Slice Sampling Unimodal

March 4, 2019

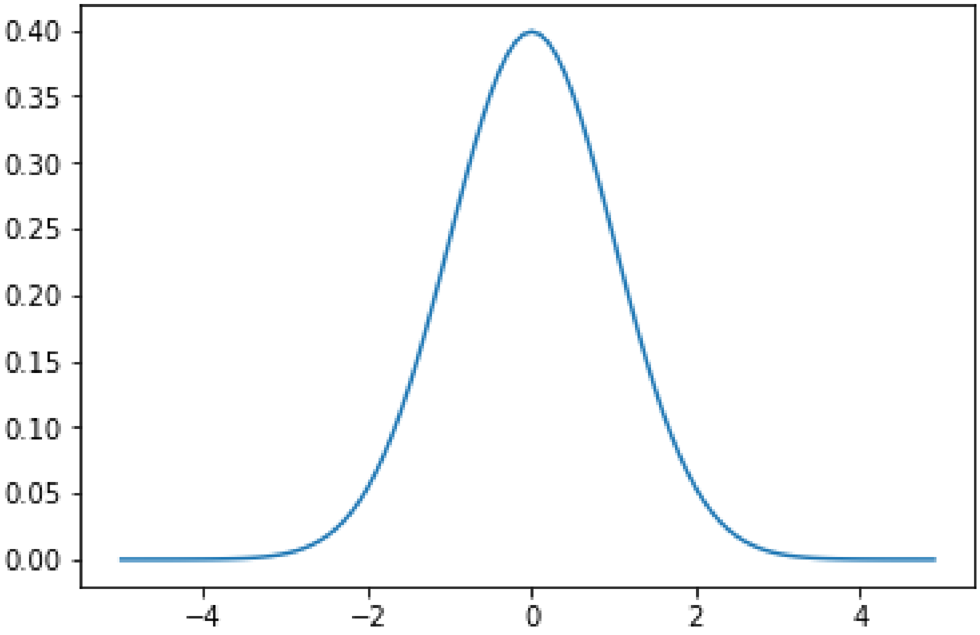
1 Unimodal Slice Sampling Example

1.0.1 Import Libraries

```
In [2]: import numpy as np
        import scipy.stats as stats
        import matplotlib.pyplot as plt
        %matplotlib inline
```

1.0.2 Generate Unimodal Gaussian

```
In [3]: # Parameters used for Gaussian
        x_low = -5
        x_high = 5
        x_step = 0.1

        # Generate pdf
        X = np.arange(x_low, x_high, x_step)
        Y = stats.norm.pdf(X)

        plt.plot(X, Y)
        plt.show()
```



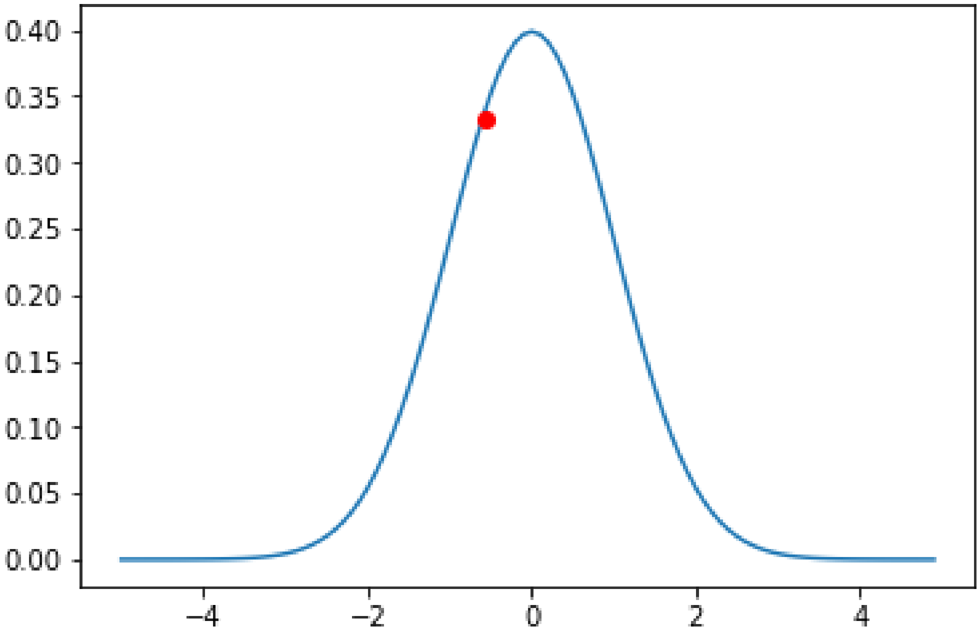
1.0.3 Define function for initial sample for x_0

```
In [6]: low = X[0]
        high = X[-1]

        def __sample_x(low=low, high=high):
            x = np.random.uniform(low=low, high=high)
            return x

        current_x = __sample_x(low, high)

        print(current_x)
```

```
-0.5704083720834312
```

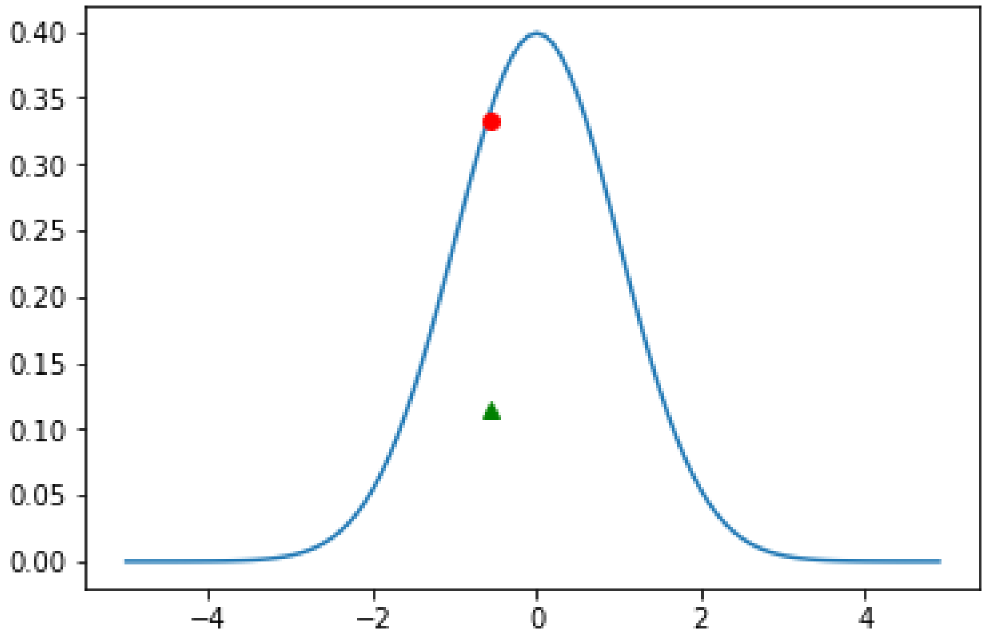
1.0.4 Define function for calculating f(x_0)

```
In [7]: def __fx(x):
            ind = np.argmin(np.abs(X - x))
            y = Y[ind]
            return y

        current_fx = __fx(current_x)

        plt.plot(X, Y)
        plt.plot([current_x], [current_fx], 'ro')
        plt.show()
```



1.0.5 Define function for sampling in the interval (0, f(x_0)), calculate y

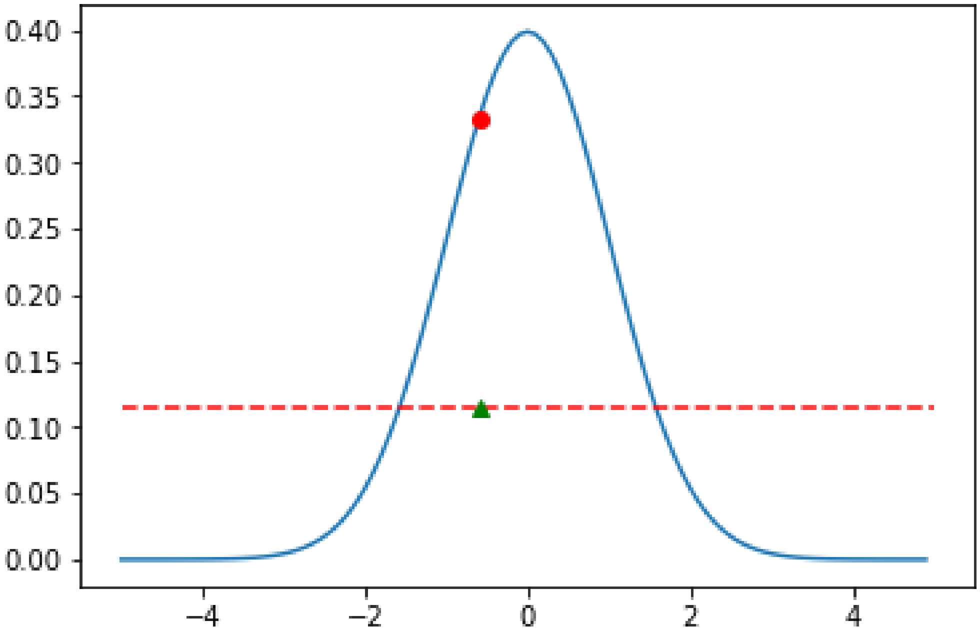
```
In [8]: def __sample_y(x, y):
            sampled_y = np.random.uniform(low=0, high=y)
            return sampled_y

        current_sampled_y = __sample_y(current_x, current_fx)


        plt.plot(X, Y)
        plt.plot([current_x], [current_fx], 'ro')
        plt.plot([current_x], [current_sampled_y], 'g^')
        plt.show()
        print(current_sampled_y)
```



```
0.11417549892990257
```

1.0.6 Define horizontal slice using y

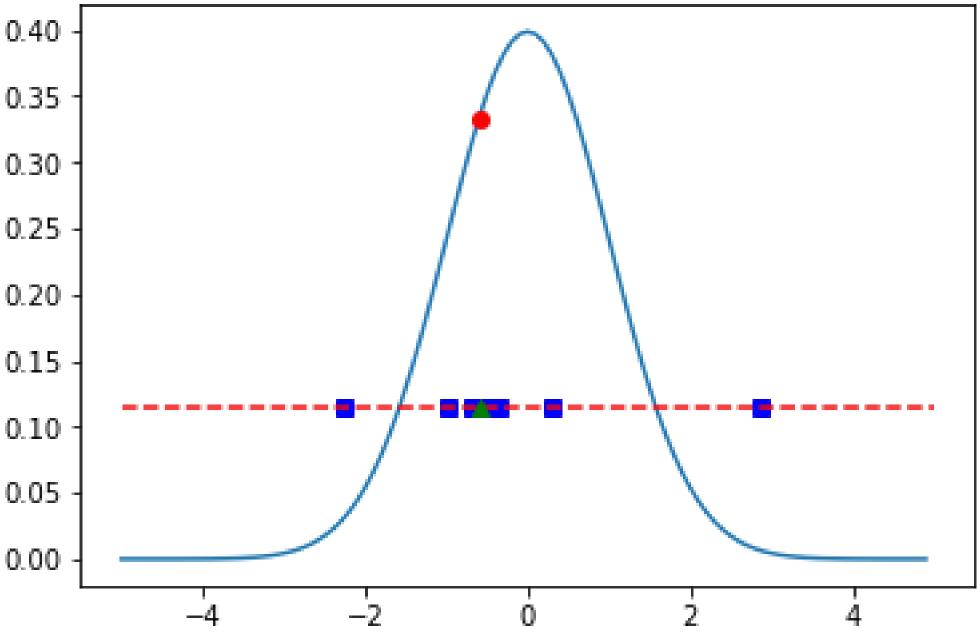
```
In [9]: def __horizontal(sampled_y):
            _x = np.linspace(-5, 5, 50)
            horizontal_line = np.array([sampled_y for i in range(len(_x))])
            return _x, horizontal_line

        current_horizontal = __horizontal(current_sampled_y)

        plt.plot(X, Y)
        plt.plot(current_horizontal[0], current_horizontal[1], 'r--')
        plt.plot([current_x], [current_fx], 'ro')
        plt.plot([current_x], [current_sampled_y], 'g^')
        plt.show()
```



1.0.7 Define function for estimating the sampling interval using doubling update

```
In [10]: def __doubling_update(x, y, sampled_y, w=0.01, p=100):
             even = []
             odd = []
             r = x + w
             l = x
             k = p

             while k > 0 and (sampled_y < __fx(l) or sampled_y < __fx(r)):
                 w = 2*w
                 k = k - 1
                 if k % 2 == 0:
                     l = r - w
                     even.append(l)
                 else:
                     r = l + w
                     odd.append(r)

             patches = np.concatenate((even,odd), axis=None)
             return l, r, patches

         double = __doubling_update(current_x, current_fx, current_sampled_y)
```

```
ascisse = np.array([current_sampled_y for i in range(9)])
plt.plot(double[2], ascisse, 'bs')
plt.plot(X, Y)
plt.plot(current_horizontal[0], current_horizontal[1], 'r--')
plt.plot([current_x], [current_fx], 'ro')
plt.plot([current_x], [current_sampled_y], 'g^')
plt.show()
```



1.0.8 Define updating rule for sampling x_n from new interval

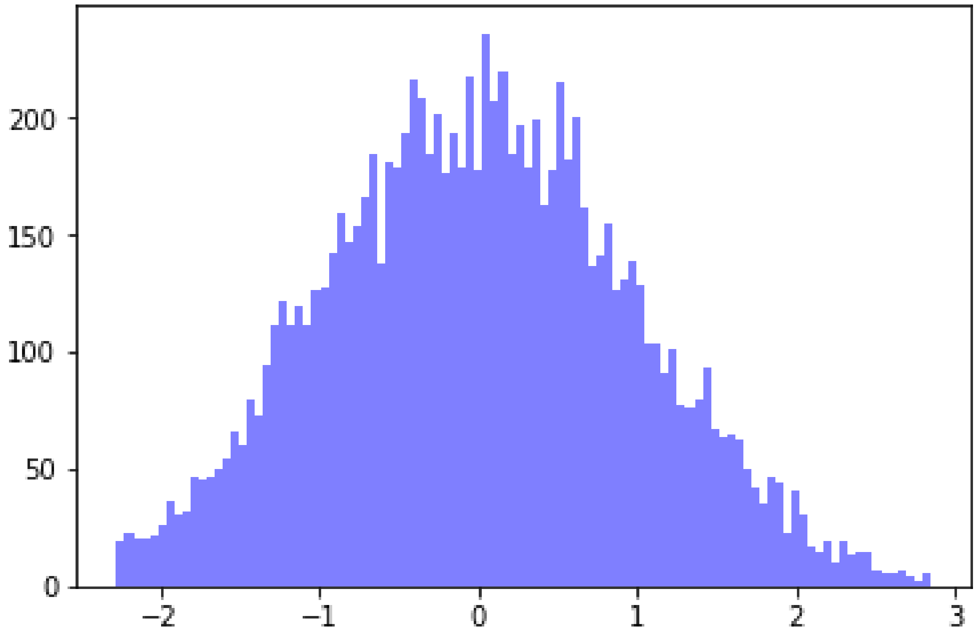
```
In [38]: def update_x_double(current_sampled_y):
             curr_x = __sample_x(double[0], double[1])
             while current_sampled_y > __fx(curr_x):
                 curr_x = __sample_x(double[0], double[1])
             return curr_x

         updated_x_double = update_x_double(current_sampled_y)
         print(updated_x_double)
```

```
-0.18200236482126986
```

1.0.9 Sample and plot results

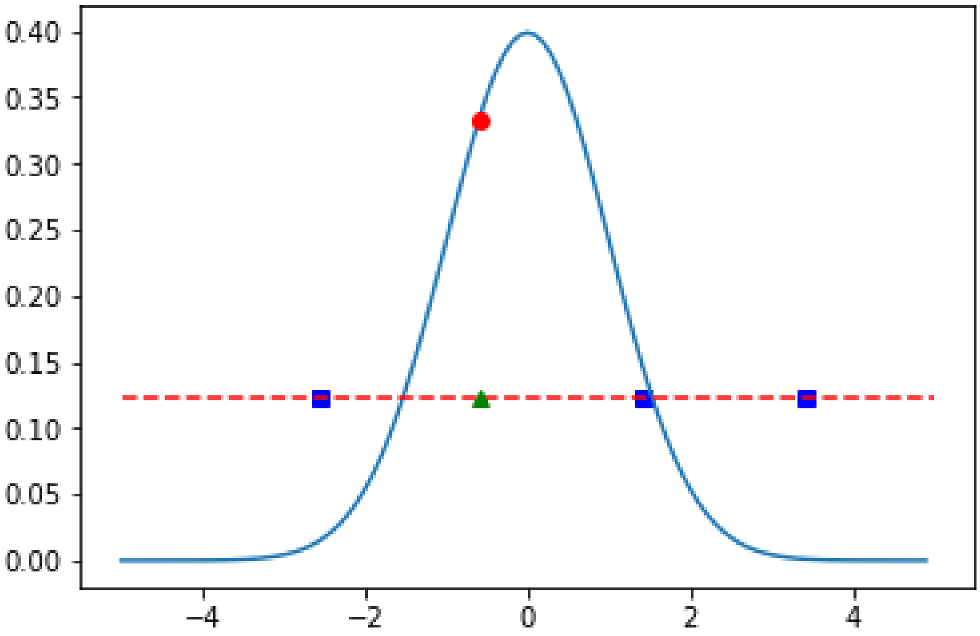
```
In [41]: samples = []
         i = 0
```

```
    while i <10000:
        new_x = update_x_double(current_sampled_y)
        new_fx = __fx(new_x)
        new_sampled_y = __sample_y(new_x, new_fx)
        new_double = __doubling_update(new_x, new_fx, new_sampled_y)
        samples.append(round(new_x,2))
        i = i+1
        current_sampled_y = new_sampled_y

    num_bins = 100
    n, bins, patches = plt.hist(samples, num_bins, facecolor='blue', alpha=0.5)
    plt.show()
```



1.0.10 Define Stepout Update function

```
In [43]: def __stepout_update(x, y, sampled_y, w=2):
             patches = []
             r = x
             l = x

             while sampled_y < __fx(l):
                 l = l - w
                 patches.append(l)

             while sampled_y < __fx(r):
                 r = r + w
                 patches.append(r)

             return l, r, patches

         stepout = __stepout_update(current_x, current_fx, current_sampled_y)

         ascisse = np.array([current_sampled_y for i in range(3)])
         current_horizontal = __horizontal(current_sampled_y)


         plt.plot(stepout[2], ascisse, 'bs')
         plt.plot(X, Y)
         plt.plot(current_horizontal[0], current_horizontal[1], 'r--')
         plt.plot([current_x], [current_fx], 'ro')
         plt.plot([current_x], [current_sampled_y], 'g^')
         plt.show()
         print(current_sampled_y)
```



```
0.12273711373662032
```

1.0.11 Define updating rule for sampling x_n from new interval

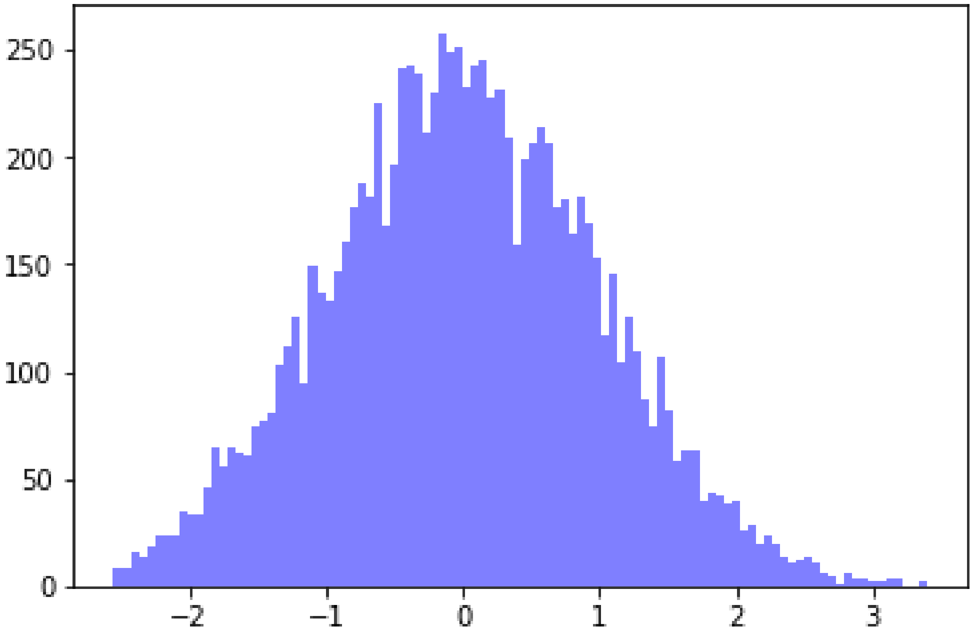
```
In [44]: def update_x_stepout(current_sampled_y):
             curr_x = __sample_x(stepout[0], stepout[1])
```

```
            while current_sampled_y > __fx(curr_x):
                curr_x = __sample_x(stepout[0], stepout[1])
            return curr_x

        updated_x_stepout = update_x_stepout(current_sampled_y)
        print(updated_x_stepout)
```

```
0.2391200402943614
```

1.0.12 Sample and plot results

```
In [45]: samples = []
         i = 0

         while i <10000:
             new_x = update_x_stepout(current_sampled_y)
             new_fx = __fx(new_x)
             new_sampled_y = __sample_y(new_x, new_fx)
             new_horizontal = __horizontal(new_sampled_y)
             new_double = __stepout_update(new_x, new_fx, new_sampled_y)
             samples.append(round(new_x,2))
             i = i+1
             current_sampled_y = new_sampled_y

         num_bins = 100
         n, bins, patches = plt.hist(samples, num_bins, facecolor='blue', alpha=0.5)
         plt.show()
```


250
200
150
100
50
0
−2
−1
0
1
2
3