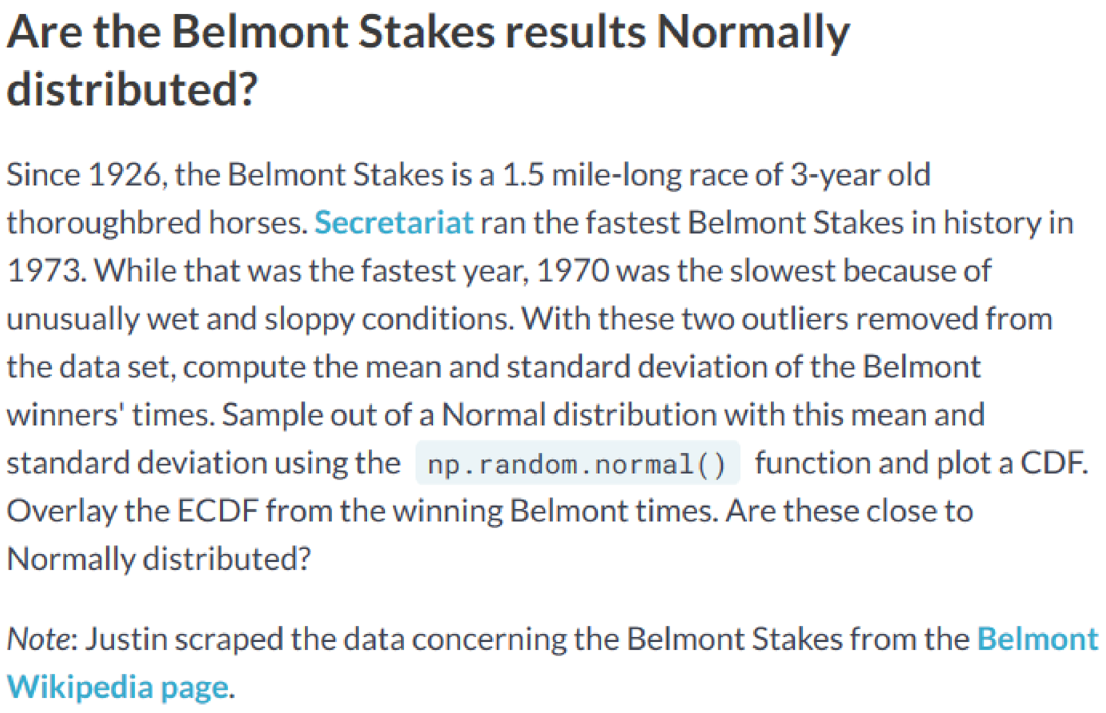
Belmont Stakes

The following analysis was excerpted from the Data Camp course "Statistical Thinking in Python"



Are the Belmont Stakes results Normally distributed?

Since 1926, the Belmont Stakes is a 1.5 mile-long race of 3-year old thoroughbred horses. Secretariat ran the fastest Belmont Stakes in history in 1973. While that was the fastest year, 1970 was the slowest because of unusually wet and sloppy conditions. With these two outliers removed from the data set, compute the mean and standard deviation of the Belmont winners' times. Sample out of a Normal distribution with this mean and standard deviation using the `np.random.normal()` function and plot a CDF. Overlay the ECDF from the winning Belmont times. Are these close to Normally distributed?

Note: Justin scraped the data concerning the Belmont Stakes from the Belmont Wikipedia page.

In [4]:

```
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
```

In [9]:

```
belmont_no_outliers = np.array([148.51, 146.65, 148.52, 150.7 , 150.42, 150.88, 151.57, 147.54,
       149.65, 148.74, 147.86, 148.75, 147.5 , 148.26, 149.71, 146.56,
       151.19, 147.88, 149.16, 148.82, 148.96, 152.02, 146.82, 149.97,
       146.13, 148.1 , 147.2 , 146.  , 146.4 , 148.2 , 149.8 , 147.  ,
       147.2 , 147.8 , 148.2 , 149.  , 149.8 , 148.6 , 146.8 , 149.6 ,
       149.  , 148.2 , 149.2 , 148.  , 150.4 , 148.8 , 147.2 , 148.8 ,
       149.6 , 148.4 , 148.4 , 150.2 , 148.8 , 149.2 , 149.2 , 148.4 ,
       150.2 , 146.6 , 149.8 , 149.  , 150.8 , 148.6 , 150.2 , 149.  ,
       148.6 , 150.2 , 148.2 , 149.4 , 150.8 , 150.2 , 152.2 , 148.2 ,
       149.2 , 151.  , 149.6 , 149.6 , 149.4 , 148.6 , 150.  , 150.6 ,
       149.2 , 152.6 , 152.8 , 149.6 , 151.6 , 152.8 , 153.2 , 152.4 ,
       152.2 ])
```

In [10]:

```
def ecdf(data):
    """Compute ECDF for a one-dimensional array of measurements."""
    # Number of data points: n
    n = len(data)

    # x-data for the ECDF: x
    x = np.sort(data)

    # y-data for the ECDF: y
    y = np.arange(1, n+1) / n

    return x, y
```

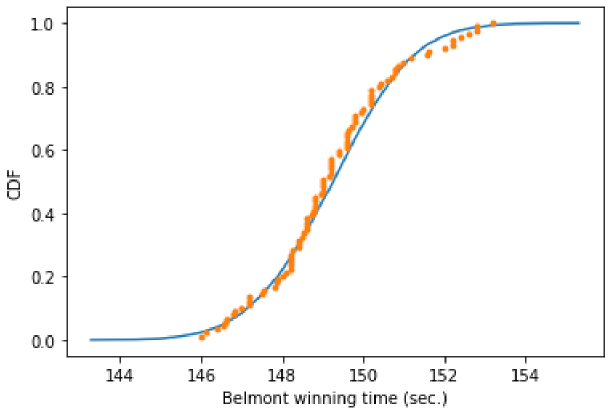
In [13]:

```
# 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()
```



The theoretical CDF and the ECDF of the data suggest that the winning Belmont times are, indeed, Normally distributed. This also suggests that in the last 100 years or so, there have not been major technological or training advances that have significantly affected the speed at which horses can run this race.

What are the chances of a horse matching or beating Secretariat's record?

Assume that the Belmont winners' times are Normally distributed (with the 1970 and 1973 years removed), what is the probability that the winner of a given Belmont Stakes will run it as fast or faster than Secretariat?

In [16]:

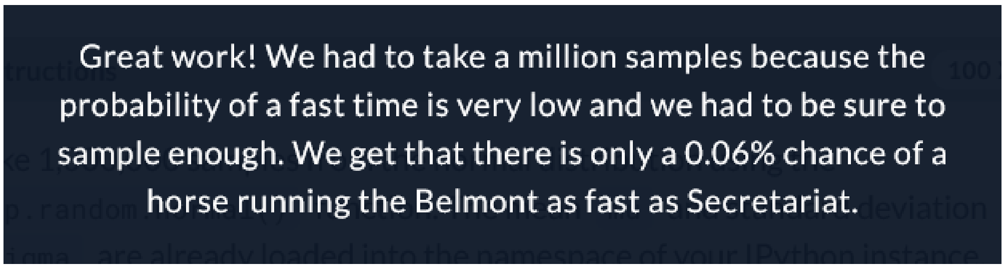
```
# Take a million samples out of the Normal distribution: samples
```

```
samples = np.random.normal(mu,sigma,size=1000000)

# Compute the fraction that are faster than 144 seconds: prob
prob = np.sum(samples <= 144)/1000000

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

```
Probability of besting Secretariat: 0.000639
```


Great work! We had to take a million samples because the probability of a fast time is very low and we had to be sure to sample enough. We get that there is only a 0.06% chance of a horse running the Belmont as fast as Secretariat.