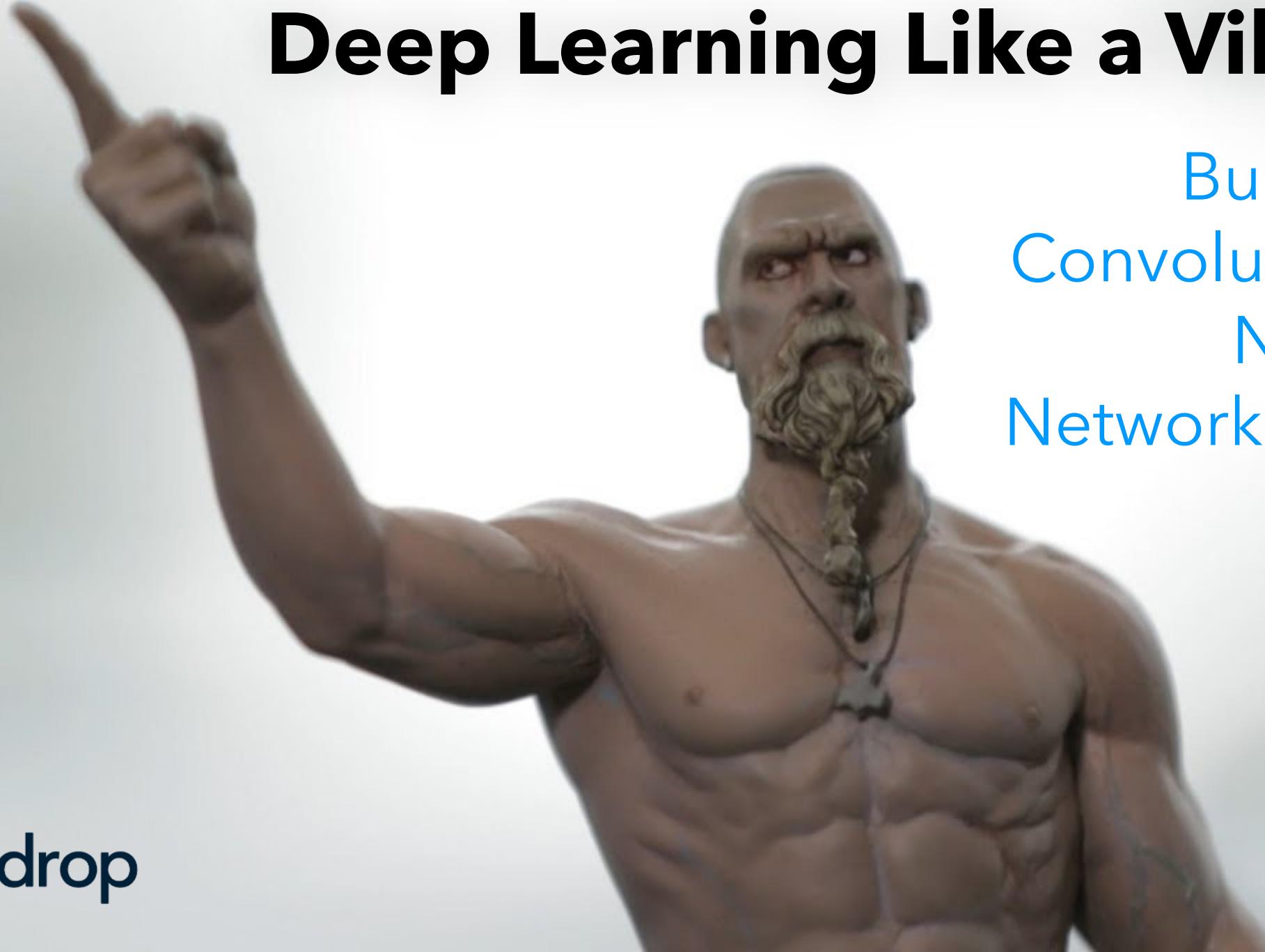


Deep Learning Like a Viking



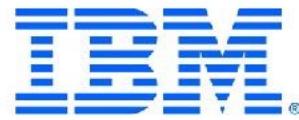
Building
Convolutional
Neural
Networks with
Keras

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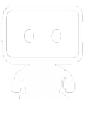
Guy Royse

Engineering Manager
ScriptDrop

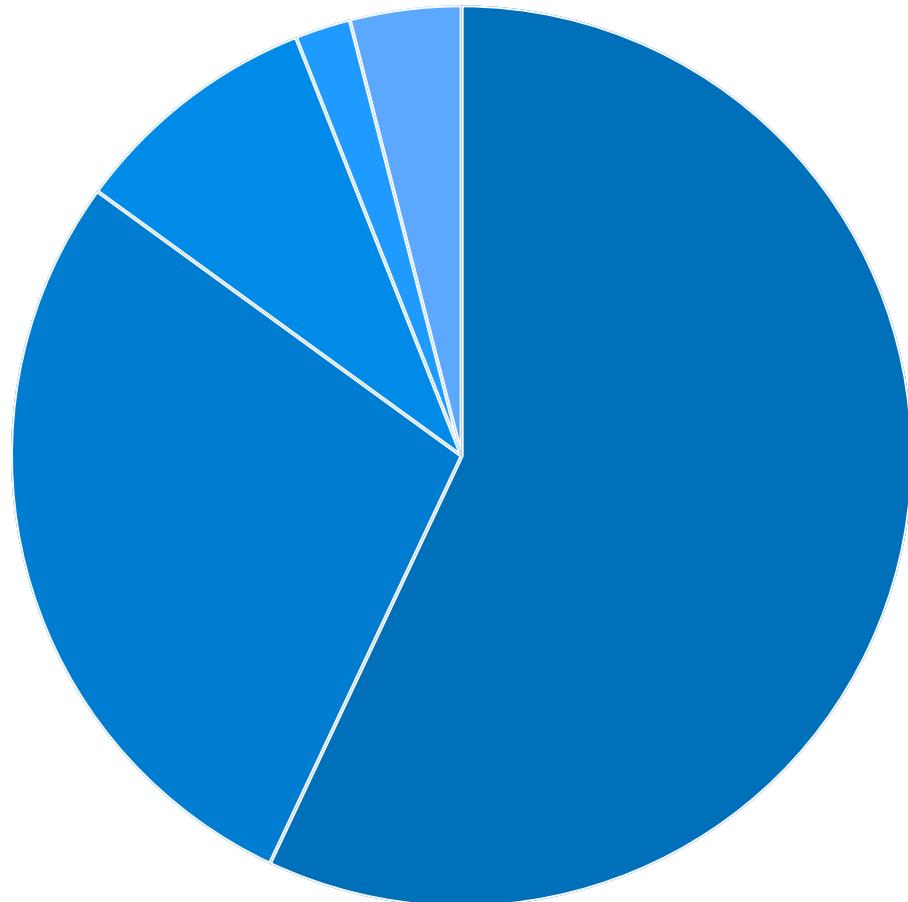
 guyroyse

 code.guy.dev

 guy.dev



IANADS



| | |
|----------------------|------|
| British Isles | 57% |
| German | 28% |
| Iberian | 9% |
| Uncertain | 4% |
| Scandinavian | 2% |
| Guy | 100% |



The Younger Futhark

| | | | | | | | | | | | | | | | | | |
|----|----|-------|----|-------|------|--------|--------|-----|----|-----|-----|-------|-------|------|----|---|---|
| ᚠ | ᚢ | ᚦ | ᚩ | ᚪ | ᚱ | ᚴ | * | ᚷ | ᛁ | ጀ | ጀ | ጀ | ጀ | ᛖ | ጀ | ጀ | ጀ |
| fe | ur | thurs | as | reith | kaun | hagall | nauthr | isa | ar | sol | tyr | bjork | mathr | logr | yr | | |

ᚠ ᚦ ᐃ ᚩ ᚪ ᚮ ᛑ ᚩ ᚰ ᐃ ᐃ ᛑ ᛑ ᛑ ᛑ ᛑ

(Kai Rais)



Lingsberg Runestones

Danr and Húskarl and Sveinn and Holmfríðr, the mother and (her) sons, had this stone erected in memory of Halfdan, the father of Danr and his brothers; and Holmfríðr in memory of her husbandman.

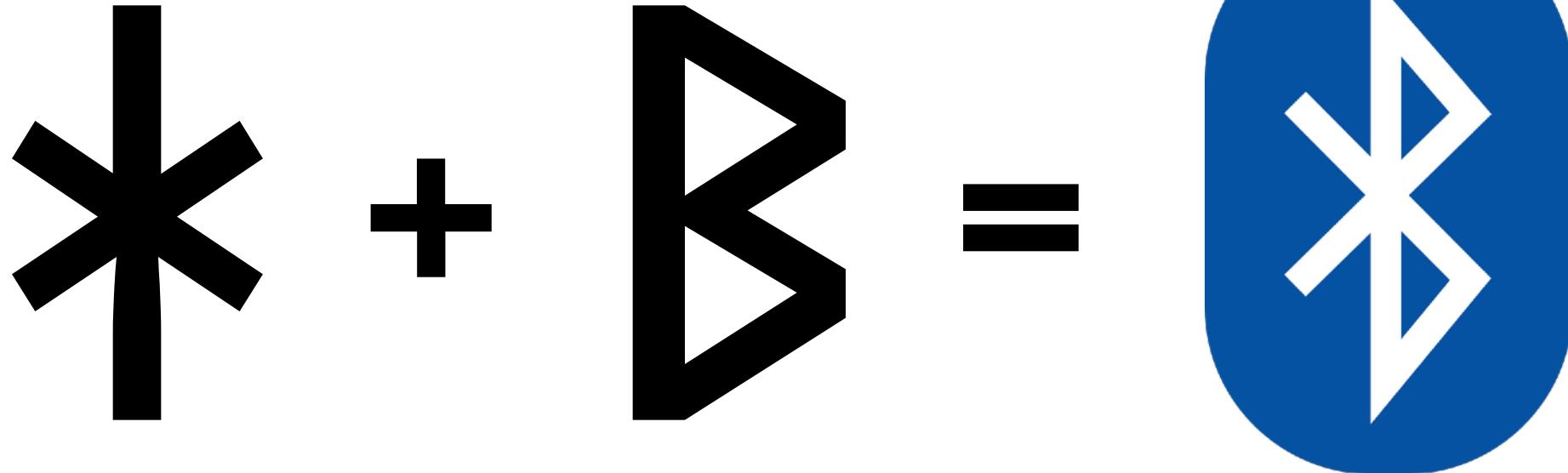


Lingsberg Runestones

Danr and Húskarl and Sveinn and
Holmfríðr, the mother and (her) sons, had
this stone erected in memory of Halfdan,
the father of Danr and his brothers; and
Holmfríðr in memory of her husbandman.



Harald Bluetooth





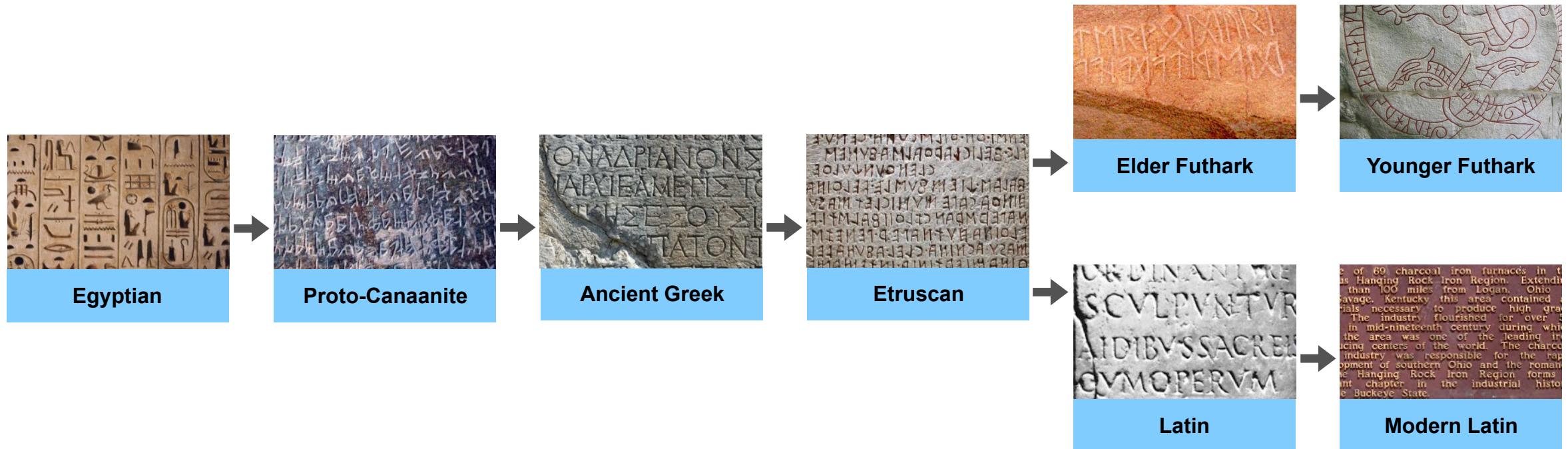
Younger Futhark vs. Latin & Greek

| | | | | | | | | | | | | | | | | | |
|----|----|-------|----|-------|------|--------|--------|-----|----|-----|-----|-------|-------|------|----|---|---|
| ᚠ | ᚢ | ᚦ | ᚩ | ᚦ | ᚱ | ᚴ | * | ᛖ | ᛁ | ᛚ | ᛏ | ᚷ | ᛏ | ᛖ | ᛗ | ᚱ | ᚲ |
| fe | ur | thurs | as | reith | kaun | hagall | nauthr | isa | ar | sol | tyr | bjork | mathr | logr | yr | | |

| | | | | | | | | | | | | | | | | | |
|---|---|---|--|---|--|--|---|--|---|---|---|--|---|--|--|--|--|
| F | U | | | R | | | I | | S | T | B | | L | | | | |
| | | ⊖ | | P | | | I | | Σ | T | B | | Λ | | | | |

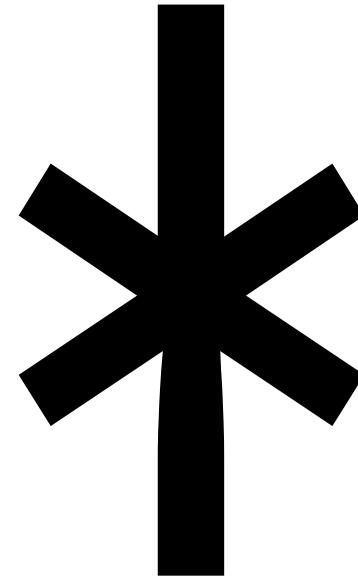
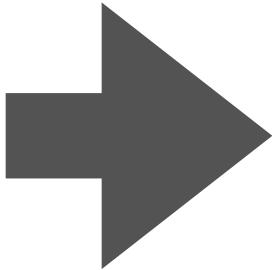


Common Ancestors



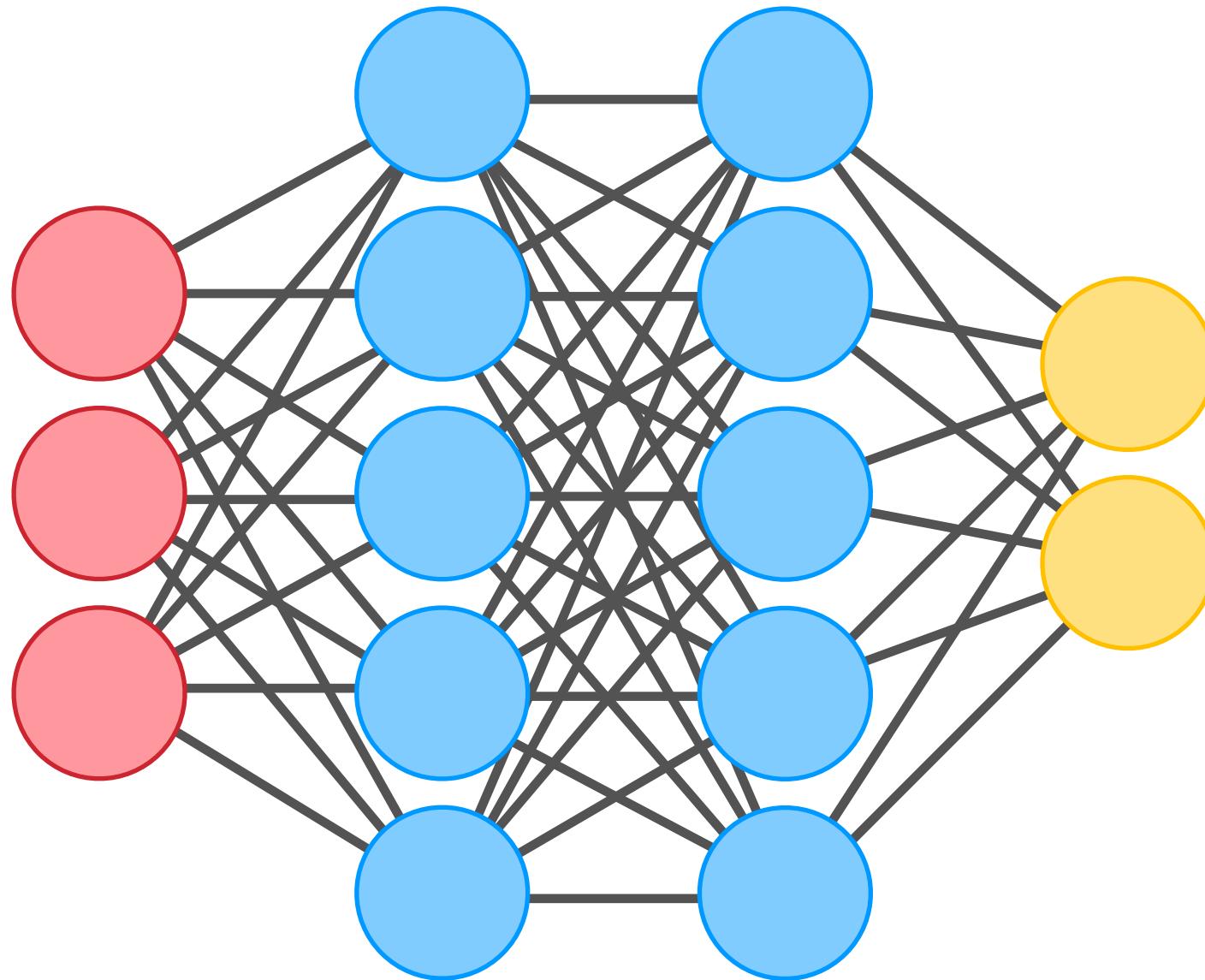


Recognizing Runes



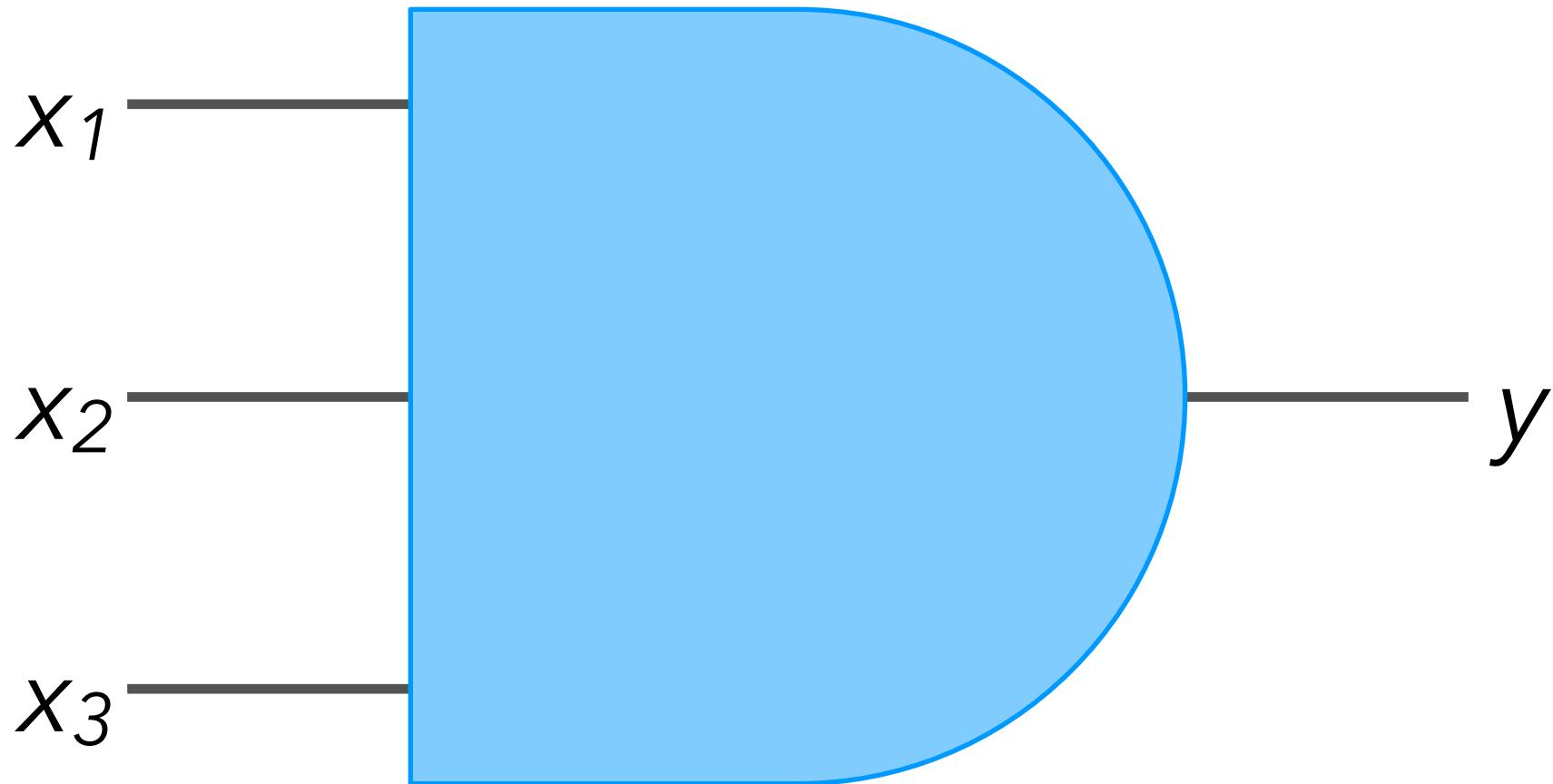


Neural Networks



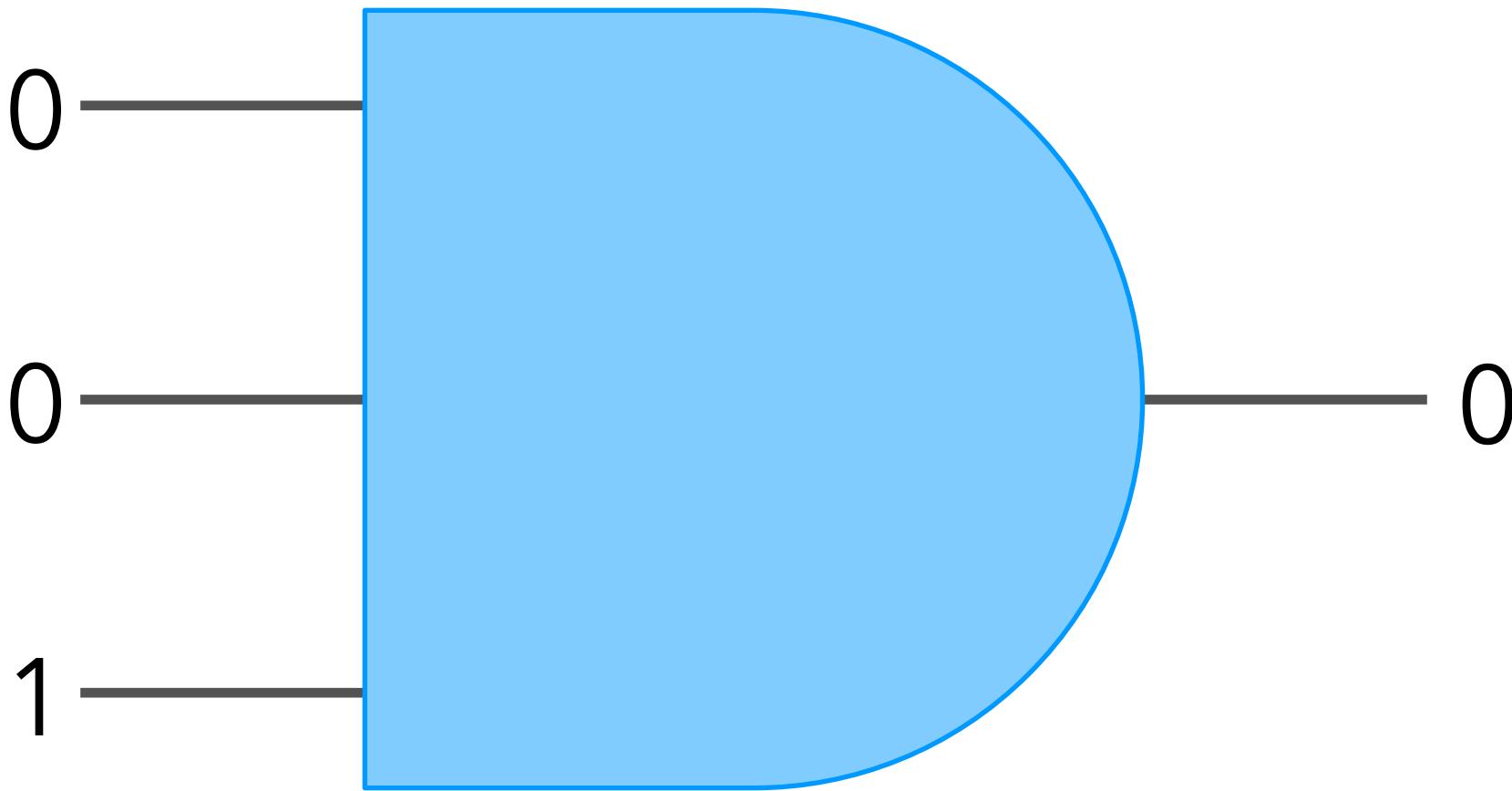


Logic Gates

