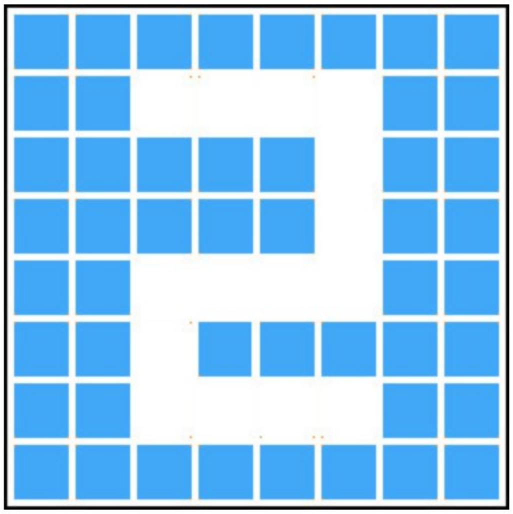


Pocket Algorith MNIST Data Set

in JULIA

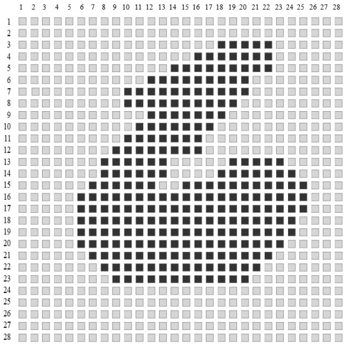
```
In [11]: using MLDatasets, Images, TestImages                   # using MNIST data set and
         images
```

```
In [12]: train_x, train_y = MNIST.traindata()
         test_x, test_y = MNIST.testdata();
```

Each MNIST image has a size of 28*28 = 784 pixels. Each pixel for simplicity is treated as being off or on, see image of the six. The black pixel are on and the outliers are off.

```
In [13]: size(train_x)

Out[13]: (28, 28, 60000)
```



```
In [14]: size(train_y)

Out[14]: (60000,)
```

```
In [15]: size(train_x[:,:,1])

Out[15]: (28, 28)
```

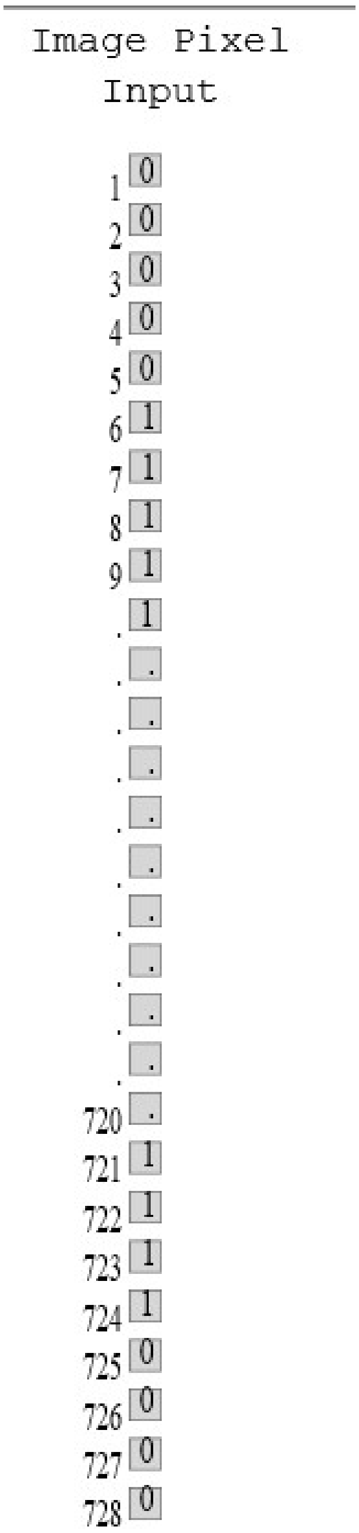
In [16]:

```
X = [reshape(train_x[:,:,i], 784, 1) for i = 1:60000]
size(X)
```

Out[16]:

```
(60000,)
```

The pixels are trained and reshaped into a vector, sort of like a train and fit into the algorithm one at a time, As the image below depicts:



In [17]:

```
size(reshape(train_x[:,:,1], 784, 1))
```

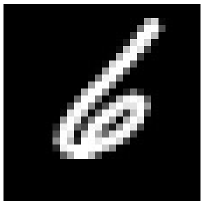
Out[17]:

```
(784, 1)
```

In [71]:

```
colorview(Gray, train_x[:, :, 1000]')
```

Out[71]:



In [37]:

```
train_y[1000]
```

Out[37]:

```
6
```

In [72]:

```
pocket_train_x = []
pocket_train_y = []
indices = []
for i = 1:6000
    if train_y[i] == 1 || train_y[i] == 6
        push!(pocket_train_x, reshape(train_x[:,:,i], 784))
        push!(pocket_train_y,  train_y[i] == 1 ? 1 : -1)
    end
end
```

In [73]:

```
size(pocket_train_x[1])
```

Out[73]:

```
(784,)
```

In [74]:

```
w = rand(785)

function sign(w, x)
    x = push!(copy(x), 1.0)
    return w'x > 0 ? 1 : -1
end


function errors(w)
    return sum([sign(w, pocket_train_x[i]) != pocket_train_y[i] ? 1 : 0
            for i = 1:size(pocket_train_x)[1]])

end
```

Out[74]:

```
errors (generic function with 1 method)
```

In [75]:
```
function pocket_algorithm(w, T)
    w_hat = copy(w)
    for i = 1:T
        for j = 1:size(pocket_train_x)[1]
            #println(size(pocket_train_x[j]))
            if sign(w, pocket_train_x[j]) != pocket_train_y[j]
                w += pocket_train_y[j] * push!(copy(pocket_train_x[j]),1.0)
                if errors(w) < errors(w_hat)
                    w_hat = copy(w)
                end
            end
        end
    end
    return w_hat
end
```

Out[75]:
```
pocket_algorithm (generic function with 1 method)
```

In [76]:
```
errors(w)
```

Out[76]:
```
608
```

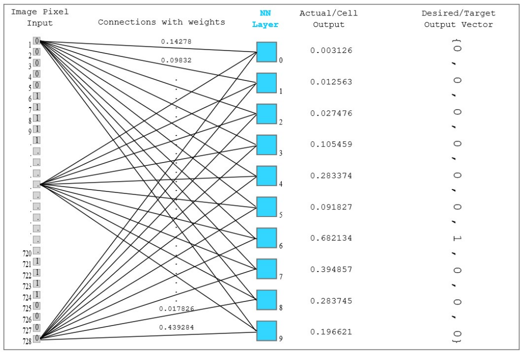
In [77]:
```
w = rand(785)
w_new = pocket_algorithm(w,10)
```

Out[77]:
```
785-element Array{Float64,1}:
 0.4762957604796676
 0.1793182916339744
 0.9152912177678387
 0.7977217950700719
 0.3186685500674138
 0.7991682537162019
 0.9090848967908594
 0.8867815382568762
 0.06238755686357722
 0.5082780523482675
 0.8591320982788055
 0.4494000289649167
 0.8451086896198747
 ⋮
 0.37950383231021867
 0.6564283365400052
 0.8968721171268912
 0.535873205109441
 0.28825116759512137
 0.024794788700200687
 0.021097769013332934
 0.6931821818596018
 0.10542477315560417
 0.2969884479232634
 0.07645896904947502
 0.6627946228631902
```

In [85]:
```
sign(w_new, pocket_train_x[6])
```

Out[85]:
```
-1
```

Our desired output is depicted below:



In [87]:

```
function check_value(i)
    println("The predicted value is")
    println(sign(w_new, reshape(test_x[:,:,indices[i][1]], 784)) == 1 ? 1 : 5)
    colorview(Gray, test_x[:,:,indices[i][1]]')
end
#[reshape(train_x[:,:,i], 784, 1) for i = 1:60000]
```

Out[87]:

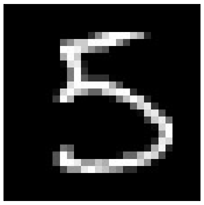
```
check_value (generic function with 1 method)
```

In [88]:

```
check_value(5)
```

```
The predicted value is
1
```

Out[88]:



```
In [89]: indices
```

```
Out[89]: 2027-element Array{Any,1}:
          (3, 1)
          (6, 1)
          (9, 5)
          (15, 1)
          (16, 5)
          (24, 5)
          (30, 1)
          (32, 1)
          (38, 1)
          (40, 1)
          (41, 1)
          (46, 5)
          (47, 1)
          ⋮
          (9947, 1)
          (9951, 1)
          (9956, 1)
          (9957, 1)
          (9970, 1)
          (9971, 5)
          (9979, 1)
          (9983, 5)
          (9985, 1)
          (9989, 5)
          (9995, 1)
          (9999, 5)
```

```
In [90]: indices = []
         for i in 1:size(test_y)[1]
             if test_y[i] == 1 || test_y[i] == 5
                 push!(indices, (i,test_y[i]))
             end
         end
```

```
In [91]: println("The predicted value is")
         println(sign(w_new, reshape(test_x[:,:,3], 784)) == 1 ? 1 : 5)
         colorview(Gray, test_x[:,:,3]')
```

```
The predicted value is
1
```

Out[91]: