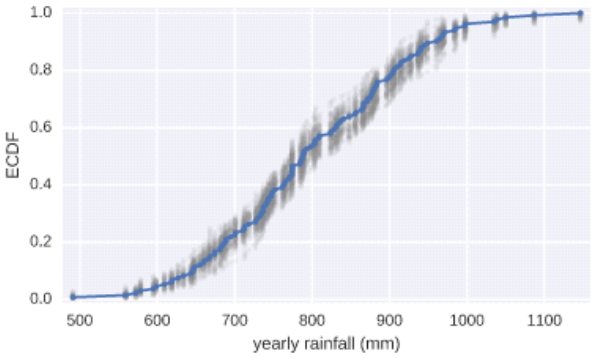
# Ch 2 Bootstrap confidence intervals

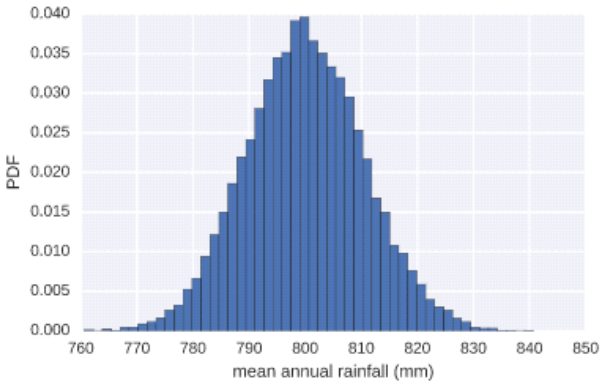
November-13-17 9:21 AM

```
#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()
```

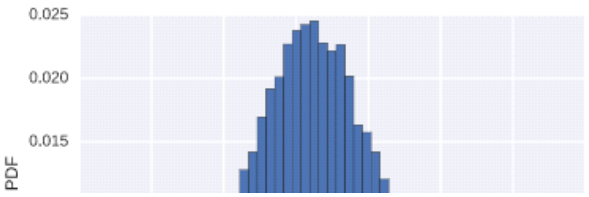



```
#Generating many bootstrap replicates
def draw_bs_reps(data, func, size=1):
    """Draw bootstrap replicates."""

    # 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, func)

    return bs_replicates
```

```
#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 , 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()
```

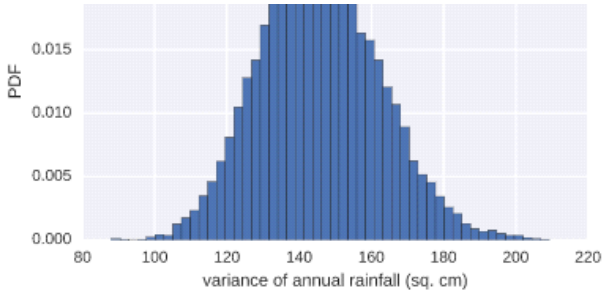



```
Conf_int = np.percentile (bs_replicates, [2.5, 97.5])
```

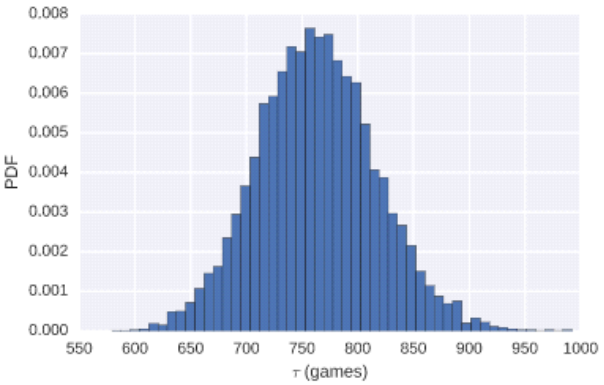



```
#Bootstrap replicates of other statistics
# Generate 10,000 bootstrap replicates of the variance: bs_replicates
bs_replicates = draw_bs_reps (rainfall, np.var, 10000)
```

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

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

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

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

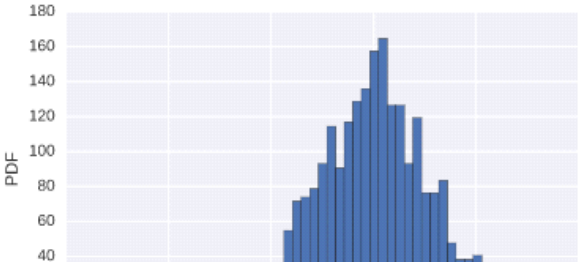



```
#Confidence interval on the rate of no-hitters
# Draw bootstrap replicates of the mean no-hitter time (equal to tau):
bs_replicates
bs_replicates = draw_bs_reps (nohitter_times, np.mean, 10000)

# 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()
```

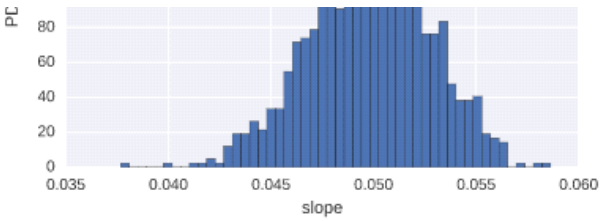



```
#A function to do pairs bootstrap
def draw_bs_pairs_linreg(x, y, size=1):
    """Perform pairs bootstrap for linear regression."""

    # 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
```

```
#Pairs bootstrap of literacy/fertility data
# 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
```



```
# 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()
```




```
#Plotting bootstrap regressions
# 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 ()

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