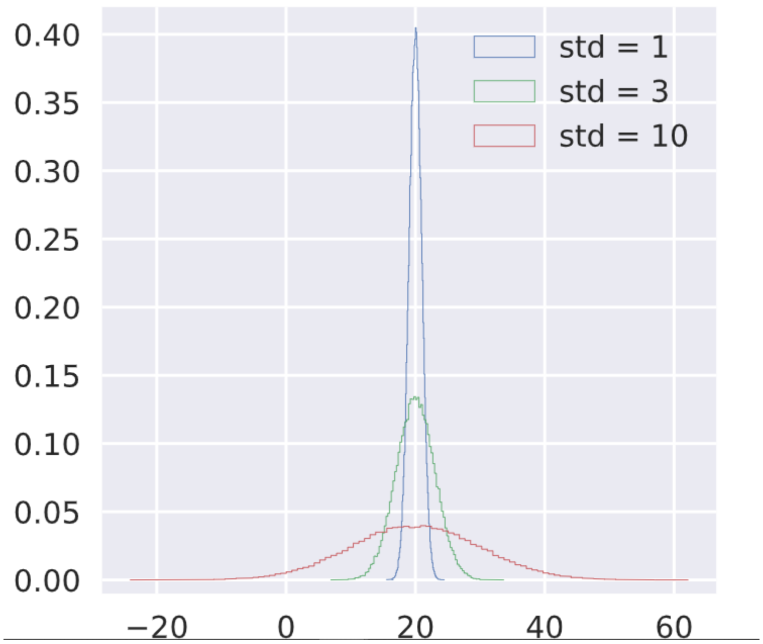
Statistical Thinking in Python Part 1

4). Thinking probabilistically-- Continuous variables

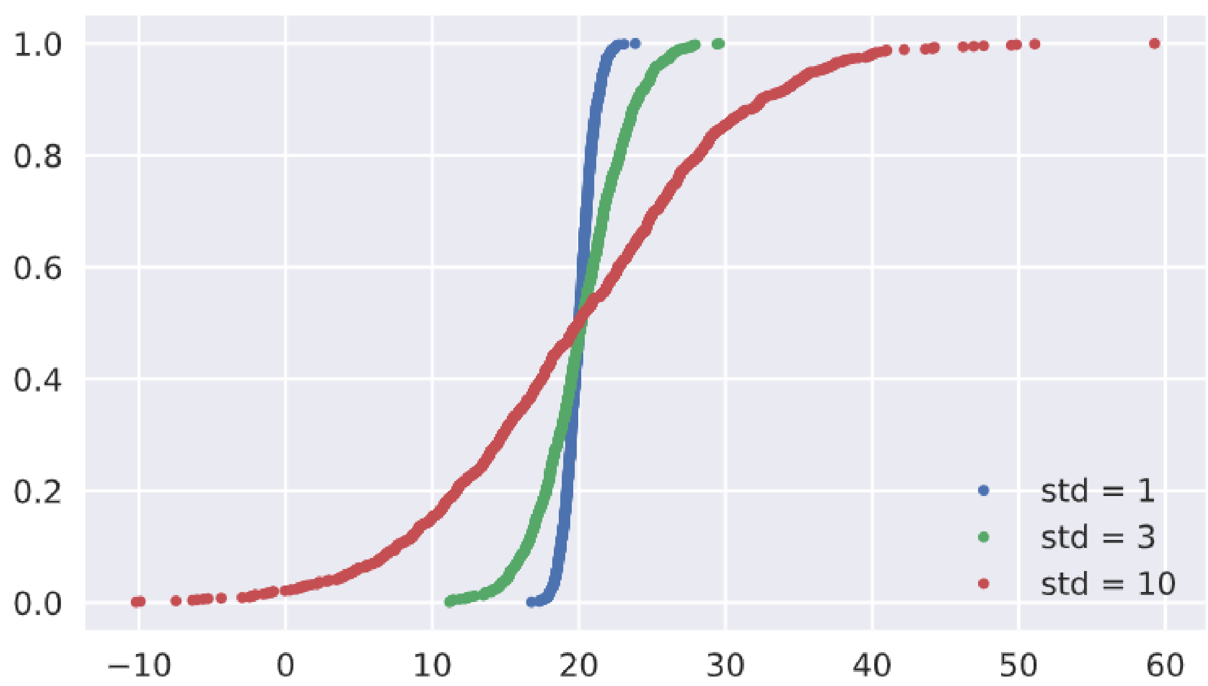
a). The Normal PDF

```
# Draw 100000 samples from Normal distribution with stds of interest: samples_std1, samples_std3, samples_std10

samples_std1=np.random.normal(20, 1, size=100000)

samples_std3=np.random.normal(20, 3, size=100000)

samples_std10=np.random.normal(20, 10, size=100000)


# Make histograms

_=plt.hist(samples_std1,bins=100, normed=True, histtype='step')

_=plt.hist(samples_std3, bins=100, normed=True, histtype='step')

_=plt.hist(samples_std10, bins=100, normed=True, histtype='step')


# Make a legend, set limits and show plot

_ = plt.legend(('std = 1', 'std = 3', 'std = 10'))

plt.ylim(-0.01, 0.42)

plt.show()
```



b). <u>The Normal CDF</u>

```
# Generate CDFs
x_std1, y_std1=ecdf(samples_std1)
x_std3, y_std3=ecdf(samples_std3)
x_std10, y_std10=ecdf(samples_std10)

# Plot CDFs
plt.plot(x_std1, y_std1, marker='.', linestyle='none')
plt.plot(x_std3, y_std3, marker='.', linestyle='none')
plt.plot(x_std10, y_std10, marker='.', linestyle='none')
# Make a legend and show the plot
_ = plt.legend(('std = 1', 'std = 3', 'std = 10'), loc='lower right')
plt.show()
```



c). <u>Are the Belmont Stakes results Normally distributed?</u>

 # Compute mean and standard deviation: mu, sigma

mu= np.mean(belmont_no_outliers)

sigma= np.std(belmont_no_outliers)