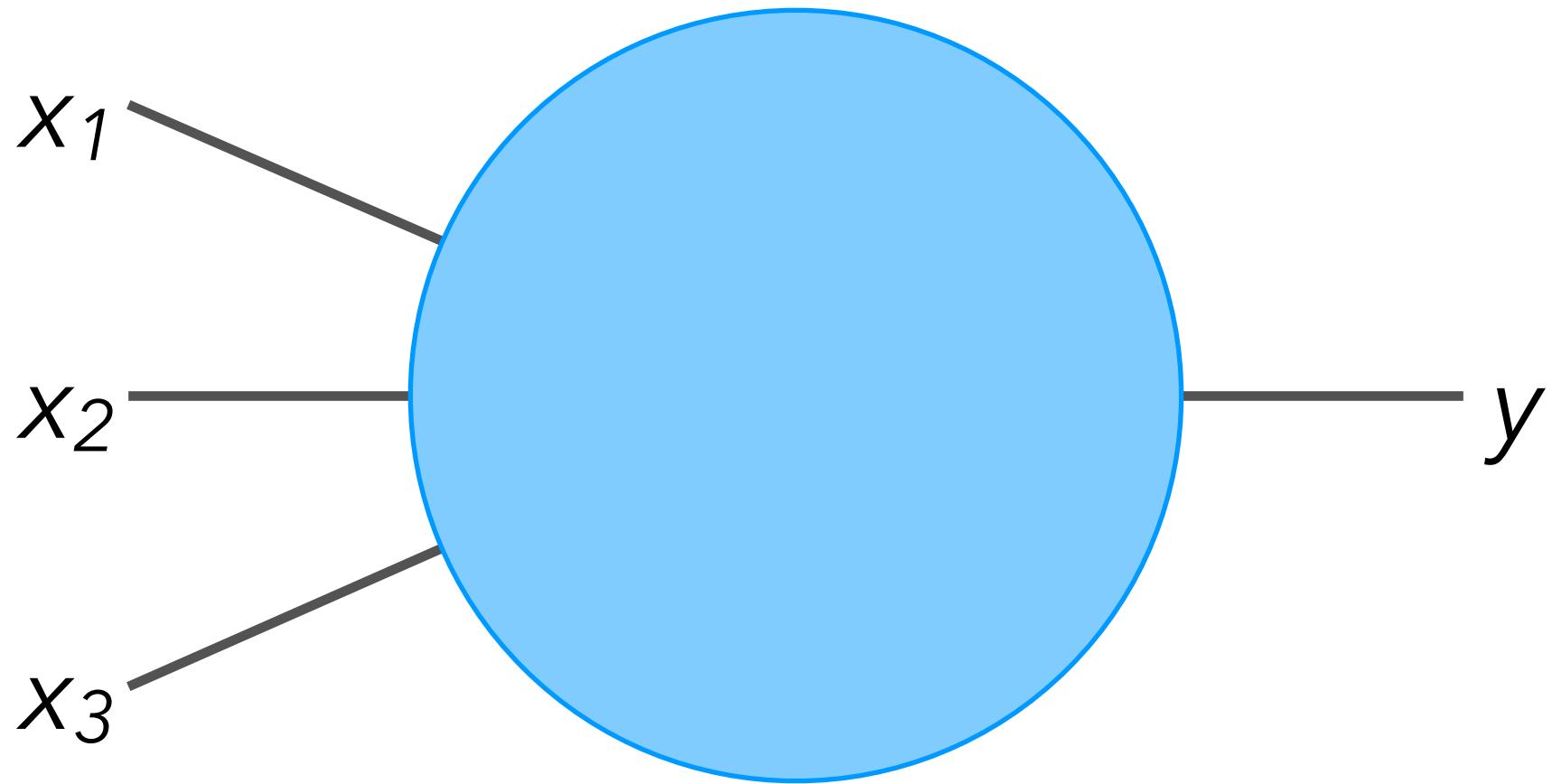




Logic Gates with Actual Numbers

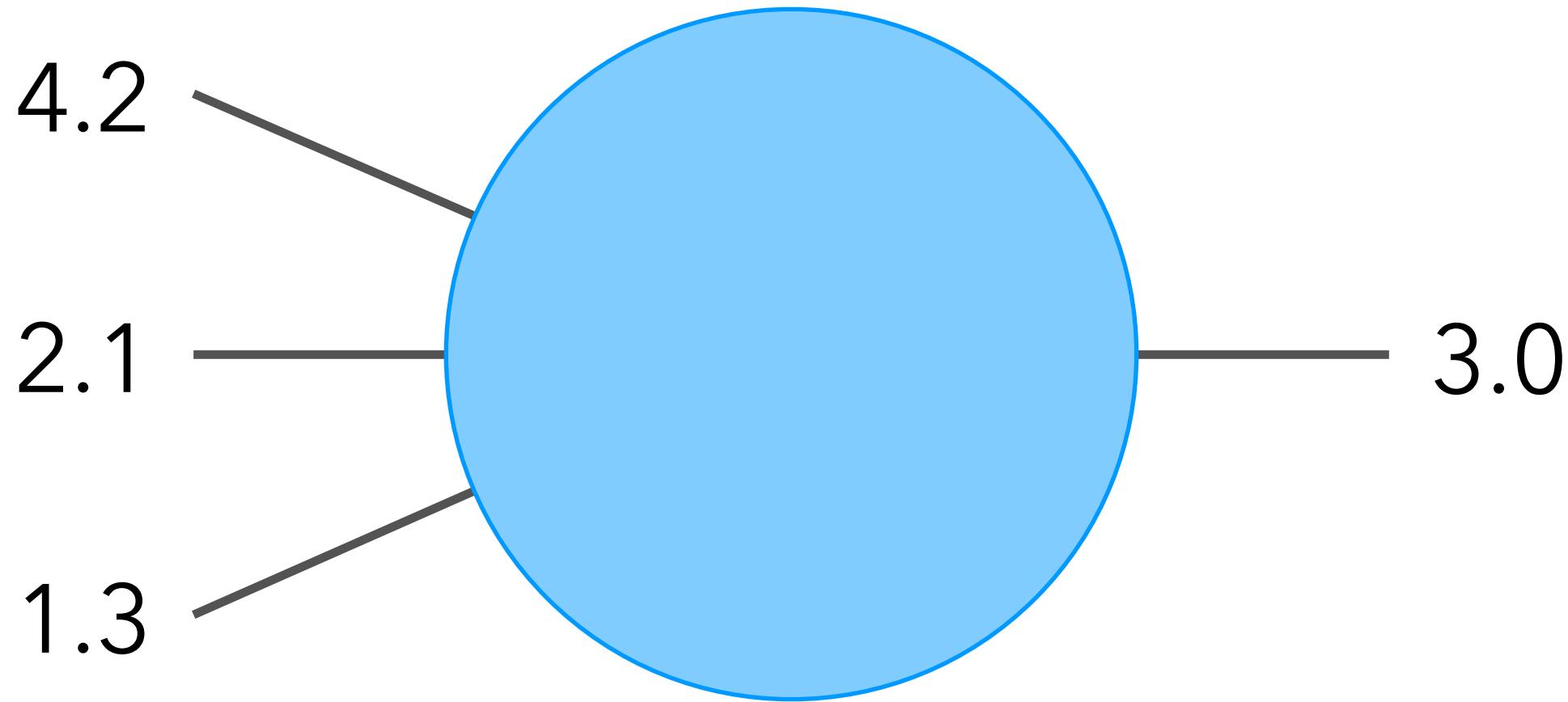


Neurons



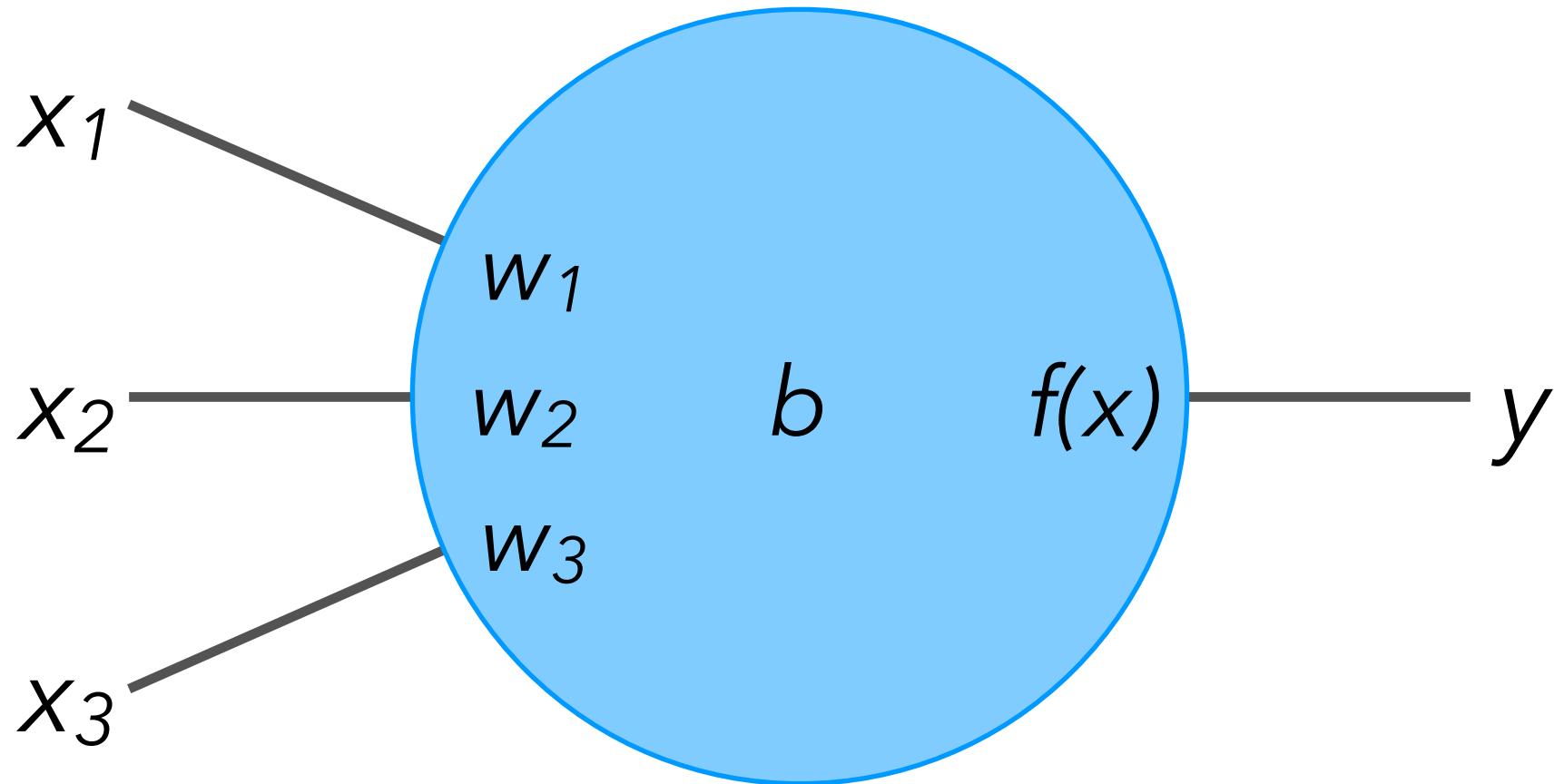


Neurons with Actual Numbers



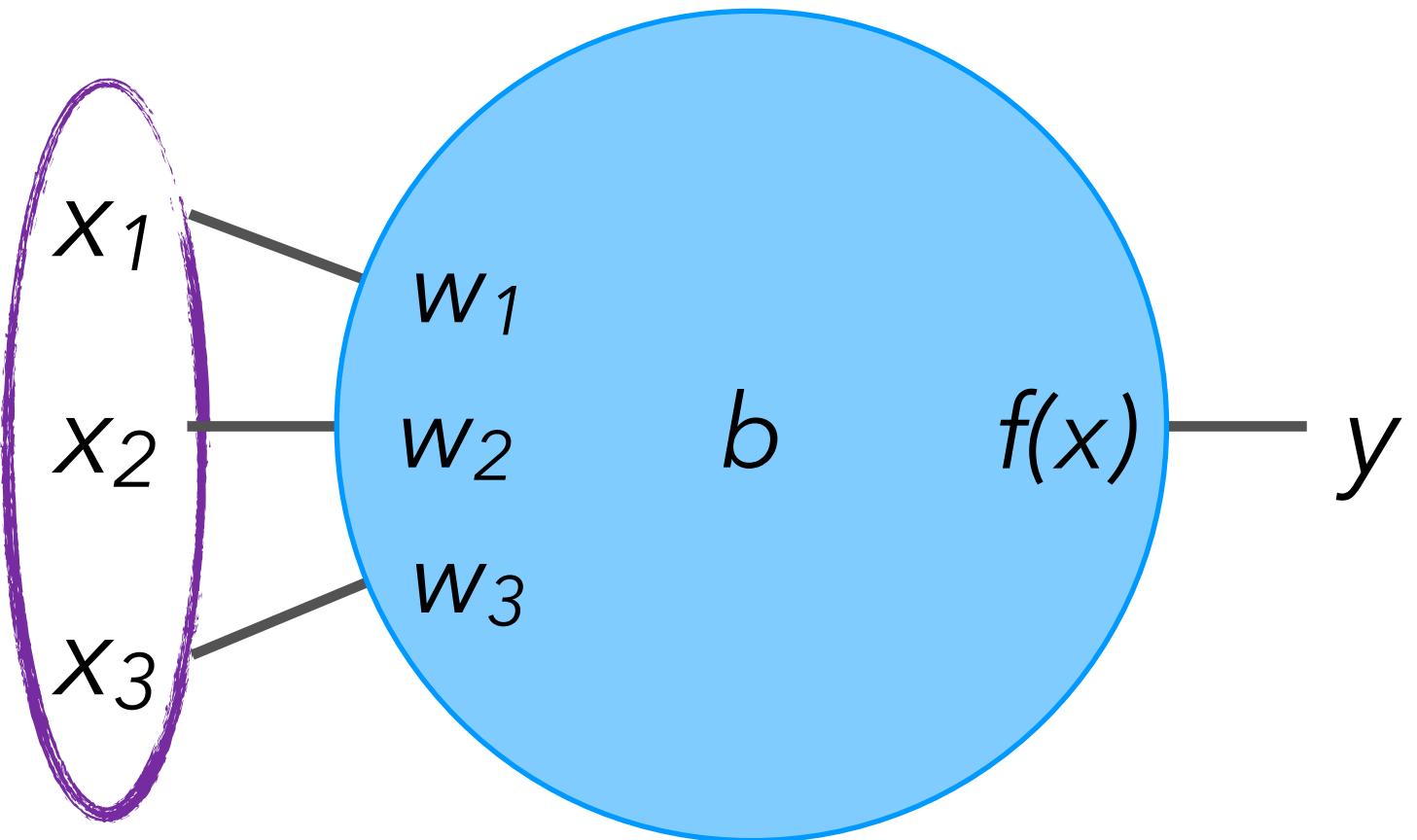


Inside a Neuron





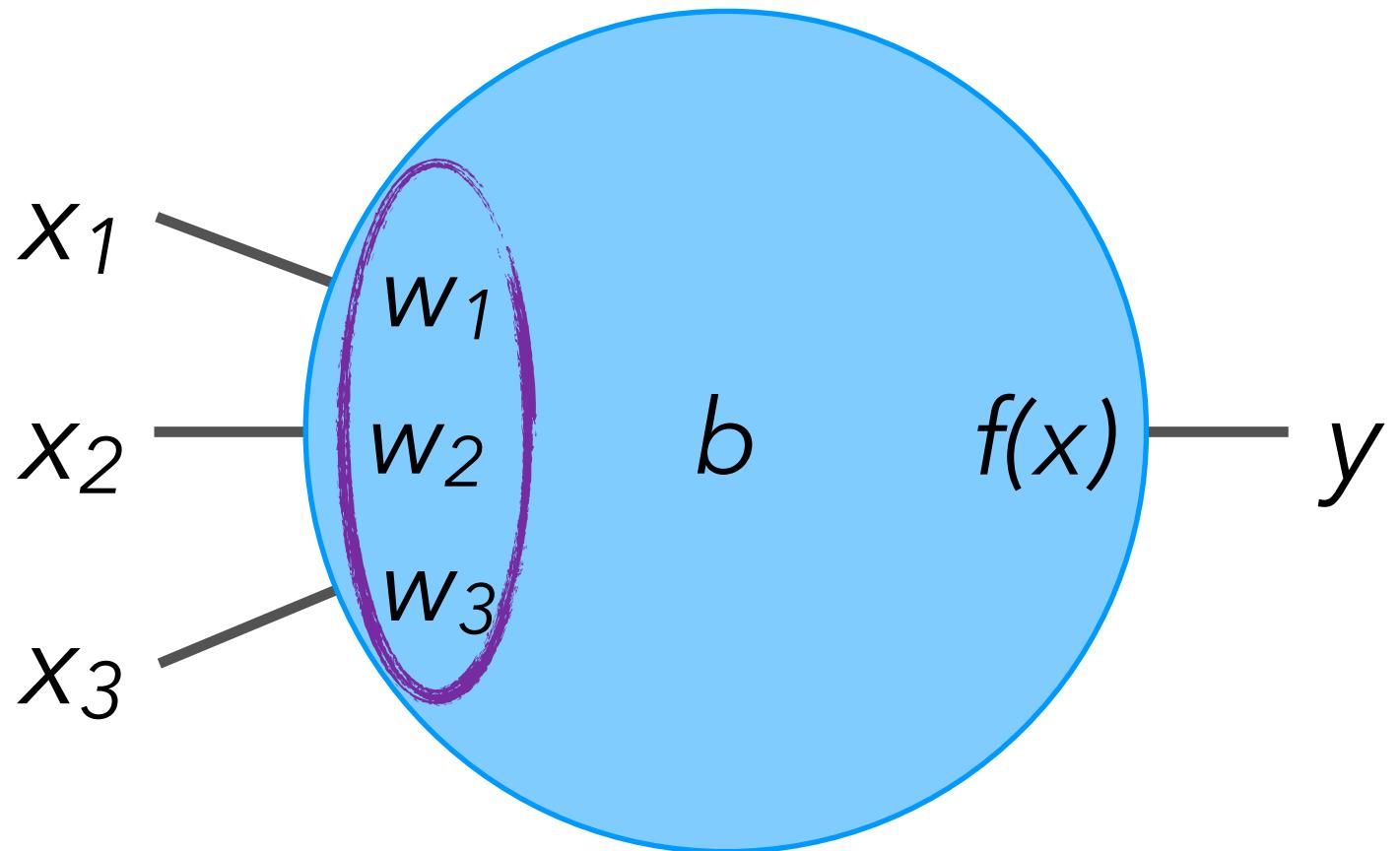
Inputs



The values coming into the neuron.



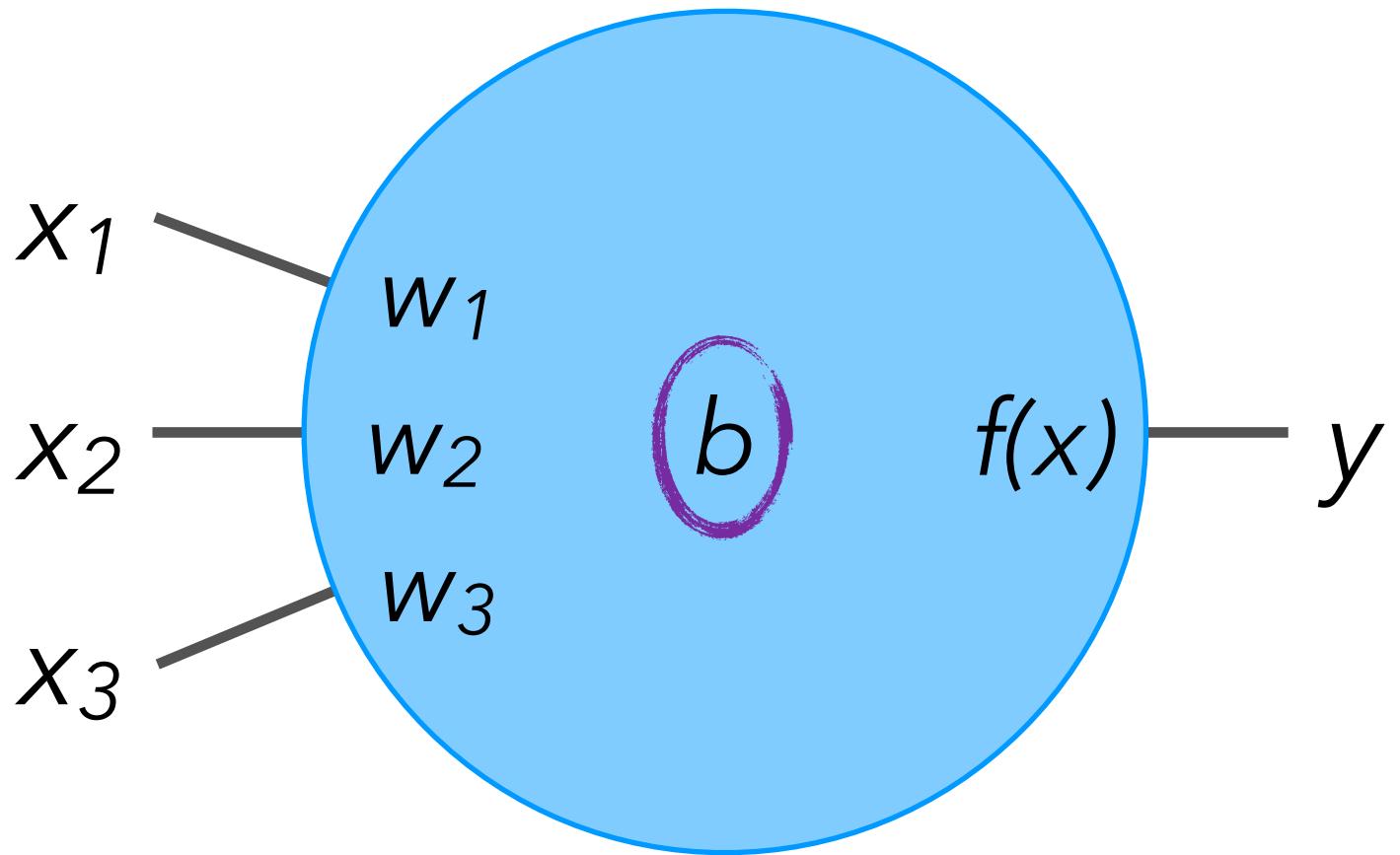
Weights



Makes an input more or less important.



Bias

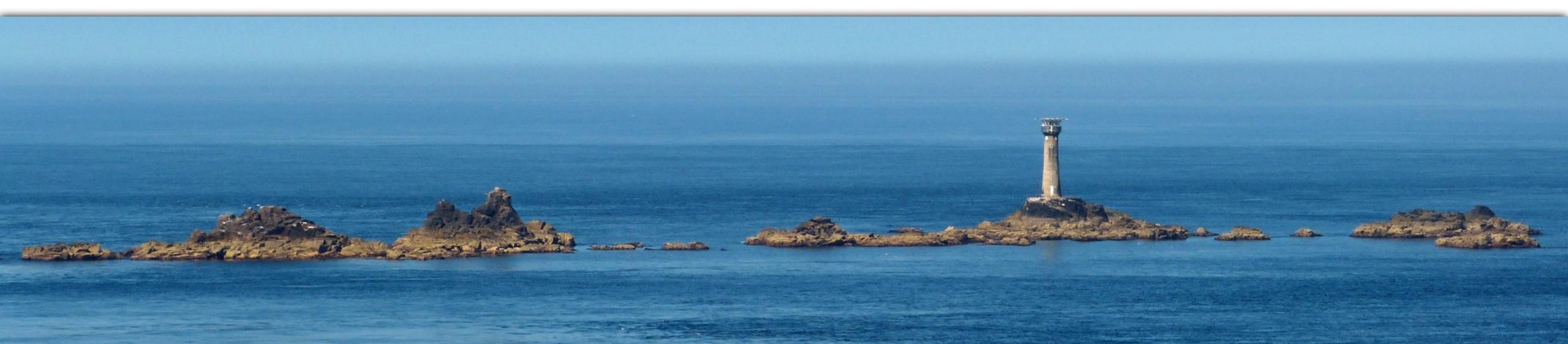


Makes the sum of the inputs more or less important.



