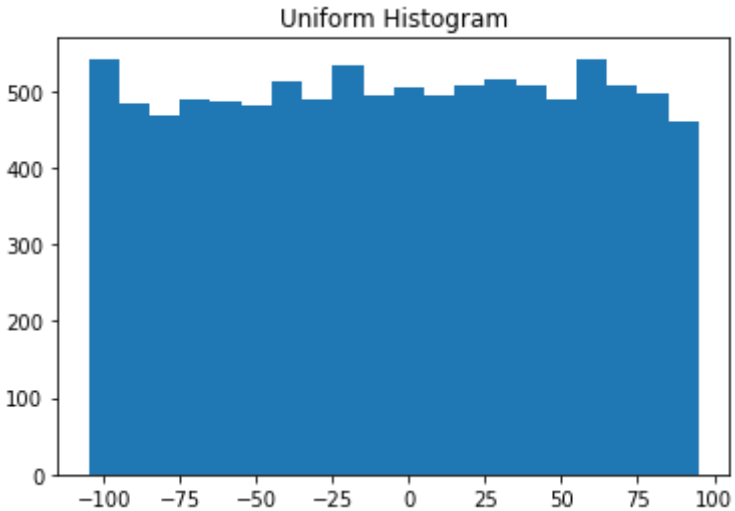
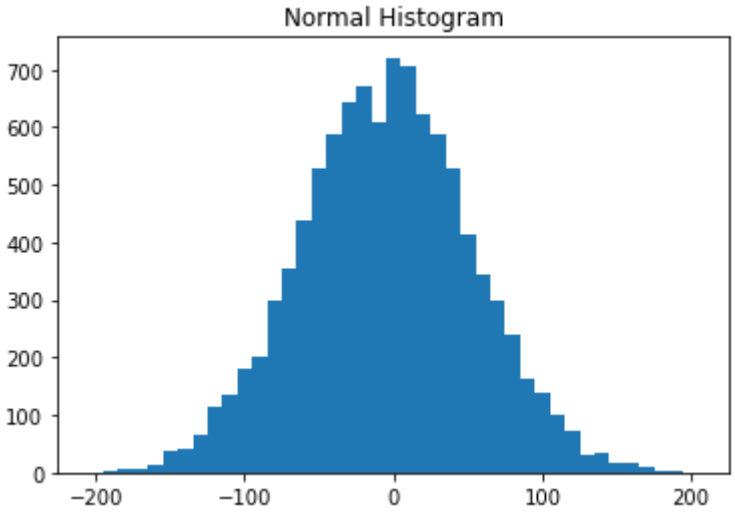
In [1]:

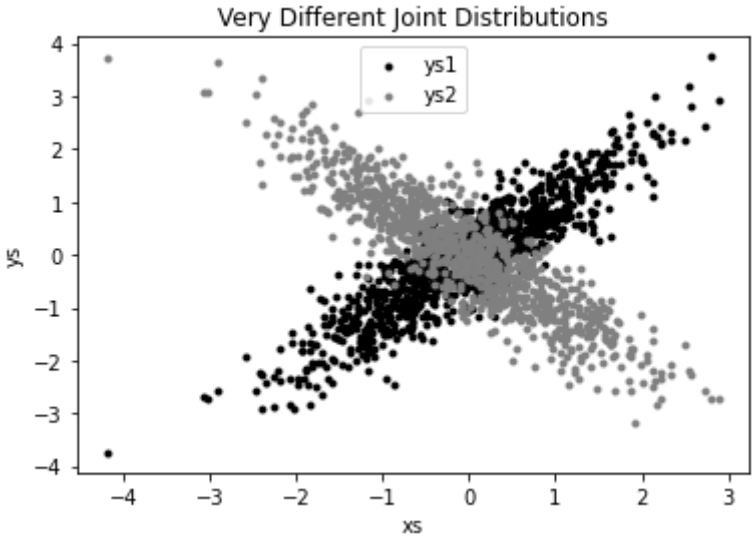
```
import random
from collections import Counter
import matplotlib.pyplot as plt
import math

def inverse_normal_cdf(p, mu=0, sigma=1, tolerance=0.00001):
    if mu != 0 or sigma != 1:
        return mu + sigma * inverse_normal_cdf(p, tolerance=tolerance)
    low_z, low_p = -10.0, 0
    hi_z, hi_p = 10.0, 1
    while hi_z - low_z > tolerance:
        mid_z = (low_z + hi_z) / 2
        mid_p = normal_cdf(mid_z)
        if mid_p < p:
            low_z, low_p = mid_z, mid_p
        elif mid_p > p:
            hi_z, hi_p = mid_z, mid_p
        else:
            break
    return mid_z

def normal_cdf(x, mu=0, sigma=1):
    return (1 + math.erf((x - mu) / math.sqrt(2) / sigma)) / 2

def bucketize(point, bucket_size):
    return bucket_size * math.floor(point / bucket_size)

def make_histogram(points, bucket_size):
    return Counter(bucketize(point, bucket_size) for point in points)

def plot_histogram(points, bucket_size, title=""):
    histogram = make_histogram(points, bucket_size)
    plt.bar(histogram.keys(), histogram.values(), width=bucket_size)
    plt.title(title)
    plt.show()

random.seed(0)
uniform = [200 * random.random() - 100 for _ in range(10000)]
normal = [57 * inverse_normal_cdf(random.random()) for _ in range(10000)]

plot_histogram(uniform, 10, "Uniform Histogram")
plot_histogram(normal, 10, "Normal Histogram")
```





In [2]:

```
import matplotlib.pyplot as plt
import random
import math
from collections import Counter

def inverse_normal_cdf(p, mu=0, sigma=1, tolerance=0.00001):
    if mu != 0 or sigma != 1:
        return mu + sigma * inverse_normal_cdf(p, tolerance=tolerance)
    low_z, low_p = -10.0, 0
    hi_z, hi_p = 10.0, 1
    while hi_z - low_z > tolerance:
        mid_z = (low_z + hi_z) / 2
        mid_p = normal_cdf(mid_z)
        if mid_p < p:
            low_z, low_p = mid_z, mid_p
        elif mid_p > p:
            hi_z, hi_p = mid_z, mid_p
        else:
            break
    return mid_z

def normal_cdf(x, mu=0, sigma=1):
    return (1 + math.erf((x - mu) / math.sqrt(2) / sigma)) / 2

def random_normal():
    return inverse_normal_cdf(random.random())

xs = [random_normal() for _ in range(1000)]
ys1 = [x + random_normal() / 2 for x in xs]
ys2 = [-x + random_normal() / 2 for x in xs]

plt.scatter(xs, ys1, marker='.', color='black', label='ys1')
plt.scatter(xs, ys2, marker='.', color='gray', label='ys2')
plt.xlabel('xs')
plt.ylabel('ys')
plt.legend(loc=9)
plt.title("Very Different Joint Distributions")
plt.show()
```


Very Different Joint Distributions
ys1
ys2
ys
xs
4
3
2
1
0
−1
−2
−3
−4
−4
−3
−2
−1
0
1
2
3

In [ ]: