assignment06

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Mathematical Foundations for Computer Vision and Machine Learning
Assignment06 - Straight-line fit (least square approximate solution)
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Link to Github

1 Setting up

To calculate least square approximation, we need data.

Variable `num` means the number of data Variable `y1` is noisy data and `y2` is clean data.

Noisy data is displayed as **blue dots** and **clean** data is displayed as **black dots**.

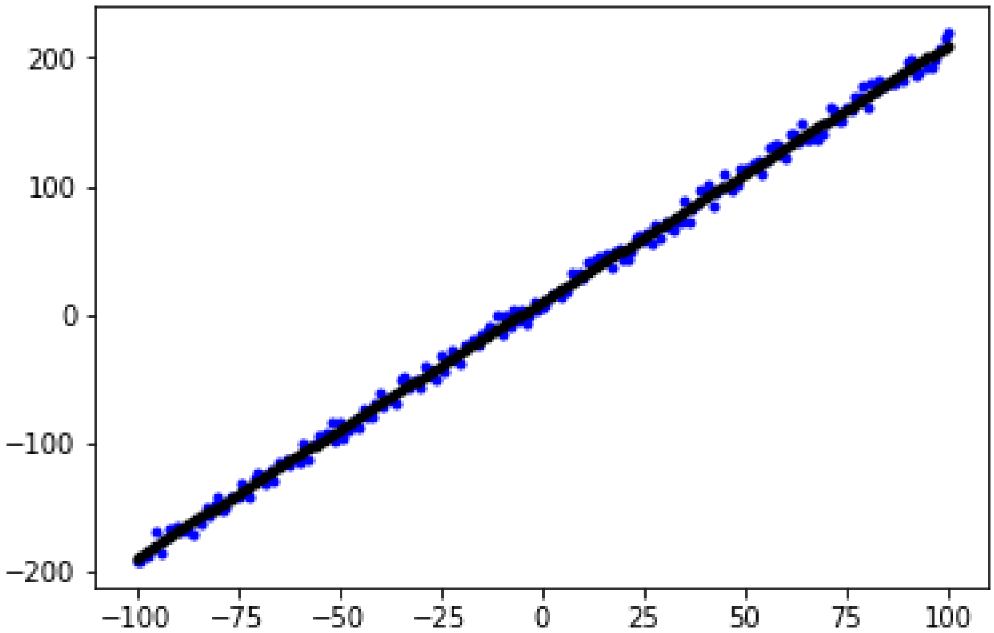
In [2]:
```
import numpy as np
import matplotlib.pyplot as plt

num      = 201
std      = 20
a        = 2
b        = 10

n        = np.random.rand(num)
nn       = n - np.mean(n)
x        = np.linspace(-100,100,num)
y1       = a * x + nn * std + b
y2       = a * x + b


# x  : x-coordinate data
# y1 : (noisy) y-coordinate data
# y2 : (clean) y-coordinate data
# y = f(x) = a * x + b

plt.plot(x,y1,'b.')
plt.plot(x,y2,'k.')
plt.show()
```



2 To Calculate Least Square

We use matrix multiplication to calculate least square.

$$ax_1 + b = y_1$$
$$ax_2 + b = y_2$$
$$ax_3 + b = y_3$$
$$\vdots$$
$$ax_n + b = y_n$$

We can write this as matmul.

$$\begin{pmatrix} x_1 & 1 \\ \vdots & \vdots \\ x_n & 1 \end{pmatrix} \begin{pmatrix} a \\ b \end{pmatrix} = \begin{pmatrix} y_1 \\ \vdots \\ y_n \end{pmatrix}$$

We can rewrite this as

$$A\theta = B$$

```
In [3]: A = np.matrix(np.transpose([x,np.ones(num)]))
        B = np.matrix(y1)
```

3 Pseudo Inverse

We can derive x from equation above by pseudo inverse.

$$\theta = \left(A^T A\right)^{-1} A^T B$$

In [4]:
```
theta = (A.T * A).I*A.T*B.T
theta = np.asarray(theta)
```

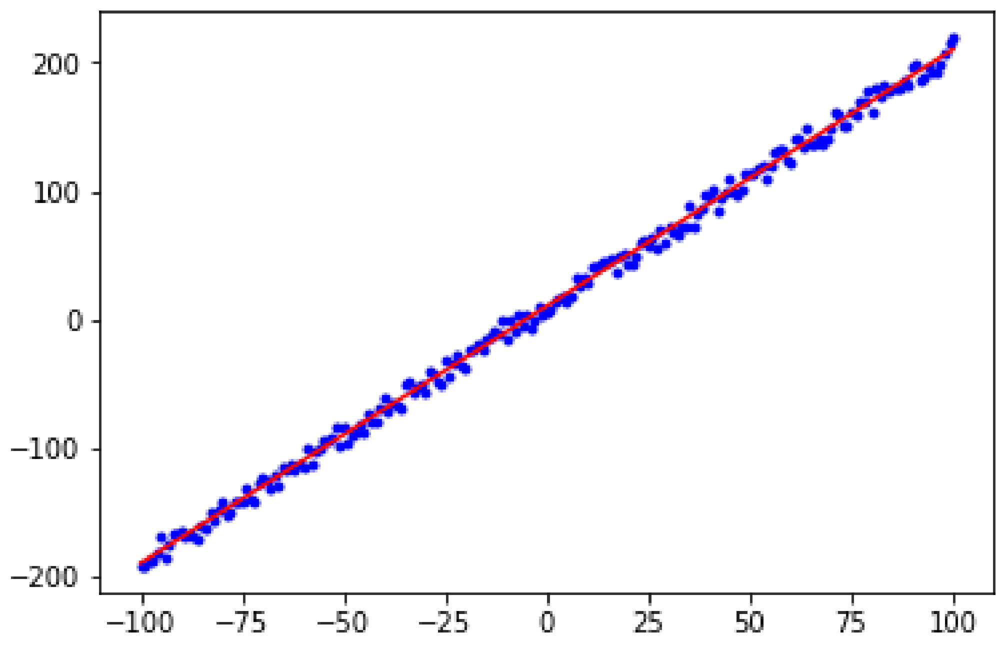
4 Approximation

$$\hat{f}(x) = \theta_1 x + \theta_2$$

The red one is the line that fits the noisy data(blue) by the least square error.

In [5]:
```
apporx  = theta[0][0] * x + theta[1][0]
plt.plot(x,y1,'b.')
plt.plot(x, apporx, 'r')

plt.show()
```



5 Compare with answer

We can see that the answer(y2, blue) and approximation is quite same.

In [6]:
```
plt.plot(x,y2,'b')
plt.plot(x, apporx, 'r')
plt.show()
```