yearly <- right_join(neighb_pts,sf_housing.yearly,by="neighborhood")
#str(sf_housing_pts)
#str(sf_housing_pts.yearly)

##################
```

```
## Load map objects
## get coordinates for map boundary
bbox <- sf_neighborhoods@bbox
sf_bbox <- c(left=bbox[1,1]-.01,
             bottom=bbox[2,1]-.005,
             right=bbox[1,2]+.01,
             top=bbox[2,2]+.005)

## load basemap from Stamen maps
basemap <- get_stamenmap(
    bbox = sf_bbox,
    zoom=12,
    maptype="toner-lite")
```

Neighborhood reference

My analysis is done with respect to neighborhoods, so a visual reference of San Francisco's neighborhoods and districts is helpful.

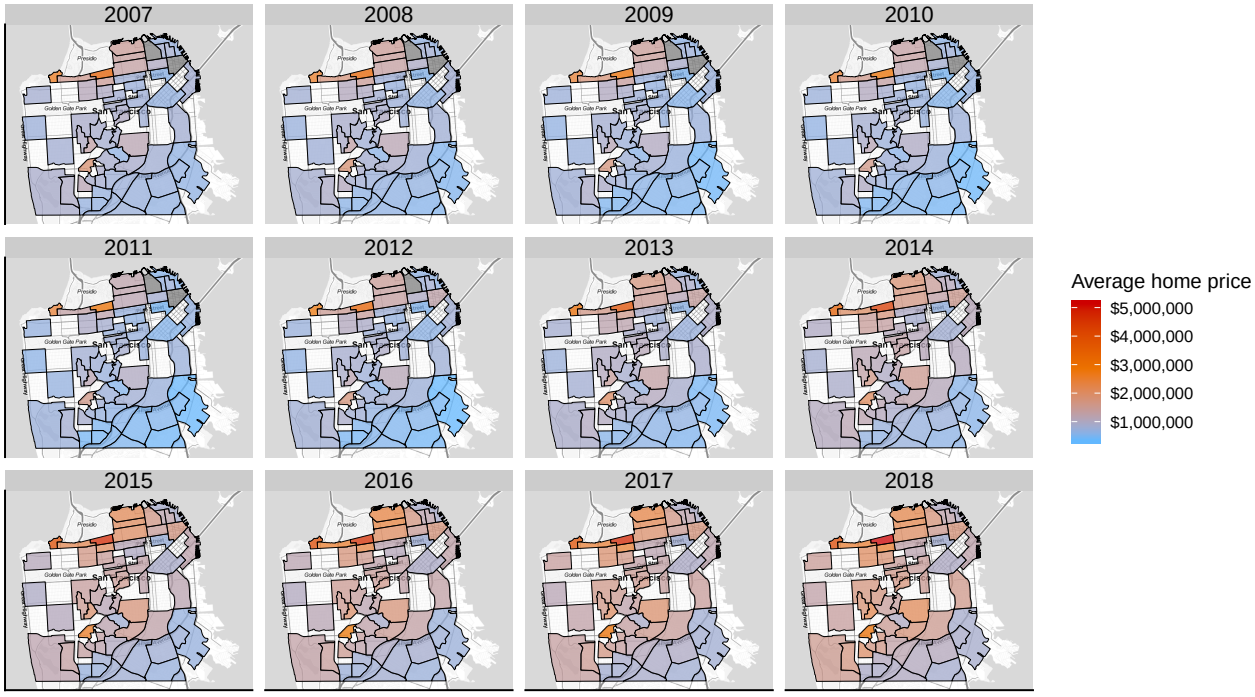
```
neighb_centroids <- neighb_pts %>%
    group_by(neighborhood) %>%
    summarize(mdn_lat=median(lat,na.rm=TRUE),
              mdn_long=median(long,na.rm=TRUE),
              mean_lat=mean(lat,na.rm=TRUE),
              mean_long=mean(long,na.rm=TRUE)) %>%
    as.data.frame()

ggmap(basemap) + coord_map() +
    mapTheme() +
    geom_polygon(data=neighb_pts,
                 aes(x=lat,y=long,group=neighborhood,fill=district),
                 col="white",alpha=.65) +
    geom_polygon(data=filter(neighb_pts,district=="Western Addition"),
                 aes(x=lat,y=long,group=neighborhood),
                 col="gray50",alpha=0,show.legend=FALSE) +
    ## ggrepel library prevents text overlapping
    geom_text_repel(data=neighb_centroids,
                aes(x=mean_lat,y=mean_long,label=neighborhood),
                size=2.34,color="black",fontface="bold",
                segment.size=.25,point.padding=NA,box.padding=.1,force=.1) +
    scale_fill_brewer("District",palette="Paired",type="qual")
```




```
#ggsave("../graphics/fig1.png",width=9,height=9)
```

San Francisco home prices by year

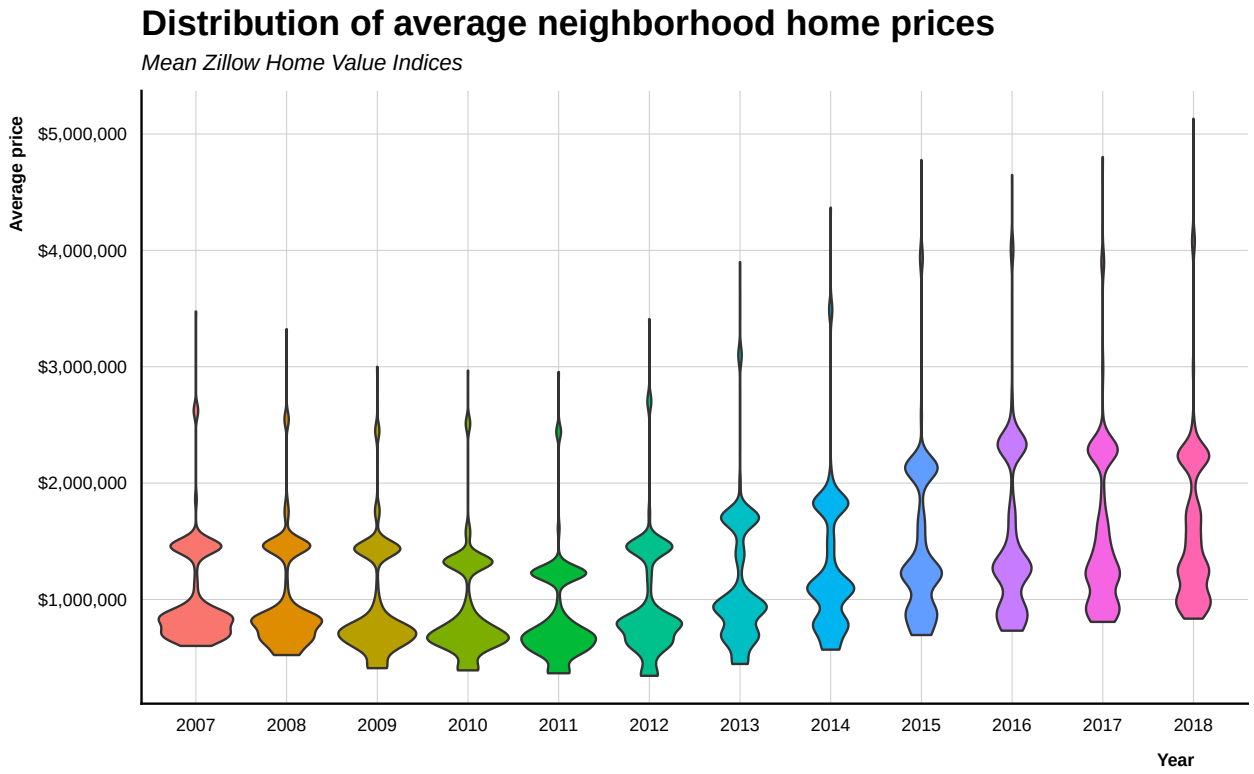
```
ggmap(basemap) + coord_map() +
    geom_polygon(data=filter(sf_housing_pts.yearly,year>=2007),
                 aes(x=lat,y=long,group=neighborhood,fill=zhvi),
                 col="black",alpha=.75,size=.25) +
    facet_wrap(~year,nrow=3) +
    labs(title="San Francisco home prices",
         subtitle="Mean Zillow Home Value Indices") +
    scale_fill_gradientn("Average home price",
                         colors=c("steelblue1","darkorange2","red3"),
                         labels = scales::dollar_format(prefix = "$")) +
    mapTheme()
```




```
#ggsave("../graphics/fig2.png",width=10,height=6)
```

First, neighborhood home prices are stagnant between 2007 and 2011 due to the subprime mortgage crisis. In Southeast the Shipyard, housing prices even decrease during this time period.

```
ggplot(filter(sf_housing_pts.yearly,year>=2007)) +
    plotTheme() + theme(legend.position="none") +
    geom_violin(aes(x=as.factor(year),y=zhvi,fill=as.factor(year)),size=.5) +
    labs(title="Distribution of average neighborhood home prices",
         subtitle="Mean Zillow Home Value Indices",
         x="Year",
         y="Average price") +
    scale_y_continuous(labels = dollar_format(prefix = "$"))
```

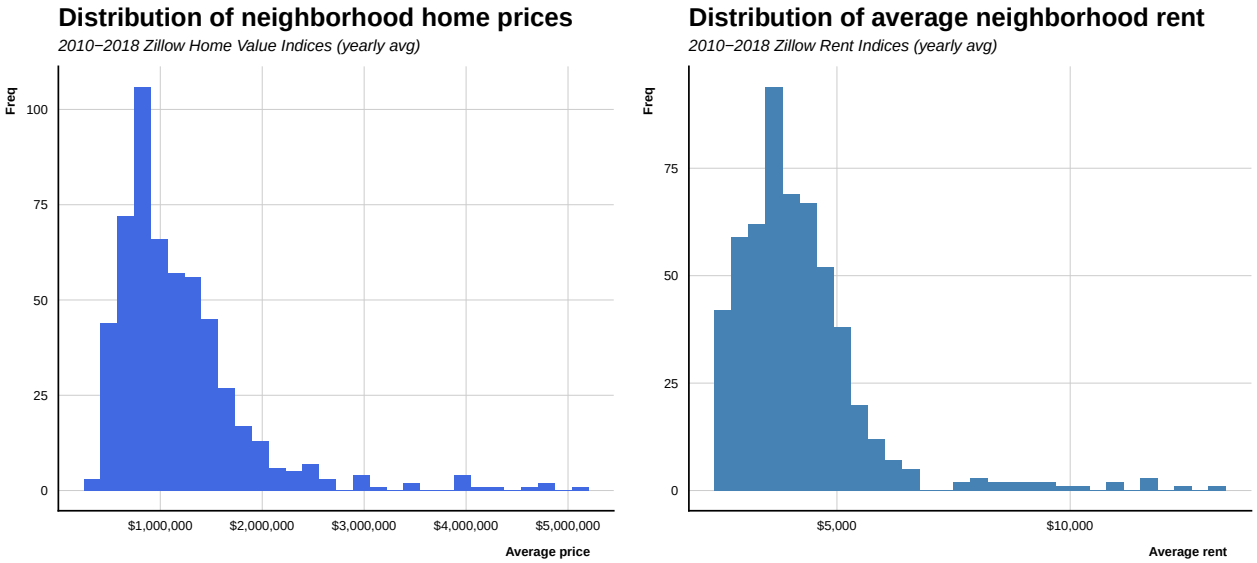



