Assignment 8

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GitHub : https://github.com/ORION-22/RegexSoftware_ASSIGNMENT.git

Linear Regression with Gradient Descent

Gradient descent algorithm

$$\theta^+ = \theta^- + \alpha m_{(y_i - h(x_i))}{}^- x$$

This minimizes the following cost function

$$J(x, \theta, y) = \frac{1}{2m} m \sum i{=}1 (h(x_i) - y_i)^2$$

where $h(x_i) = \theta^T {}^- x$

## Batch gradient descent

```
FOR j FROM 0 -> max_iteration:
    FOR i FROM 0 -> m:
        theta += (alpha / m) * (y[i] - h(x[i])) * x_bar
    ENDLOOP
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```

In [1]:
```python
import numpy as np
import matplotlib.pyplot as plt
```

In [2]:
```python
"""Generate data"""
true_slope = 10.889
true_intercept = 3.456
input_var = np.arange(0.0,100.0)
output_var = true_slope * input_var + true_intercept + 500.0 * np.random.rand(len(input_var))
```

In [4]:
```python
%matplotlib notebook
plt.figure()
plt.scatter(input_var, output_var)
plt.xlabel('x')
plt.ylabel('y')
plt.show()
```
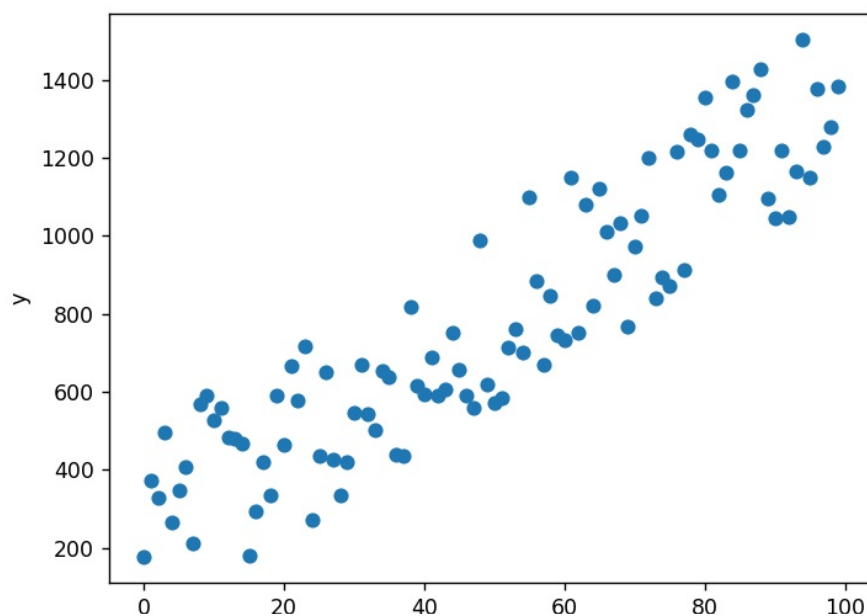
In [5]:
```python
def compute_cost(input_var, output_var, params):
    "Compute linear regression cost"
    num_samples = len(input_var)
    cost_sum = 0.0
    for x,y in zip(input_var, output_var):
        y_hat = np.dot(params, np.array([1.0, x]))
        cost_sum += (y_hat - y) ** 2

    cost = cost_sum / (num_samples * 2.0)

    return cost
```

In [14]:
```python
def lin_reg_batch_gradient_descent(input_var, output_var, params, alpha, max_iter):
    """Compute the params for linear regression using batch gradient descent"""
    iteration = 0
    num_samples = len(input_var)
    cost = np.zeros(max_iter)
    params_store = np.zeros([2, max_iter])

    while iteration < max_iter:
        cost[iteration] = compute_cost(input_var, output_var, params)
        params_store[:, iteration] = params

        print('\n')
        print(f'iteration: {iteration}')
        print(f'cost: {cost[iteration]}')

        for x,y in zip(input_var, output_var):
            y_hat = np.dot(params, np.array([1.0, x]))
            gradient = np.array([1.0, x]) * (y - y_hat)
            params += alpha * gradient/num_samples

        iteration += 1

    return params, cost, params_store
```

In [15]:
```python
"""Train the model"""
from sklearn.model_selection import train_test_split
x_train, x_test, y_train, y_test = train_test_split(input_var, output_var, test_size=0.20)

params_0 = np.array([20.0, 80.0])

alpha_batch = 1e-3
max_iter = 500
params_hat_batch, cost_batch, params_store_batch =\
    lin_reg_batch_gradient_descent(x_train, y_train, params_0, alpha_batch, max_iter)
```

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iteration: 0
cost: 7285077.137129135


iteration: 1
cost: 26172.17175506378


iteration: 2
cost: 18699.136047629923


iteration: 3
cost: 18664.83551568936


iteration: 4
cost: 18659.776341441087


iteration: 5
cost: 18655.426158603652


iteration: 6
cost: 18651.099479402073


iteration: 7
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cost: 18646.77563383206


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cost: 18642.453992668205


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cost: 18638.13453571693


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cost: 17152.27058123518

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cost: 17148.704302342932

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cost: 17028.51773565033


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iteration: 497
cost: 16770.595961548755


iteration: 498
cost: 16767.222673370045


iteration: 499
cost: 16763.851091037453
```
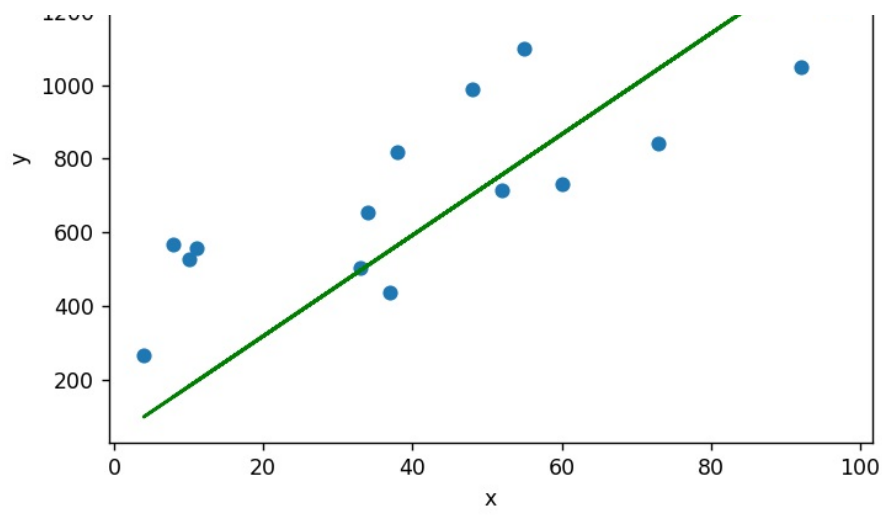
In [12]:

```python
plt.figure()
plt.scatter(x_test, y_test)
plt.plot(x_test, params_hat_batch[0] + params_hat_batch[1]*x_test, 'g', label='batch')
plt.xlabel('x')
plt.ylabel('y')
plt.legend()
plt.show()
print(f'batch      T0, T1: {params_hat_batch[0]}, {params_hat_batch[1]}')
rms_batch = np.sqrt(np.mean(np.square(params_hat_batch[0] + params_hat_batch[1]*x_test - y_test)))
print(f'batch rms:      {rms_batch}')
```

```
batch      T0, T1: 45.724476210337706, 13.677535202151057
batch rms:       223.62194768882088
```

In [ ]: