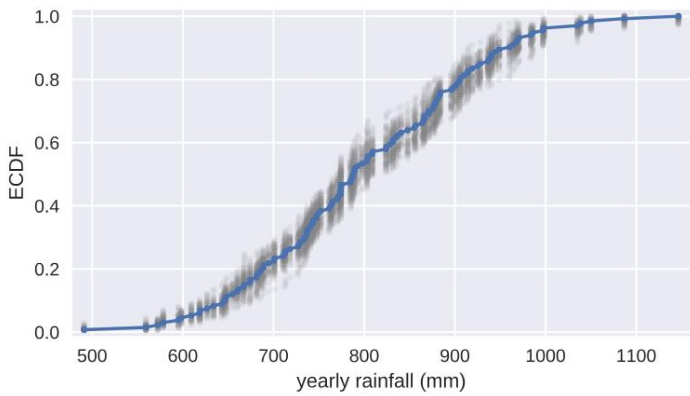
Statistical Thinking in Python Part 2

2). Bootstrap confidence intervals

a). Visualizing Bootstrap Samples:

```
for _ in range(50):
    # Generate bootstrap sample: bs_sample
    bs_sample = np.random.choice(rainfall, size=len(rainfall))

    # Compute and plot ECDF from bootstrap sample
    x, y = ecdf(bs_sample)
    _ = plt.plot(x, y, marker='.', linestyle='none',
                 color='gray', alpha=0.1)
# Compute and plot ECDF from original data
x, y = ecdf(rainfall)
_ = plt.plot(x, y, marker='.')
# Make margins and label axes
plt.margins(0.02)
_ = plt.xlabel('yearly rainfall (mm)')
_ = plt.ylabel('ECDF')
# Show the plot
plt.show()
```

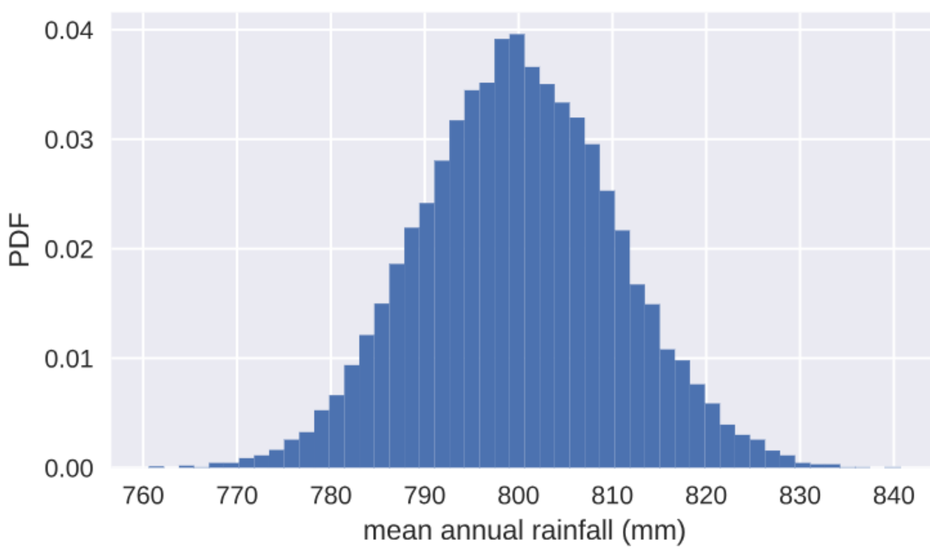


b). Generating many bootstrap replicates:

```
def draw_bs_reps(data, func, size=1):
    """Draw bootstrap replicates."""

    # Initialize array of replicates: bs_replicates
    bs_replicates = np.empty(size)

    # Generate replicates
    for i in range(size):
        bs_replicates[i] = bootstrap_replicate_1d(data,size=func)

    return bs_replicates
```

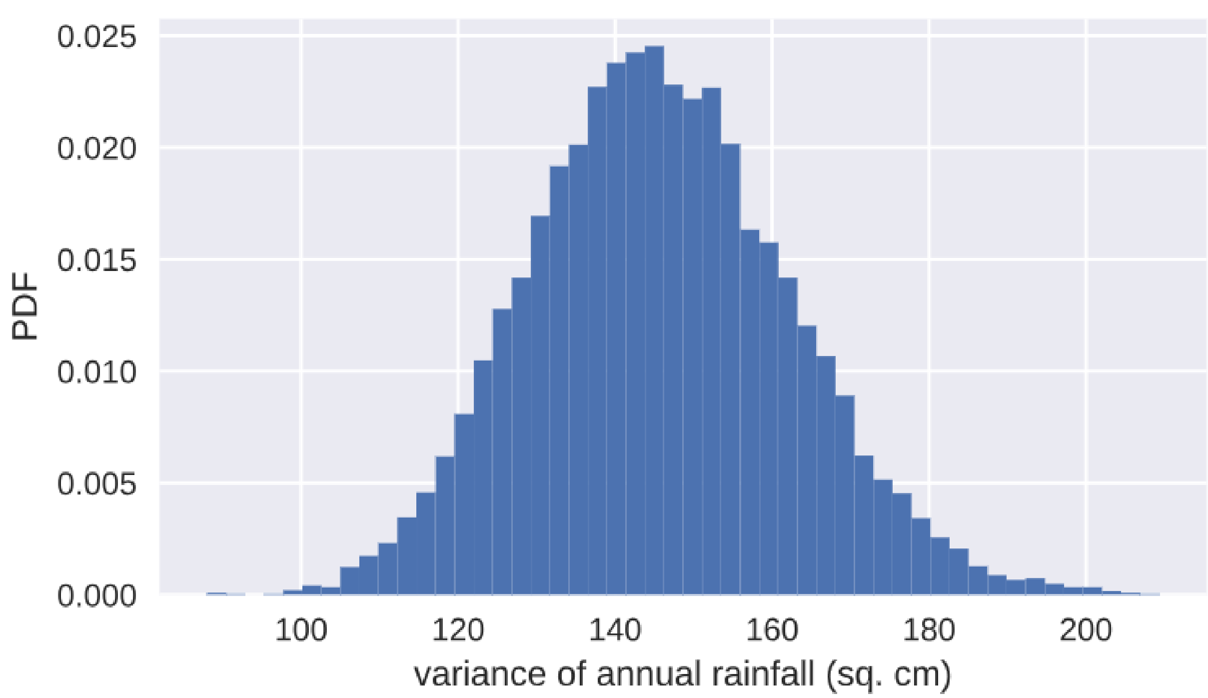
c). Bootstrap replicates of the mean and the SEM

```
# Take 10,000 bootstrap replicates of the mean: bs_replicates
bs_replicates = draw_bs_reps(rainfall, np.mean,size=10000)

# Compute and print SEM
sem = np.std(rainfall) / np.sqrt(len(rainfall))
print(sem)

# Compute and print standard deviation of bootstrap replicates
bs_std = np.std(bs_replicates)
print(bs_std)

# Make a histogram of the results
_ = plt.hist(bs_replicates, bins=50, normed=True)
_ = plt.xlabel('mean annual rainfall (mm)')
_ = plt.ylabel('PDF')

# Show the plot
plt.show()
```



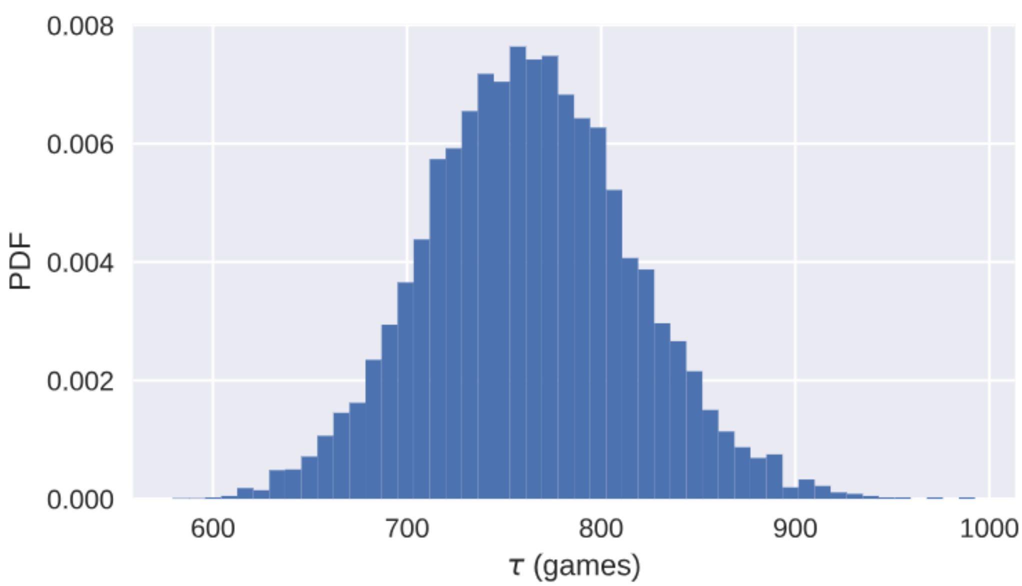
e). Bootstrap replicate of other parameters

```
#Generate 10,000 bootstrap replicates of the variance: bs_replicates
bs_replicates = draw_bs_reps(rainfall,np.var,size=10000)

# Put the variance in units of square centimeters
bs_replicates/=100

# Make a histogram of the results
_ = plt.hist(bs_replicates, bins=50, normed=True)
_ = plt.xlabel('variance of annual rainfall (sq. cm)')
_ = plt.ylabel('PDF')

# Show the plot
plt.show()
```



f). Confidence interval on the rate of nohitters

```
# Draw bootstrap replicates of the mean no-hitter time (equal to tau): bs_replicates
bs_replicates = draw_bs_reps(nohitter_times,np.mean,size=10000)

# Compute the 95% confidence interval: conf_int
conf_int = np.percentile(bs_replicates,[2.5,97.5])

# Print the confidence interval
print('95% confidence interval =', conf_int, 'games')

# Plot the histogram of the replicates
_ = plt.hist(bs_replicates, bins=50, normed=True)
_ = plt.xlabel(r'$\tau$ (games)')
_ = plt.ylabel('PDF')

# Show the plot
plt.show()
```