```
#ggsave("graphics/fig3.png",width=8,height=5,device="png")
```

This is a better view of change over time. Housing prices decrease during the subprime mortgage crisis, then shoot up after 2012 and split into a trimodal distribution.

Comparing home prices and rent

```
prices <- ggplot(filter(sf_housing.yearly,year>=2010),aes(x=zhvi)) +
    geom_histogram(fill="royalblue") +
    plotTheme() +
    scale_x_continuous(labels=dollar_format(prefix="$")) +
    labs(title="Distribution of neighborhood home prices",
         subtitle="2010-2018 Zillow Home Value Indices (yearly avg)",
         x="Average price",
         y="Freq")

rent <- ggplot(filter(sf_housing.yearly,year>=2010),aes(x=zri)) +
    geom_histogram(fill="steelblue") +
    plotTheme() +
    scale_x_continuous(labels=dollar_format(prefix="$")) +
    labs(title="Distribution of average neighborhood rent",
         subtitle="2010-2018 Zillow Rent Indices (yearly avg)",
         x="Average rent",
         y="Freq")

grid.arrange(prices,rent,ncol=2)
```



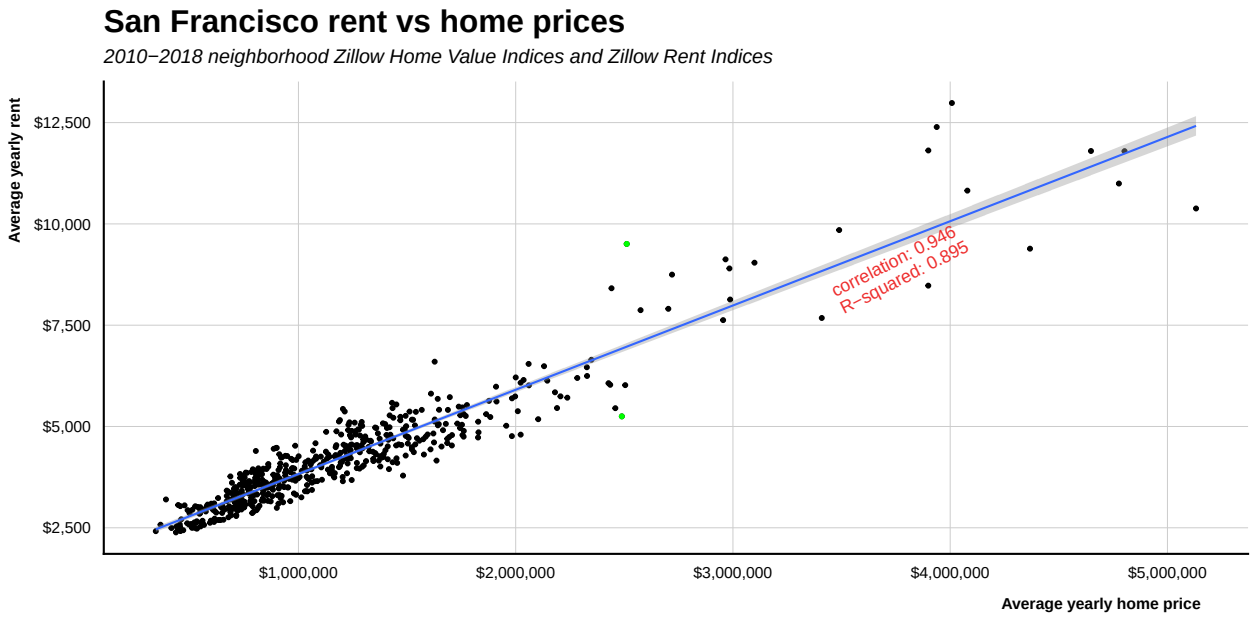

```
#ggsave("../graphics/4.png",width=11,height=5)
```

The plots above includes all home types–condos, single-family, multi-family–and home sizes–bedroom, 2-bedroom, 3-bedroom, etc.

The typical home price was a little under $1 million and typical rent was roughly $4,000 per month from 2010 to 2018. There are also rare neighborhoods where the median home price exceeds $3,000,000 and median rent exceeds $6,000.

Home price and rent follow a similar distribution.

```
cor.zhvi_zri <- cor(sf_housing.yearly$zhvi[sf_housing.yearly$year>=2007],
                    sf_housing.yearly$zri[sf_housing.yearly$year>=2007],
                    use = "complete.obs") %>%
    round(3)

fit.zhvi_zri <- lm(zri~zhvi,filter(sf_housing.yearly,year>=2007))

ggplot(filter(sf_housing.yearly,year>=2007),aes(x=zhvi,y=zri)) +
    geom_point(size=.75) +
    geom_smooth(method="lm",size=.5) +
    geom_point(data=sf_housing.yearly[c(506,1142),],aes(x=zhvi,y=zri),col="green",size=.75) +
    labs(title="San Francisco rent vs home prices",
         subtitle="2010-2018 neighborhood Zillow Home Value Indices and Zillow Rent Indices",
         x="Average yearly home price",
         y="Average yearly rent") +
    plotTheme() +
    scale_x_continuous(labels=dollar_format(prefix="$")) +
    scale_y_continuous(labels=dollar_format(prefix="$")) +
    annotate("text",x=3400000,y=8940,
             label=paste(paste("correlation:",cor.zhvi_zri)),
             angle=27,size=3,col="firebrick2",vjust=2.7,hjust=0) +
    annotate("text",x=3400000,y=8940,
             label=paste(paste("R-squared:",round(summary(fit.zhvi_zri)$r.squared,3))),
             angle=27,size=3,col="firebrick2",vjust=4.2,hjust=0)
```




```
#ggsave("../graphics/fig5.png",width=9,height=6)
```

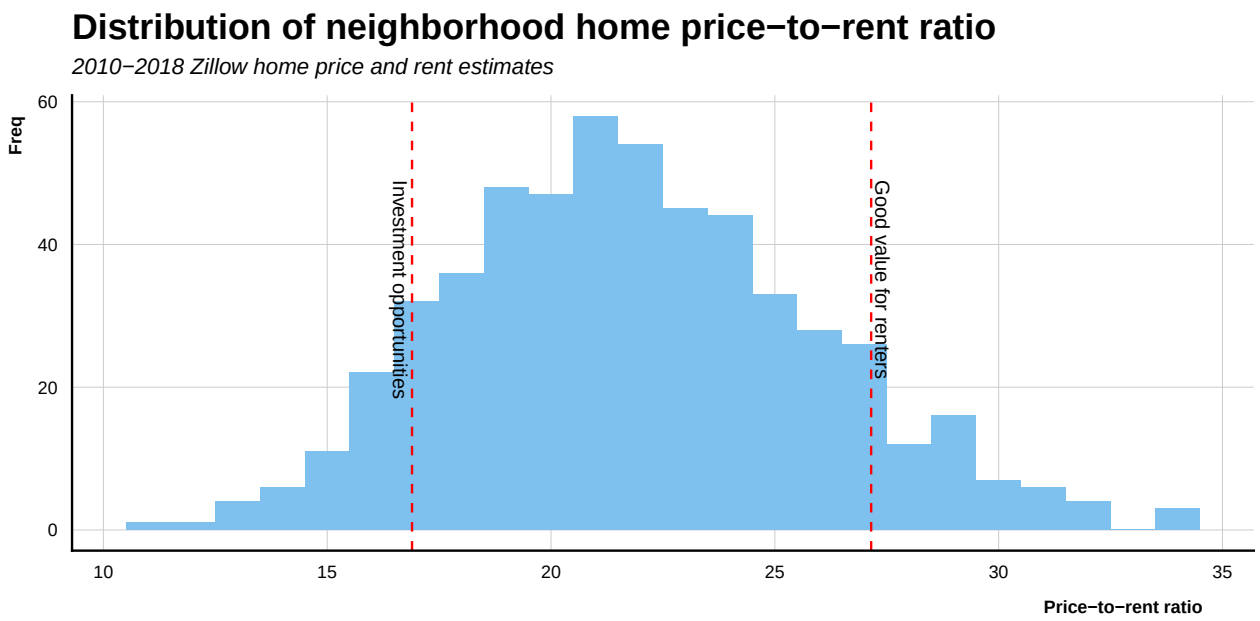
Average yearly home price explains 89.5% of the variation in average yearly rent. Still, rent can vary at a fixed home price: at $2.5m, the minimum rent is $5250/mo and maximum is $9506/mo.

If someone offered me two $2.5m homes to rent–one at $5250/mo and one at $9506/mo–I'd take the $5250/mo most cases.

In the scenario above, I fixed home price. Say you fix your rent budget instead. **What is the highest home value you could get for that budget?** If you're purchasing rental properties, **what's the highest monthly rent you could get for a fixed purchasing budget?** These questions launch us into the next analysis.

Price-to-rent

```
ptr_deciles <- quantile(sf_housing.yearly$price_to_rent[sf_housing.yearly$year>=2010],
                        seq(0,1,.1),
                        na.rm=TRUE)

ggplot(filter(sf_housing.yearly,year>=2010),aes(x=round(price_to_rent,1))) +
    geom_histogram(fill="skyblue2",binwidth=1) +
    geom_vline(aes(xintercept=ptr_deciles[2]),linetype="dashed",col="red") +
    annotate("text",x=ptr_deciles[2],y=49,angle=270,label="Investment opportunities",vjust=1.3,hjust=0,s
    annotate("text",x=ptr_deciles[10],y=49,angle=270,label="Good value for renters",vjust=-.3,hjust=0,si
    geom_vline(aes(xintercept=ptr_deciles[10]),linetype="dashed",col="red") +
    plotTheme() +
    labs(title="Distribution of neighborhood home price-to-rent ratio",
         subtitle="2010-2018 Zillow home price and rent estimates",
         x="Price-to-rent ratio",
         y="Freq") +
    theme(legend.position="none")
```




```
#ggsave("../graphics/fig6.png",width=8,height=4)
```

These are average neighborhood price-to-rent ratios from 2010 to 2018, where price-to-rent ratio is

$$\frac{\text{home price}}{12 \times \text{monthly rent}}$$

.

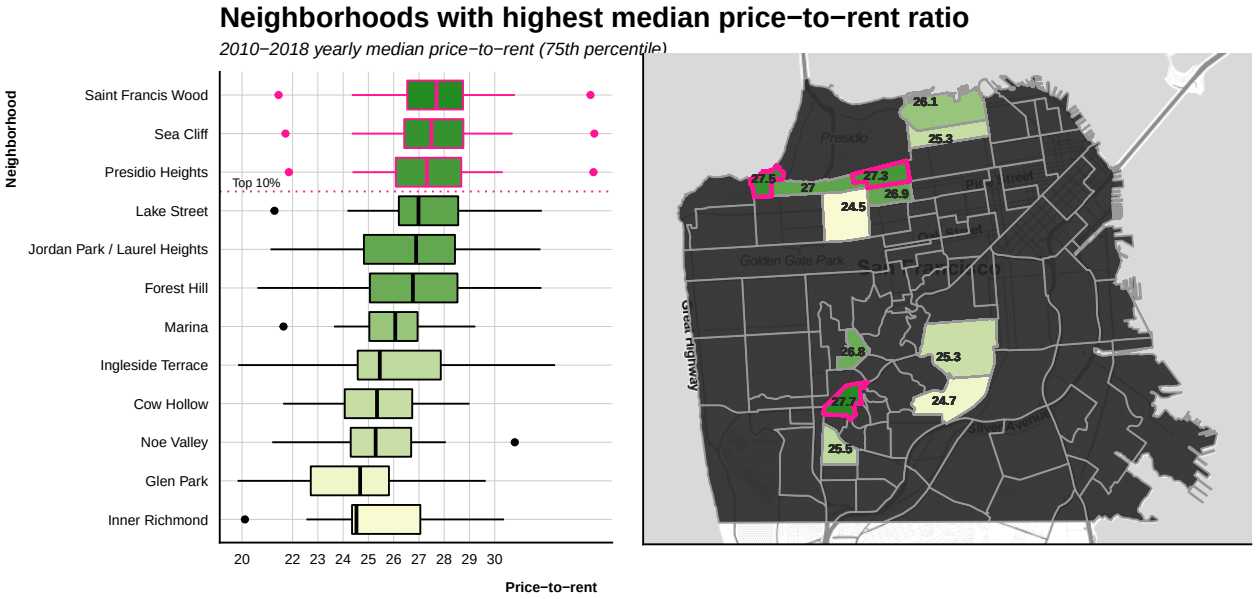
Price-to-rent is home price divided by a years estimated rent. You can view it as the estimated years to pay off a rental property. Maximizing this ratio would give renters good value; minimizing this ratio (fewer years to payoff) would give landlords good returns.

If you're renting an apartment, you want to maximize price-to-rent. These neighborhoods have higher bang for rental buck. Highest 10% neighborhoods are marked in the right panel.

If you're investing in rental property, you want to minimize price-to-rent so you get quick returns on investment. Lowest 10% price-to-rent neighborhoods are marked in the left.

```
ptr_quartiles <- quantile(sf_housing.yearly$price_to_rent[sf_housing.yearly$year>=2010],
                          seq(0,1,.25),
                          na.rm=TRUE)

high_ptr.10 <- filter(sf_housing.yearly,year>=2010,median(price_to_rent,na.rm=TRUE)>=ptr_deciles[10])
high_ptr_neighbs.10 <- unique(high_ptr.10$neighborhood)

high_ptr.25 <- filter(sf_housing.yearly,year>=2010,median(price_to_rent,na.rm=TRUE)>=ptr_quartiles[4])
high_ptr.25$pctile <- "75th percentile"
high_ptr.25$pctile[high_ptr.25$neighborhood %in% high_ptr_neighbs.10] <- "90th percentile"

high_ptr.25_agg <- high_ptr.25 %>%
    group_by(neighborhood) %>%
    summarize(mdn.zhvi=median(zhvi,na.rm=TRUE),
              mdn.zri=median(zri,na.rm=TRUE),
              mdn.price_to_rent=median(price_to_rent,na.rm=TRUE))

high_ptr.25 <- left_join(high_ptr.25,high_ptr.25_agg,by="neighborhood")
high_ptr_pts.25 <- right_join(neighb_pts,high_ptr.25,"neighborhood")
```

```
high_ptr.boxplot <- ggplot(high_ptr.25) +
    geom_boxplot(aes(x=reorder(factor(neighborhood),
                               price_to_rent,
                               FUN=function(x) median(x,na.rm=TRUE)),
                     y=price_to_rent,
                     fill=mdn.price_to_rent,
                     col=pctile)) +
    plotTheme() + coord_flip() +
    labs(title="Neighborhoods with highest median price-to-rent ratio",
         subtitle="2010-2018 yearly median price-to-rent (75th percentile)",
         x="Neighborhood",
         y="Price-to-rent") +
    theme(legend.position="none") +
    scale_y_continuous(breaks=c(20,22:30)) +
    scale_fill_gradientn(colors=c("lightgoldenrodyellow","forestgreen")) +
    scale_color_manual(values=c("black","deeppink")) +
    geom_vline(xintercept=9.5,col="deeppink",linetype="dotted") +
    annotate("text",x=9.5,y=20,label="Top 10%",vjust=-.5,hjust=.2,size=2.4)

## for plotting statistics on map
high_ptr_centroids <- right_join(neighb_centroids,high_ptr.25,by="neighborhood")
## adjust some points
high_ptr_centroids$mean_lat[high_ptr_centroids$neighborhood=="Saint Francis Wood"] <-
    high_ptr_centroids$mean_lat[high_ptr_centroids$neighborhood=="Saint Francis Wood"] -.003
high_ptr_centroids$mean_long[high_ptr_centroids$neighborhood=="Presidio Heights"] <-
    high_ptr_centroids$mean_long[high_ptr_centroids$neighborhood=="Presidio Heights"] + .0001
high_ptr_centroids$mean_lat[high_ptr_centroids$neighborhood=="Presidio Heights"] <-
    high_ptr_centroids$mean_lat[high_ptr_centroids$neighborhood=="Presidio Heights"] + .001
high_ptr_centroids$mean_long[high_ptr_centroids$neighborhood=="Jordan Park / Laurel Heights"] <-
    high_ptr_centroids$mean_long[high_ptr_centroids$neighborhood=="Jordan Park / Laurel Heights"] + .00
high_ptr_centroids$mean_long[high_ptr_centroids$neighborhood=="Lake Street"] <-
    high_ptr_centroids$mean_long[high_ptr_centroids$neighborhood=="Lake Street"] - .0006
high_ptr_centroids$mean_lat[high_ptr_centroids$neighborhood=="Forest Hill"] <-
    high_ptr_centroids$mean_lat[high_ptr_centroids$neighborhood=="Forest Hill"] +.0007

high_ptr.map <- ggmap(basemap) + coord_map() +
    geom_polygon(data=neighb_pts,
                 aes(x=lat,y=long,group=neighborhood),
                 col="gray60",fill="gray15",alpha=.9) +
    geom_polygon(data=filter(high_ptr_pts.25,pctile=="75th percentile"),
                 aes(x=lat,y=long,group=neighborhood,fill=mdn.price_to_rent),
                 col="gray60") +
    geom_polygon(data=filter(high_ptr_pts.25,pctile=="90th percentile"),
                 aes(x=lat,y=long,group=neighborhood,fill=mdn.price_to_rent),
                 col="deeppink",size=1) +
    geom_text(data=high_ptr_centroids,
              aes(x=mean_lat,y=mean_long,label=round(mdn.price_to_rent,1)),
              size=2.5,color="gray17",fontface="bold",nudge_y=-.00065) +
    mapTheme() + theme(legend.position="none")  +
    scale_fill_gradientn(colors=c("lightgoldenrodyellow","forestgreen"))

grid.arrange(high_ptr.boxplot,high_ptr.map,nrow=1)
```



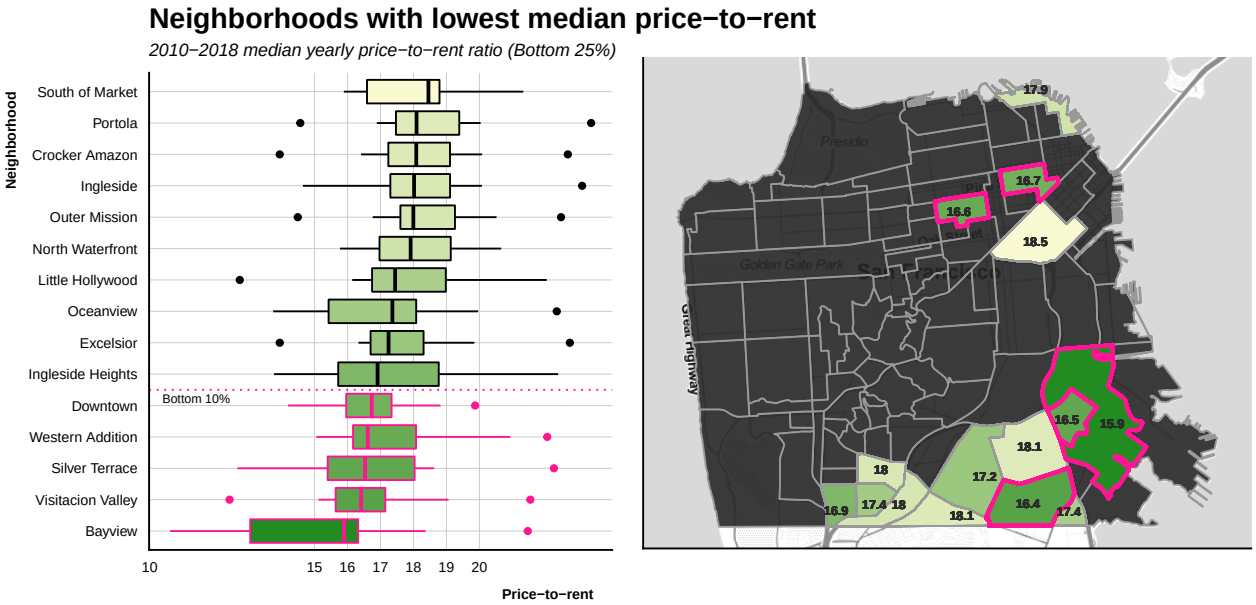

```
#ggsave("../graphics/fig6.png",fig6,width=10,height=4.85)
```

Saint Francis Wood, Sea Cliff, and Presidio Heights are high value neighborhoods to rent in. Because they are affluent neighborhoods, home values are likely to be higher in those neighobrhoods. If you can find reasonable rent in these areas, you're probably getting high value from this renting situation.

As a sanity check, I found nice Craigslist listings in Saint Francis Wood and Presidio for about $1500/br, and the apartments looked nice. That's super reasonable for the area.

```
low_ptr.10 <- filter(sf_housing.yearly,year>=2010,median(price_to_rent,na.rm=TRUE)<=ptr_deciles[2])
low_ptr_neighbs.10 <- unique(low_ptr.10$neighborhood)

low_ptr.25 <- filter(sf_housing.yearly,year>=2010,median(price_to_rent,na.rm=TRUE)<=ptr_quartiles[2])
low_ptr.25$pctile <- "Max 25th percentile"
low_ptr.25$pctile[low_ptr.25$neighborhood %in% low_ptr_neighbs.10] <- "Max 10th percentile"

## create aggregates
low_ptr.25_agg <- low_ptr.25 %>%
    group_by(neighborhood) %>%
    summarize(mdn.zhvi=median(zhvi,na.rm=TRUE),
              mdn.zri=median(zri,na.rm=TRUE),
              mdn.price_to_rent=median(price_to_rent,na.rm=TRUE))

low_ptr.25 <- left_join(low_ptr.25,low_ptr.25_agg,by="neighborhood")
low_ptr_pts.25 <- right_join(neighb_pts,low_ptr.25,"neighborhood")

low_ptr.boxplot <- ggplot(low_ptr.25) +
    geom_boxplot(aes(x=reorder(factor(neighborhood),
                               price_to_rent,
                               FUN=function(x) median(x,na.rm=TRUE)),
                     y=price_to_rent,
                     fill=mdn.price_to_rent,,
                     color=pctile)) +
    plotTheme() + coord_flip() +
    labs(title="Neighborhoods with lowest median price-to-rent",
         subtitle="2010-2018 median yearly price-to-rent ratio (Bottom 25%)",
```

```
         x="Neighborhood",
         y="Price-to-rent") +
    scale_fill_gradientn(colors=c("forestgreen","lightgoldenrodyellow")) +
    scale_y_continuous(breaks=c(10,15:20)) +
    theme(legend.position="none") +
    geom_vline(xintercept=5.5,col="deeppink",linetype="dotted") +
    annotate("text",x=5.5,y=11,vjust=1.5,hjust=.3,label="Bottom 10%",size=2.3) +
    scale_color_manual(values=c("deeppink","black"))

## names(sf_housing_pts.yearly)
low_ptr_centroids <- right_join(neighb_centroids,low_ptr.25,by="neighborhood")
low_ptr_centroids$mean_lat[low_ptr_centroids$neighborhood=="Outer Mission"] <-
    low_ptr_centroids$mean_lat[low_ptr_centroids$neighborhood=="Outer Mission"] + .0045
low_ptr_centroids$mean_long[low_ptr_centroids$neighborhood=="Downtown"] <-
    low_ptr_centroids$mean_long[low_ptr_centroids$neighborhood=="Downtown"] + .0016
low_ptr_centroids$mean_lat[low_ptr_centroids$neighborhood=="Downtown"] <-
    low_ptr_centroids$mean_lat[low_ptr_centroids$neighborhood=="Downtown"] - .003


low_ptr.map <- ggmap(basemap) + coord_map() +
    geom_polygon(data=neighb_pts,
                 aes(x=lat,y=long,group=neighborhood),
                 color="gray60",fill="gray15",alpha=.9) +
    geom_polygon(data=filter(low_ptr_pts.25,pctile=="Max 25th percentile"),
                 aes(x=lat,y=long,group=neighborhood,fill=mdn.price_to_rent),
                 col="gray60") +
    geom_polygon(data=filter(low_ptr_pts.25,pctile=="Max 10th percentile"),
                 aes(x=lat,y=long,group=neighborhood,fill=mdn.price_to_rent),
                 col="deeppink",size=1) +
    geom_text(data=low_ptr_centroids,
              aes(x=mean_lat,y=mean_long,label=round(mdn.price_to_rent,1)),
              size=2.5,color="gray17",fontface="bold") +
    mapTheme() +
    scale_fill_gradientn(colors=c("forestgreen","lightgoldenrodyellow")) +
    theme(legend.position="none")
    #scale_color_manual(values=c("gray60","blue"))
    #theme(legend.position="none")

grid.arrange(low_ptr.boxplot,low_ptr.map,nrow=1)
```

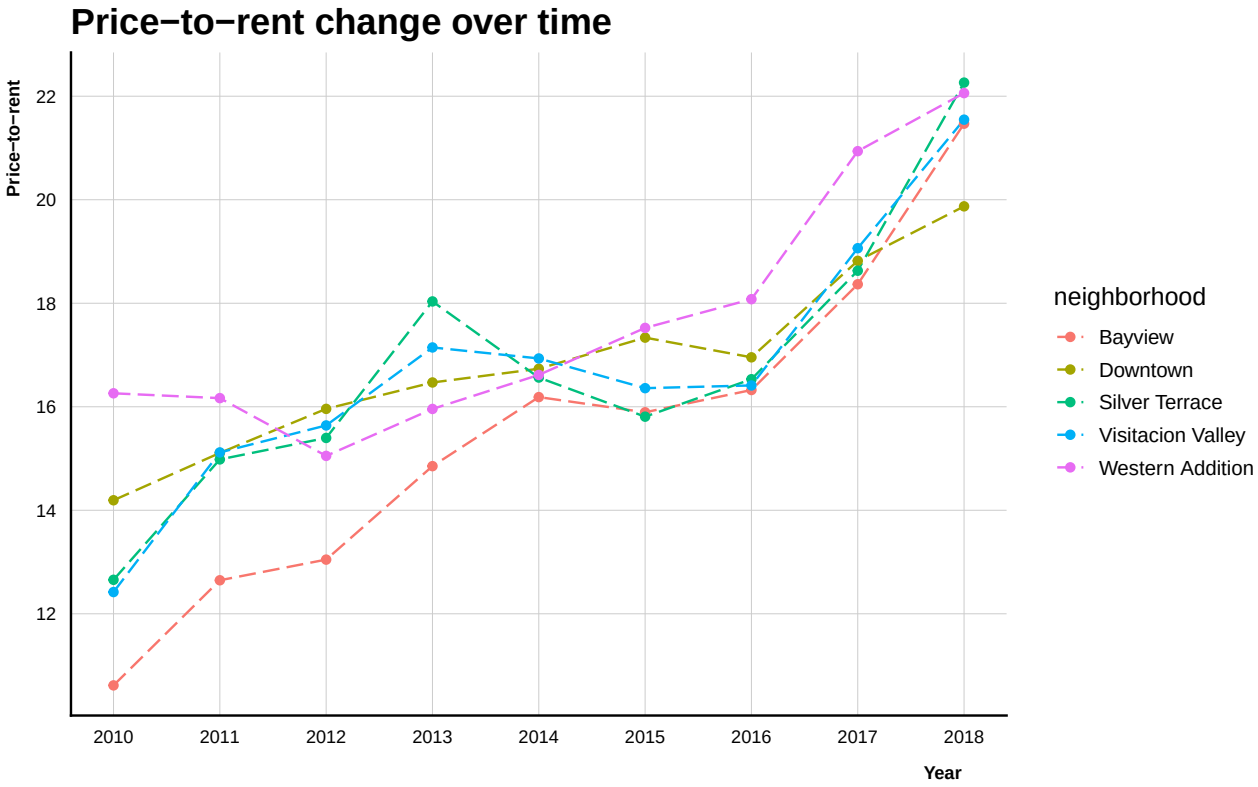



```
#ggsave("../graphics/fig7.png",width=10,height=4.9)
```

Bayview has historically high crime rates, but has grown $400k in average home price from $500k to $900k based on Trulia data. There are coffee shops and eateries sprouting up in that area that cater to young professionals, making it a more accessible neighborhood with a cheaper price tag. It looks like it takes roughly under 16 years to pay off a rental purchase in that area. That's as good as it gets in the city, and real estate property in Bayview is appreciating quickly, meaning higher selloff value.

Next, we will look at change over time.

```
ggplot(data=low_ptr.10,aes(x=year,y=price_to_rent,color=neighborhood)) +
    geom_line(linetype="longdash") +
    geom_point() +
    plotTheme() +
    scale_x_continuous(breaks=2010:2018) +
    scale_y_continuous(breaks=seq(10,22,2)) +
    labs(x="Year",
         y="Price-to-rent",
         title="Price-to-rent change over time")
```




```
#ggsave("../graphics/fig8.png",width=8,height=5)
```

Looking at change over time, we see that Downtown actually has the lowest current price-to-rent, so we should add that to list of rental property investment candidates.

Conclusion

We identified a few good starting neighborhoods to look to rent in from a value perspective. Consider starting with Saint Francis Wood, Sea Cliff, and Presidio Heights. From a buyer's perspective, Bayview, Visitacion Valley, Downtown are good neighborhoods for purchasing rental properties.

I didn't have much time to go in-depth in this analysis, but I'll probably extend this in the future. Things I'll consider in future analysis:

- look at 3- and 4-bedroom apartments (more rooms tend to be cheaper)
- graph rent per square feet to find apartments that provide more space for less money
- think about looking at densities of nearby restaurants because convenience is important

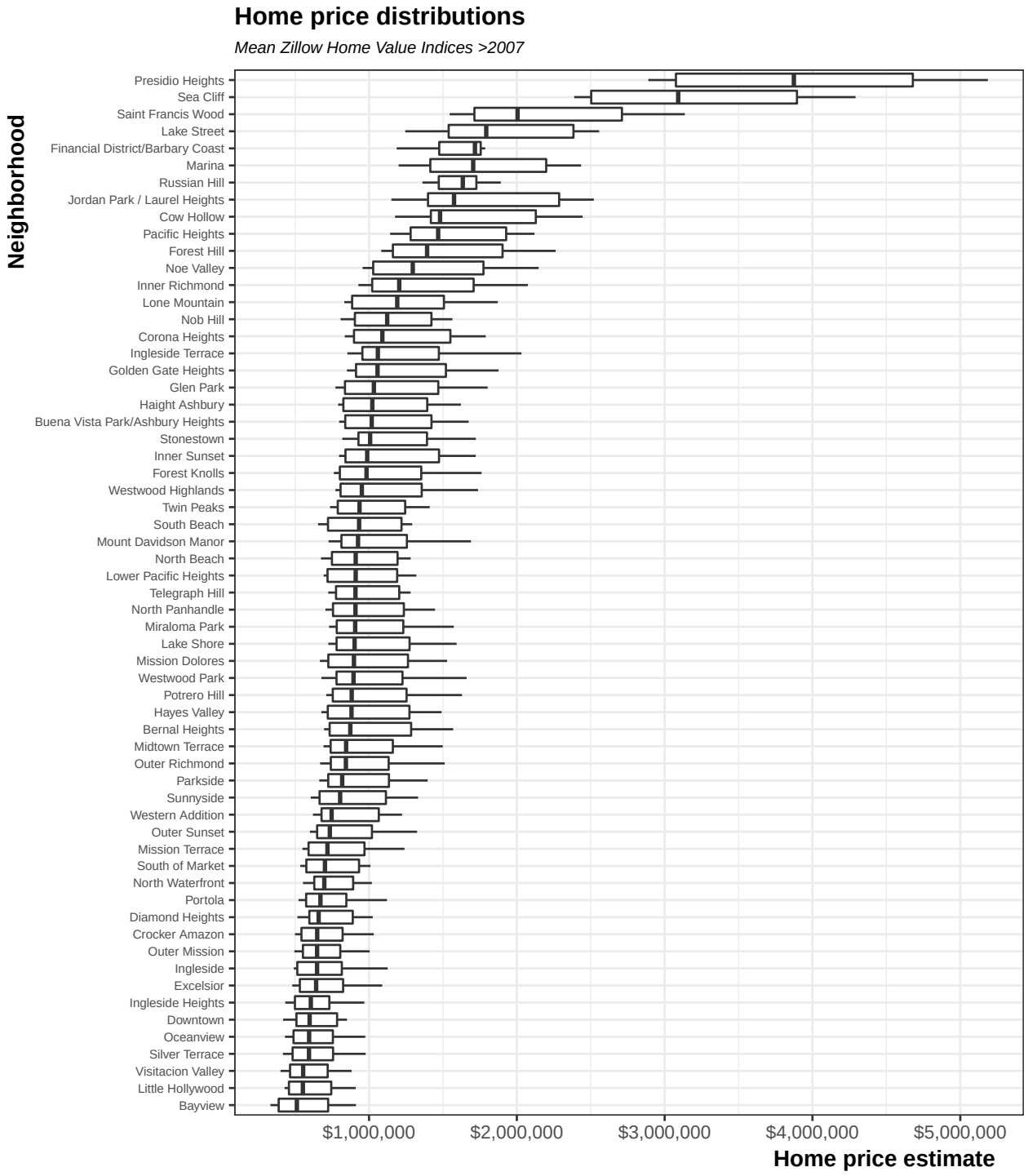
Learning how to map was probably the hardest part about this project. I studied the Urban Spatial for several days, and stepped through the code slowly. Learning how geom_polygon() worked was helpful. The function draws polygons by connecting points using the "group" aesthetic.

Feedback? Drop a comment or dm!

Appendix

```
ggplot(filter(sf_housing,year>2007)) +
    geom_boxplot(aes(x=reorder(neighborhood,zhvi,
```

```
                              FUN = function(x) {median(x,na.rm=TRUE)}),
                  y=zhvi)) +
labs(x="Neighborhood",y="Home price estimate",title="Home price distributions",
     subtitle="Mean Zillow Home Value Indices >2007") +
scale_y_continuous(labels=dollar_format(prefix="$")) +
coord_flip() +
theme_bw() +
theme(axis.text.y=element_text(size=6),
      plot.title=element_text(size=12,face="bold"),
      plot.subtitle=element_text(size=8,face="italic"),
      axis.title.x = element_text(hjust=.95,face="bold"),
      axis.title.y = element_text(hjust=.95,face="bold"))
```




```
#ggsave("../graphics/home_price.png",width=7,height=8)
```