 # Sample out of a normal distribution with this mu and sigma: samples

samples= np.random.normal(mu, sigma, size=10000)

 # Get the CDF of the samples and of the data

x_theor, y_theor=ecdf(samples)

x, y= ecdf(belmont_no_outliers)

 # Plot the CDFs and show the plot

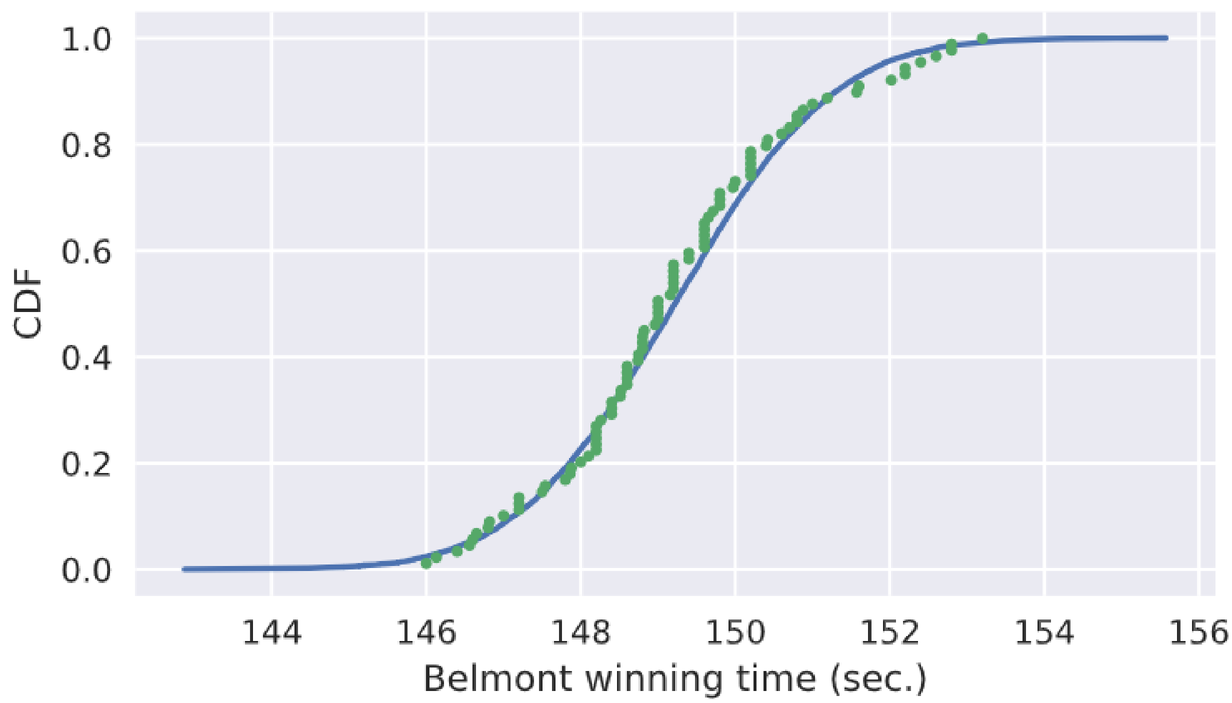
_ = plt.plot(x_theor, y_theor)

_ = plt.plot(x, y, marker='.', linestyle='none')

_ = plt.xlabel('Belmont winning time (sec.)')

_ = plt.ylabel('CDF')

plt.show()



d). <u>What are the chances of a horse matching or beating Secretariat's record?</u>

```
# Take a million samples out of the Normal distribution: samples
samples= np.random.normal(mu, sigma, size=1000000)


# Compute the fraction that are faster than 144 seconds: prob
prob= np.sum(samples<=144)/len(samples)


# Print the result
print('Probability of besting Secretariat:', prob)
```

<script.py> output:

```
Probability of besting Secretariat: 0.000635
```

e). <u>If you have a story, you can simulate it!</u>

```
def successive_poisson(tau1, tau2, size=1):
    """Compute time for arrival of 2 successive Poisson processes."""
    # Draw samples out of first exponential distribution: t1
    t1 = np.random.exponential(tau1, size=size)

    # Draw samples out of second exponential distribution: t2
    t2 = np.random.exponential(tau2, size=size)

    return t1 + t2
```

f). **Distribution of no-hitters and cycles**

```
# Draw samples of waiting times: waiting_times
waiting_times= successive_poisson(764, 715, size=100000)

# Make the histogram
plt.hist(waiting_times, bins=100, normed=True, histtype='step')

# Label axes
plt.xlabel('X')
plt.ylabel('Y')

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