Activation functions

Puteaux, Fall/Winter 2020-2021

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################################
##                            ##
##  Deep Learning in Python   ##
##                            ##
################################
```

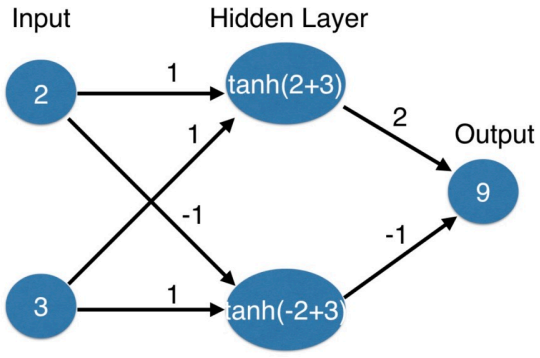
```
§1 Introduction to Deep Learning in Python
```

```
§1.1 Basics of deep learning and neural networks
```

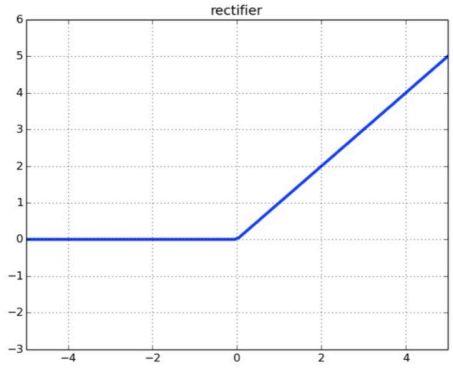
1 Activation functions

1.1 How do activation functions work?

It is applied to node inputs to produce node output.



1.2 What is the rectified linear activation (ReLU)?



$$RELU(x) = \begin{cases} 0 & if \quad x < 0 \\ x & if \quad x \geq 0 \end{cases}$$

1.3 Code of activation functions:

[1]:
```
import numpy as np

input_data = np.array([-1, 2])
weights = {
    'node_0': np.array([3, 3]),
    'node_1': np.array([1, 5]),
    'output': np.array([2, -1])
}
node_0_input = (input_data * weights['node_0']).sum()
node_0_output = np.tanh(node_0_input)
node_1_input = (input_data * weights['node_1']).sum()
node_1_output = np.tanh(node_1_input)
hidden_layer_outputs = np.array([node_0_output, node_1_output])
output = (hidden_layer_outputs * weights['output']).sum()

print(output)
```

```
0.9901095378334199
```

1.4 Practice exercises for activation functions:

▶ Package pre-loading:

[2]:
```
import numpy as np
```

▶ Data pre-loading:

[3]:
```
input_data = np.array([3, 5])

weights = {
```

```
    'node_0': np.array([2, 4]),
    'node_1': np.array([4, -5]),
    'output': np.array([2, 7])
}
```

▶ **The rectified linear activation function practice:**

[4]:
```
def relu(input):
    '''Define your relu activation function here'''
    # Calculate the value for the output of the relu function: output
    output = max(0, input)

    # Return the value just calculated
    return (output)


# Calculate node 0 value: node_0_output
node_0_input = (input_data * weights['node_0']).sum()
node_0_output = relu(node_0_input)

# Calculate node 1 value: node_1_output
node_1_input = (input_data * weights['node_1']).sum()
node_1_output = relu(node_1_input)

# Put node values into array: hidden_layer_outputs
hidden_layer_outputs = np.array([node_0_output, node_1_output])

# Calculate model output (do not apply relu)
model_output = (hidden_layer_outputs * weights['output']).sum()

# Print model output
print(model_output)
```

```
52
```

▶ **Data re-pre-loading:**

[5]:
```
input_data = [
    np.array([3, 5]),
    np.array([1, -1]),
    np.array([0, 0]),
    np.array([8, 4])
]
```

▶ **Network to many observations/rows of data applying practice:**

[6]:
```
# Define predict_with_network()
def predict_with_network(input_data_row, weights):
```

```
    # Calculate node 0 value
    node_0_input = (input_data_row * weights['node_0']).sum()
    node_0_output = relu(node_0_input)

    # Calculate node 1 value
    node_1_input = (input_data_row * weights['node_1']).sum()
    node_1_output = relu(node_1_input)

    # Put node values into array: hidden_layer_outputs
    hidden_layer_outputs = np.array([node_0_output, node_1_output])

    # Calculate model output
    input_to_final_layer = (hidden_layer_outputs * weights['output']).sum()
    model_output = relu(input_to_final_layer)

    # Return model output
    return (model_output)


# Create empty list to store prediction results
results = []
for input_data_row in input_data:
    # Append prediction to results
    results.append(predict_with_network(input_data_row, weights))

# Print results
print(results)
```

```
[52, 63, 0, 148]
```