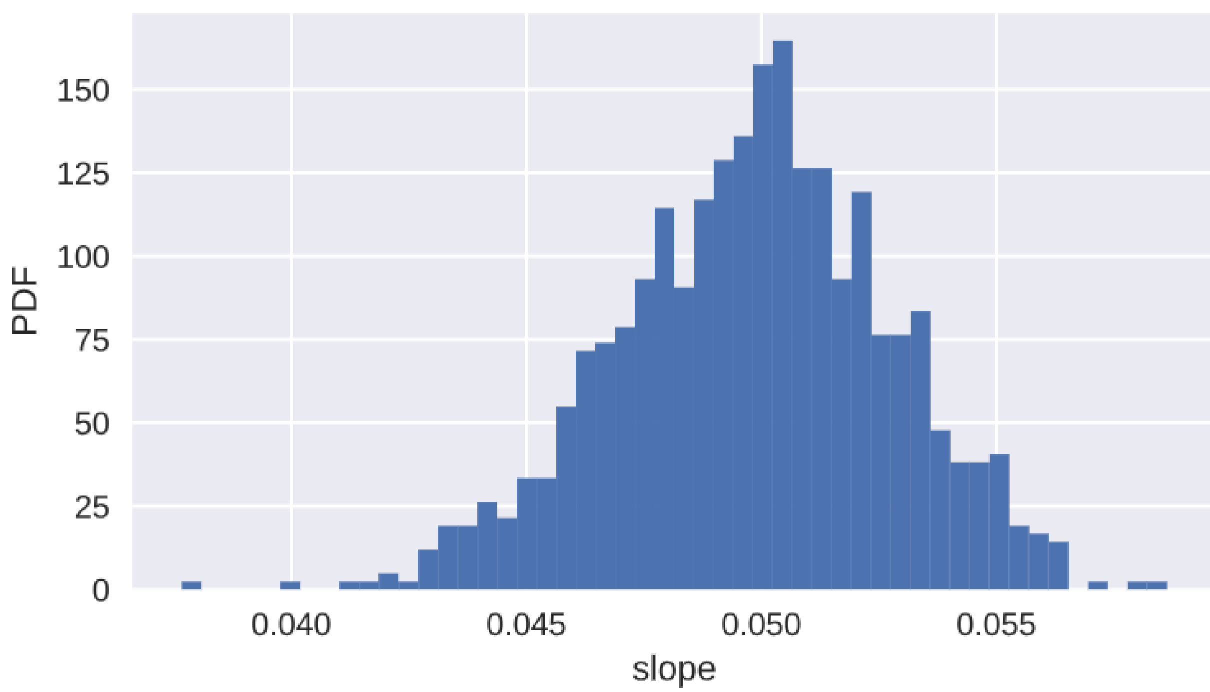


g). A Function to do pairs bootstrap:

```
def draw_bs_pairs_linreg(x, y, size=1):
    """Perform pairs bootstrap for linear regression."""

    # Set up array of indices to sample from: inds
    inds = np.arange(len(x))

    # Initialize replicates: bs_slope_reps, bs_intercept_reps
    bs_slope_reps = np.empty(size)
    bs_intercept_reps = np.empty(size)

    # Generate replicates
    for i in range(size):
        bs_inds = np.random.choice(inds, size=len(inds))
        bs_x, bs_y = x[bs_inds], y[bs_inds]
        bs_slope_reps[i], bs_intercept_reps[i] = np.polyfit(bs_x, bs_y,1)

    return bs_slope_reps, bs_intercept_reps
```

h). Pairs bootstrap of fertility/illiteracy

```
# Generate replicates of slope and intercept using pairs bootstrap
bs_slope_reps, bs_intercept_reps = draw_bs_pairs_linreg(illiteracy, fertility, 1000)

# Compute and print 95% CI for slope
print(np.percentile(bs_slope_reps, [2.5, 97.5]))

# Plot the histogram
_ = plt.hist(bs_slope_reps, bins=50, normed=True)
_ = plt.xlabel('slope')
_ = plt.ylabel('PDF')
plt.show()
```



i). **Plotting bootstrap regression**

```
# Generate array of x-values for bootstrap lines: x
x = np.array([0,100])

# Plot the bootstrap lines
for i in range(100):
    _ = plt.plot(x, bs_slope_reps[i] * x + bs_intercept_reps[i],
                 linewidth=0.5, alpha=0.2, color='red')

# Plot the data
_ = plt.plot(illiteracy, fertility, marker='.', linestyle='none')

# Label axes, set the margins, and show the plot
_ = plt.xlabel('illiteracy')
_ = plt.ylabel('fertility')
plt.margins(0.02)
plt.show()
```