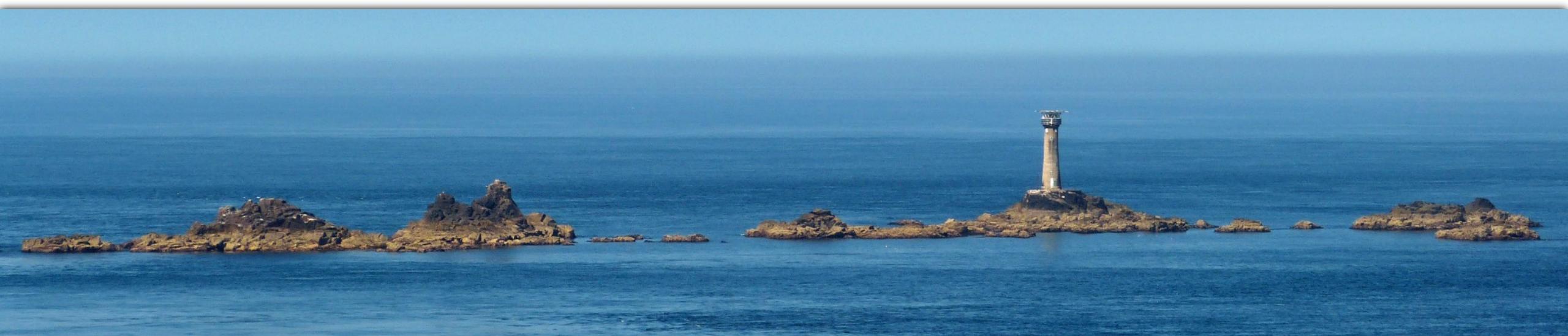
The Math So Far

$$X_1W_1 + X_2W_2 + X_3W_3 + b$$



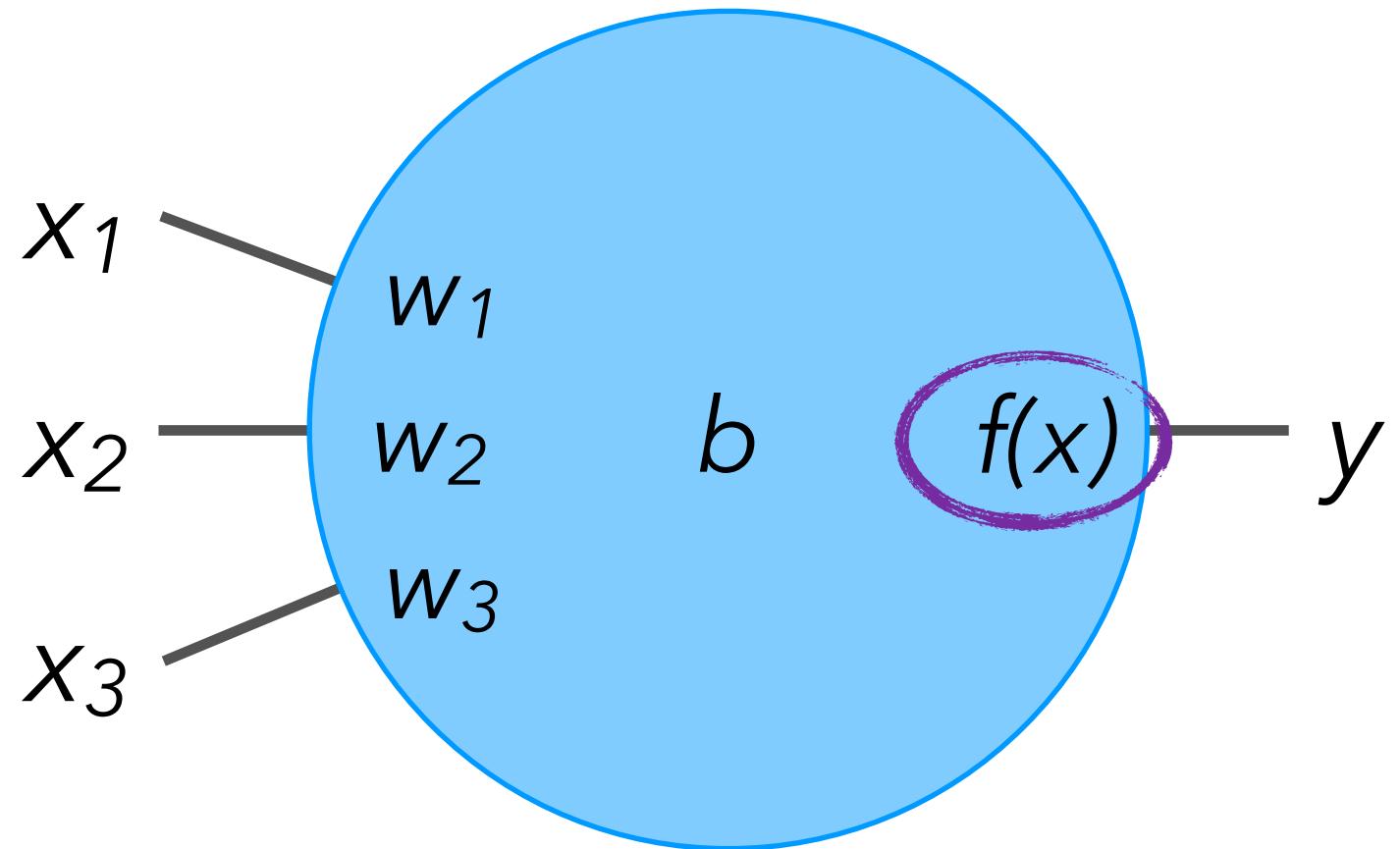
Even Mathier

$$\sum_i x_i w_i + b$$





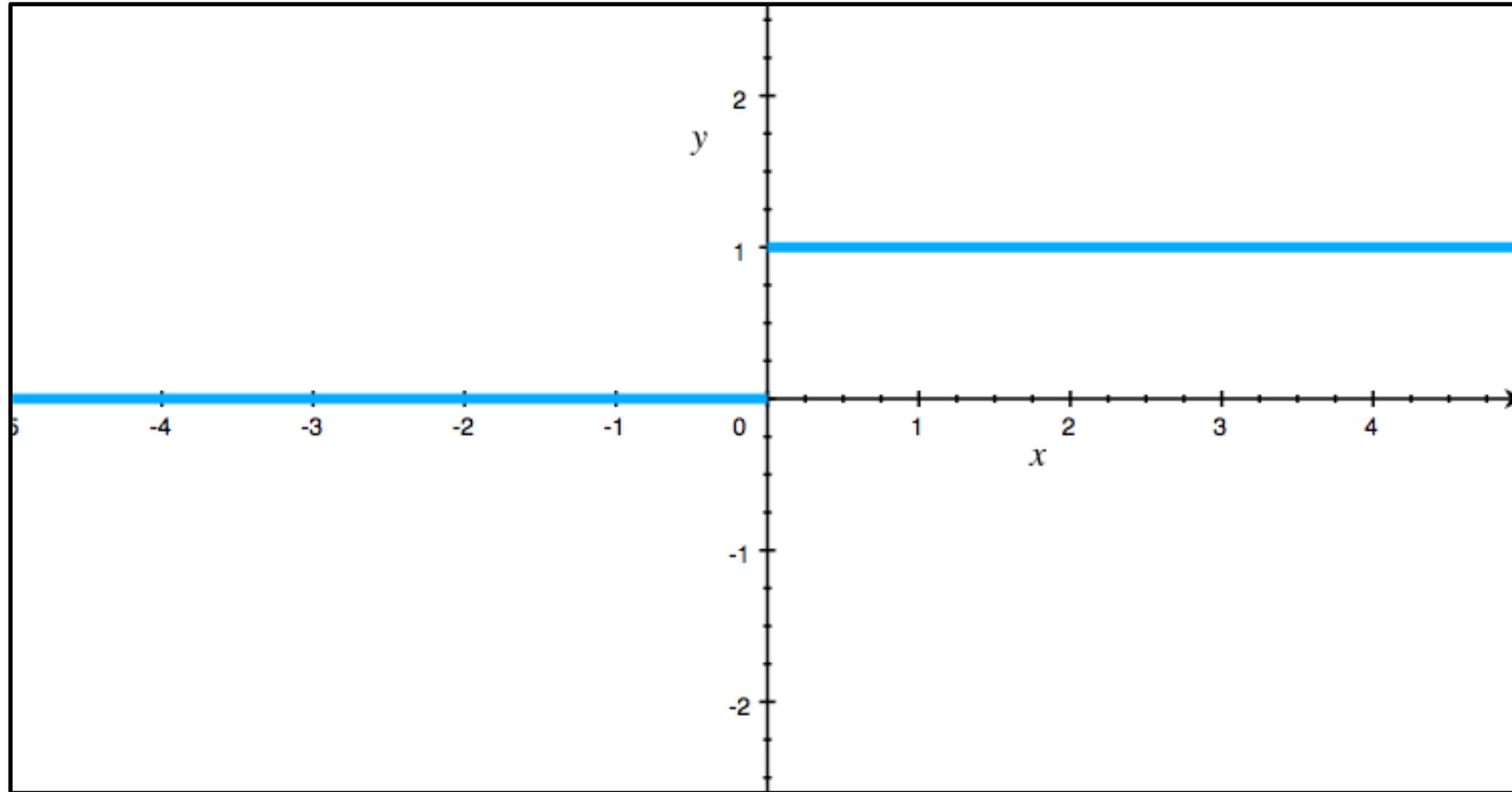
Activation Function



Adjusts the output of the neuron.

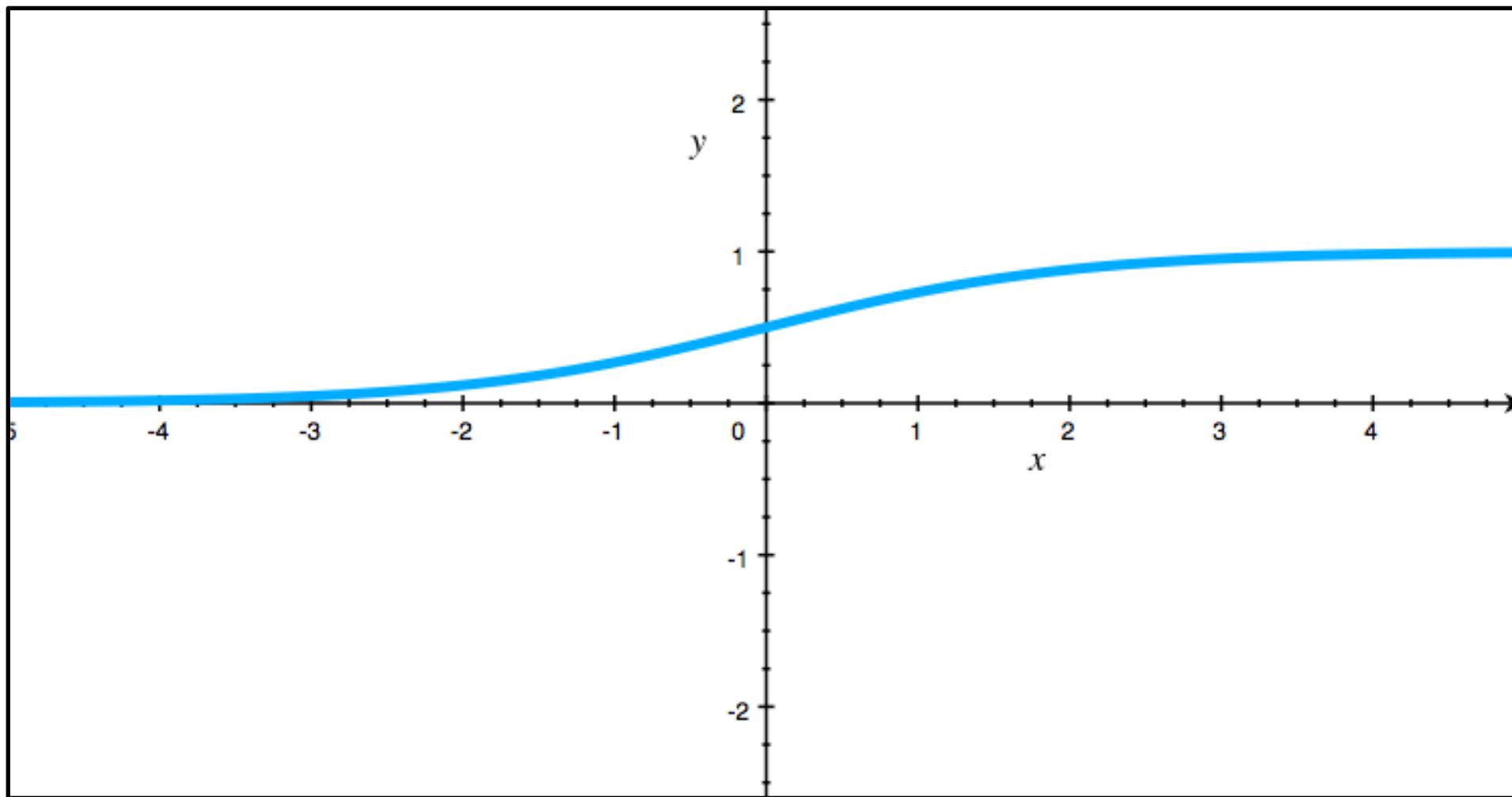


Step Function



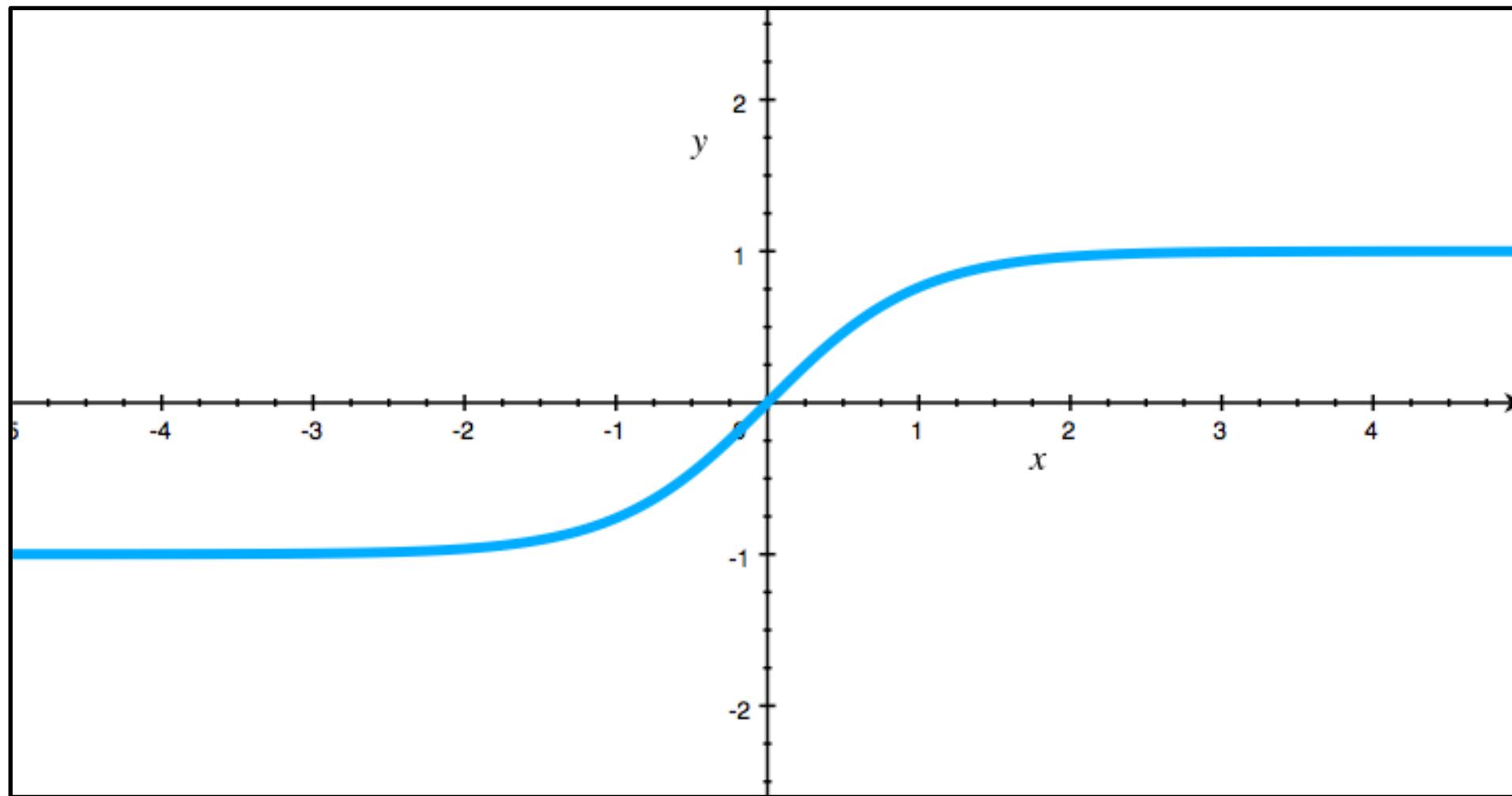


Sigmoid Function



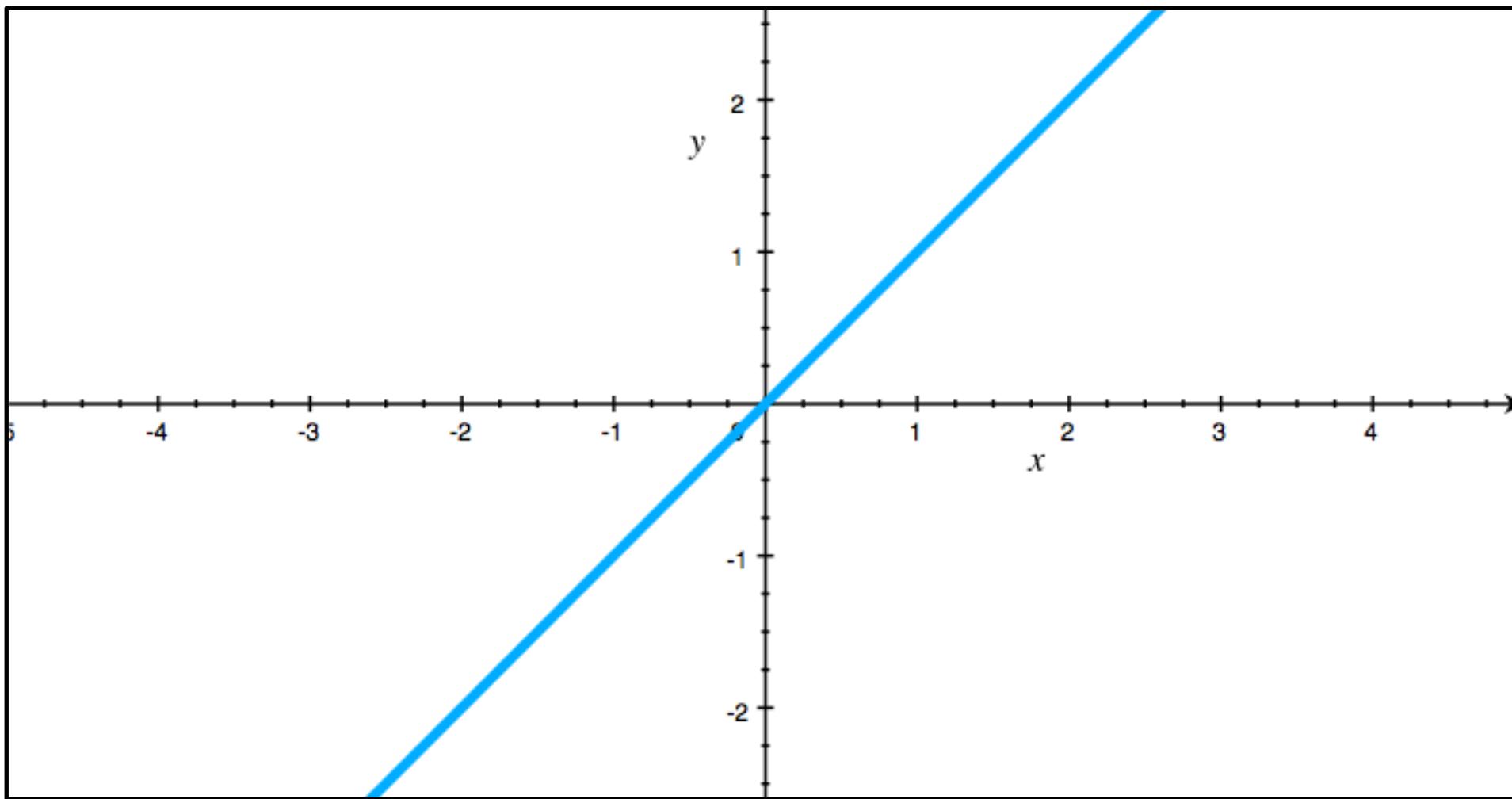


tanh Function



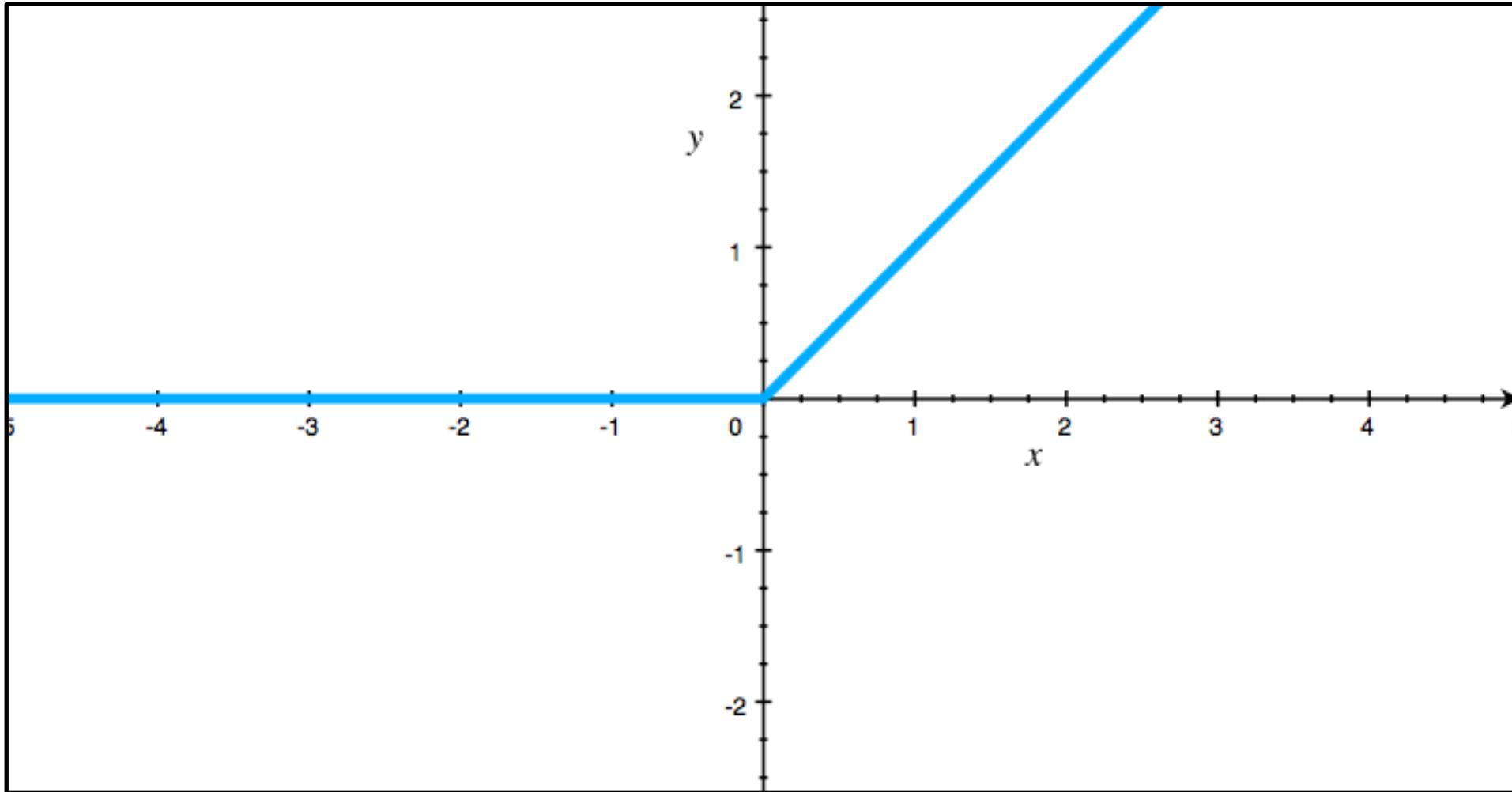


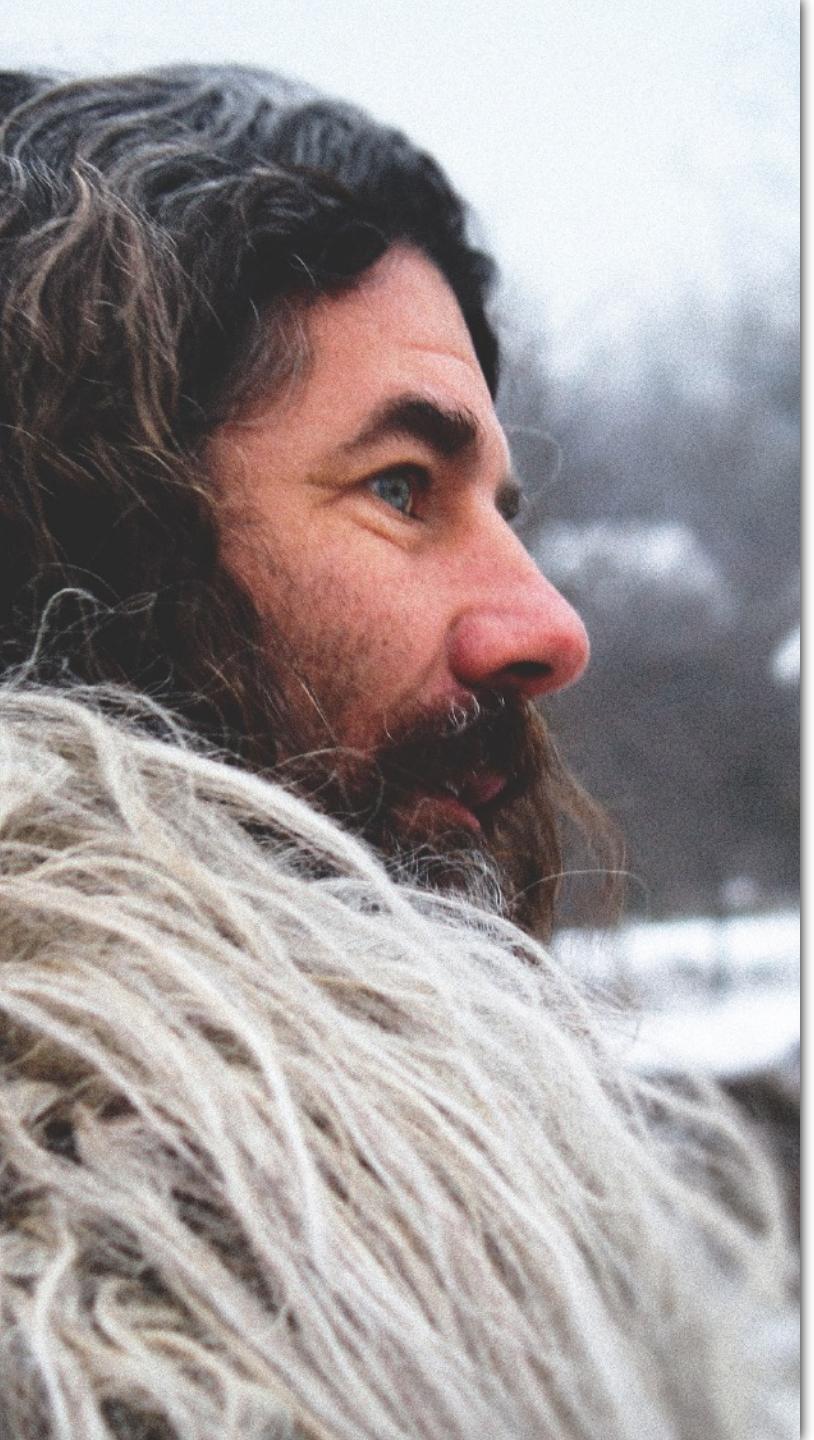
Linear Function



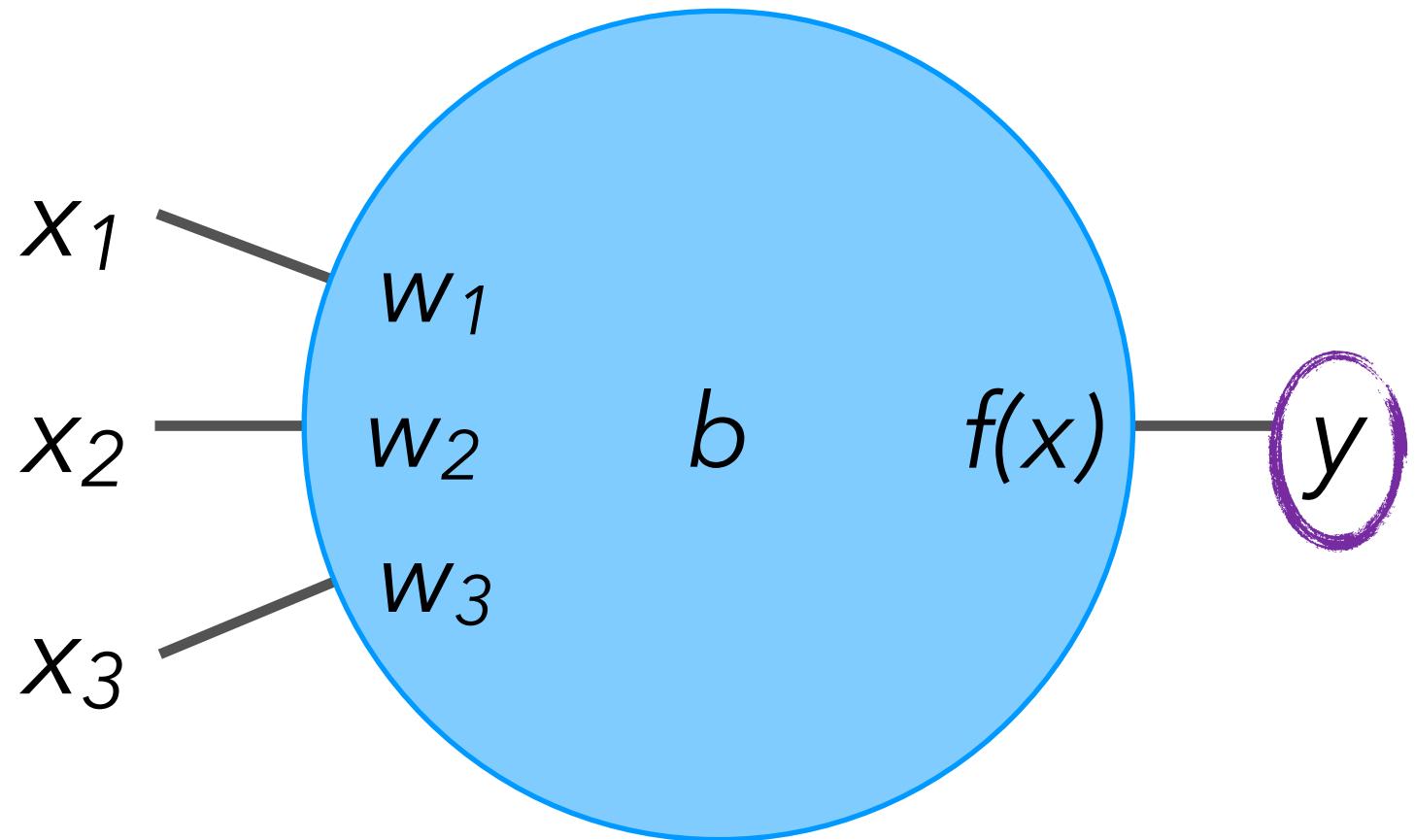


Rectified Linear Units (ReLU)



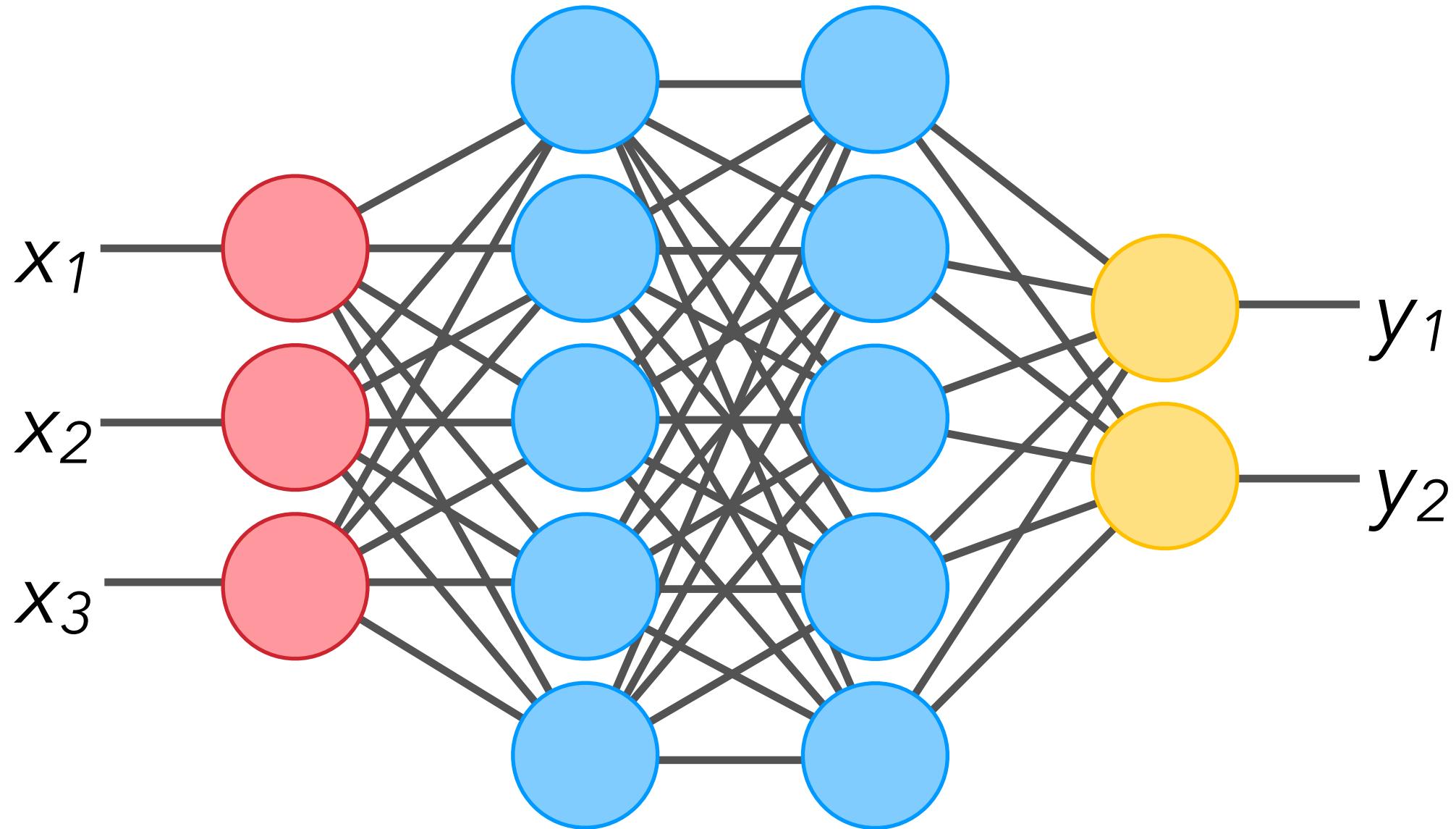


Output



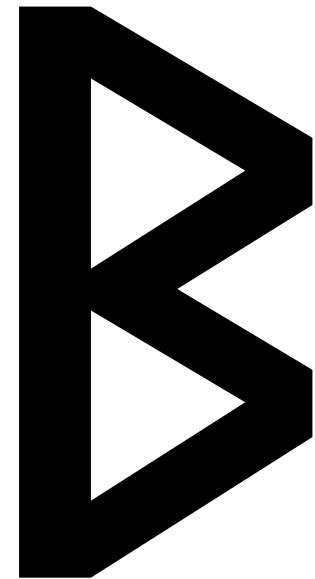
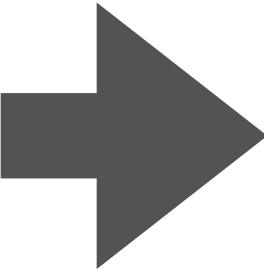
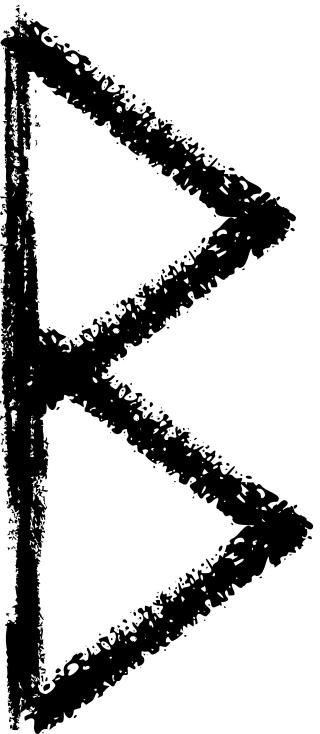
The value leaving the neuron.

Neural Networks

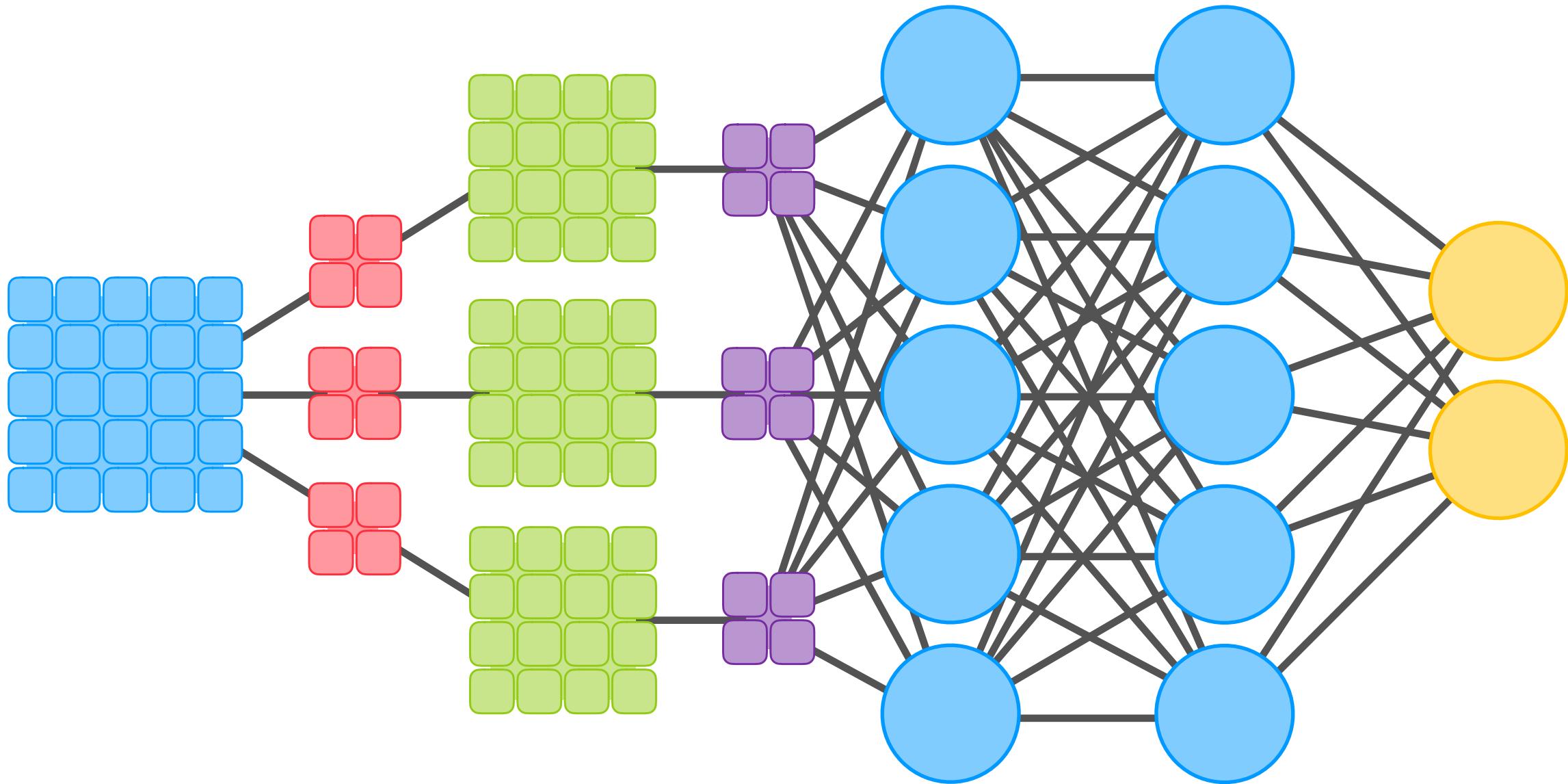




Bad at Recognizing Runes

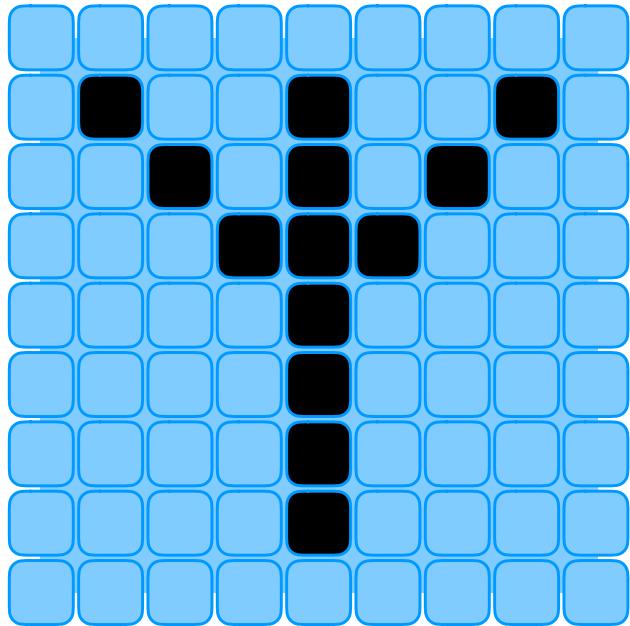


Convolutional Neural Networks

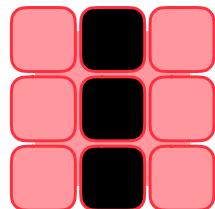




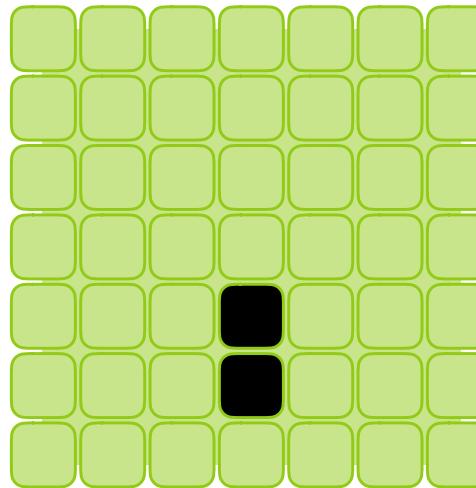
Convolutions



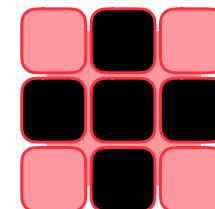
Input



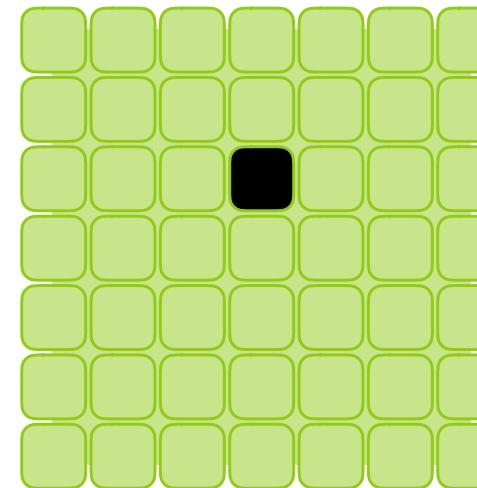
Filter



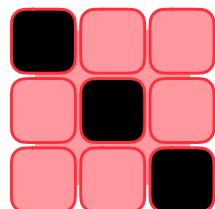
Output



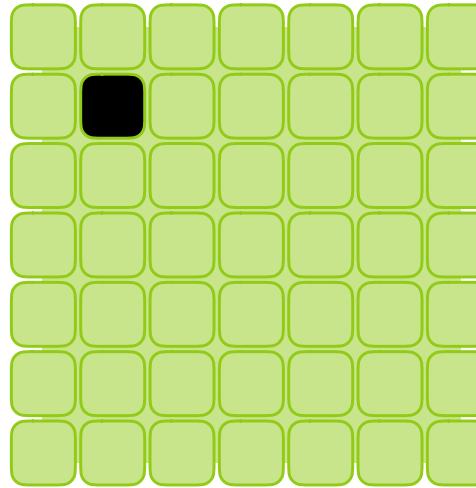
Filter



Output



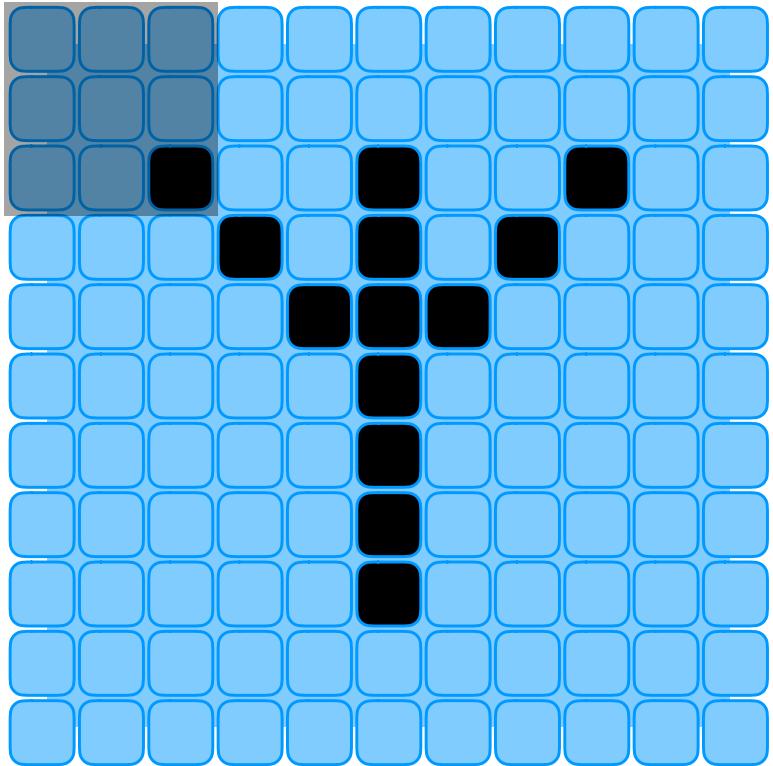
Filter



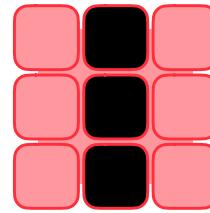
Output



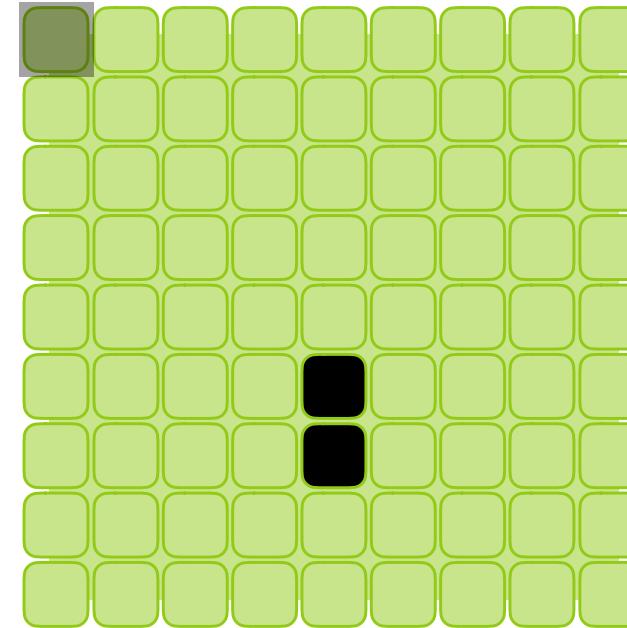
Convolutions with Fancy Animation



Input



Filter



Output



Convolutions with Numbers

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Input

| | | |
|----|---|----|
| -1 | 1 | -1 |
| -1 | 1 | -1 |
| -1 | 1 | -1 |
| -1 | | |

Filter

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Output



Convolutions with Familiar Looking Numbers

X_i

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

W_i

| | | |
|----|---|----|
| -1 | 1 | -1 |
| -1 | 1 | -1 |
| -1 | 1 | -1 |

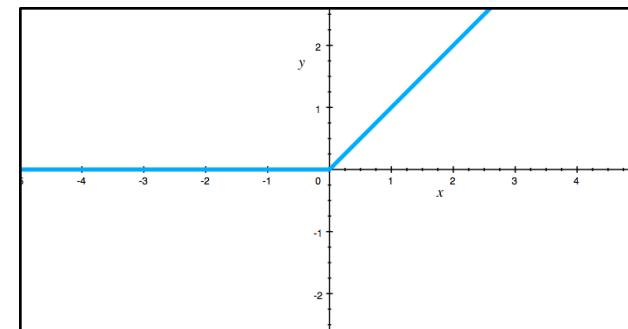
-1

b

y_i

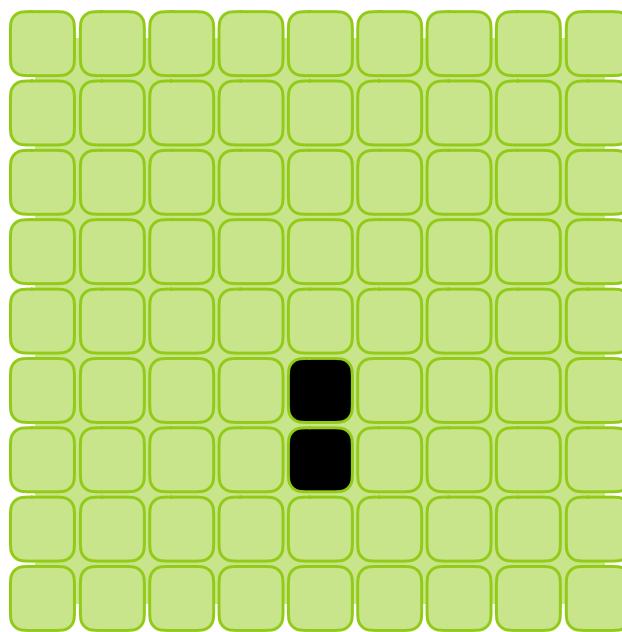
| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

$$\sum_i x_i w_i + b$$



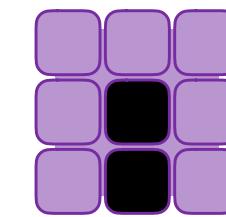


Pooling



Output

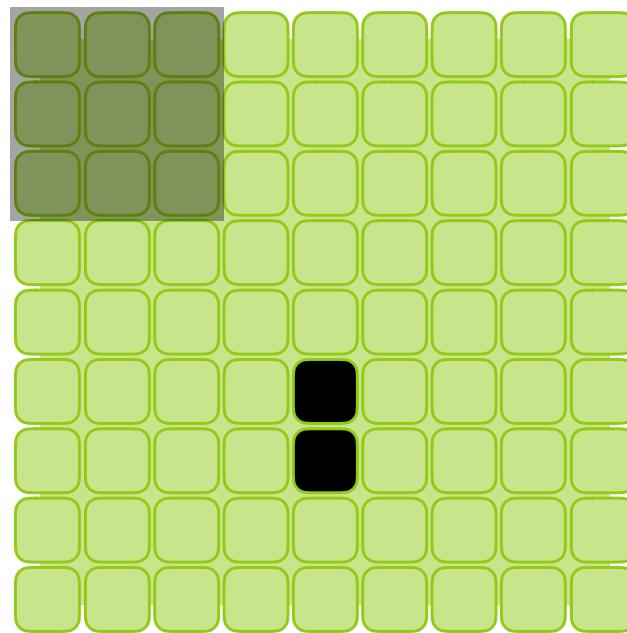
3×3



Pooled

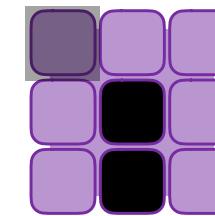


Pooling with Fancy Animation



Output

3×3



Pooled



Pooling with Numbers

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Output

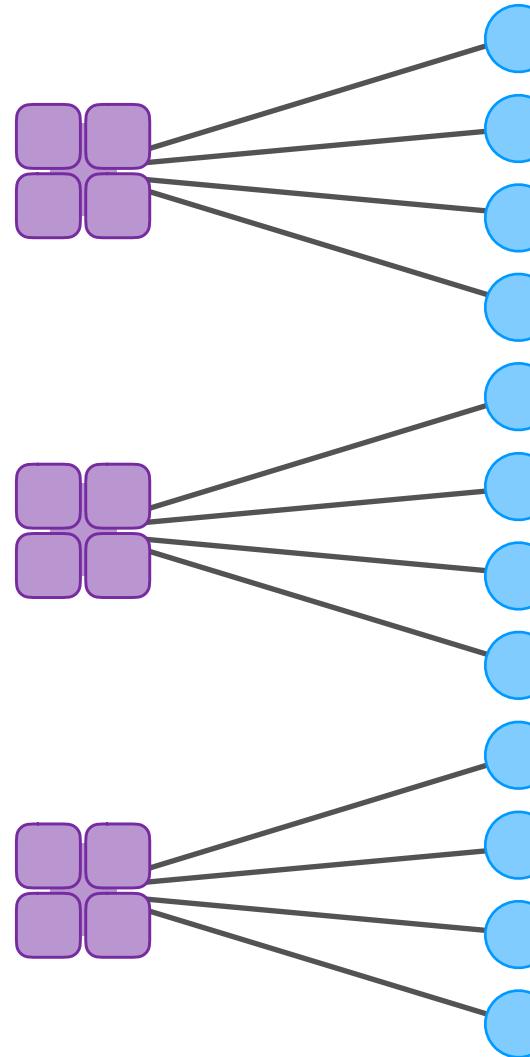
3 x 3

| | | |
|---|---|---|
| 0 | 1 | 0 |
| 0 | 2 | 0 |
| 0 | 2 | 0 |

Pooled

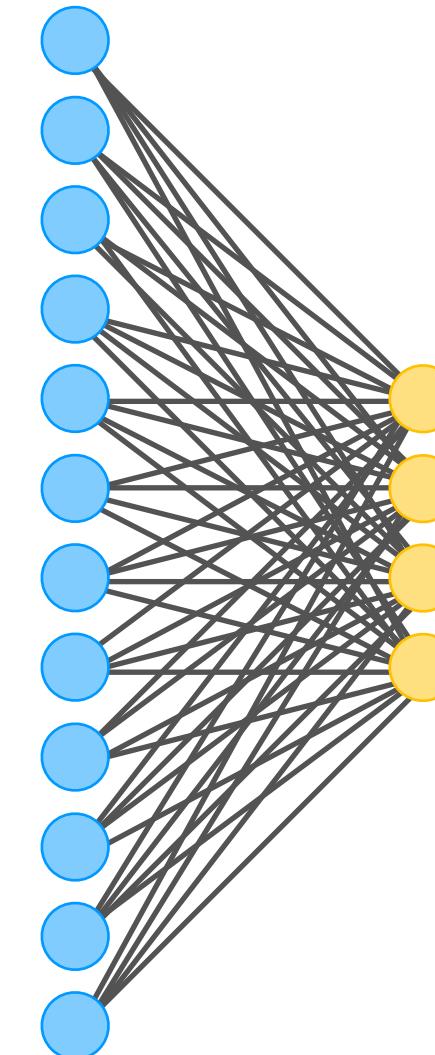


Flattening

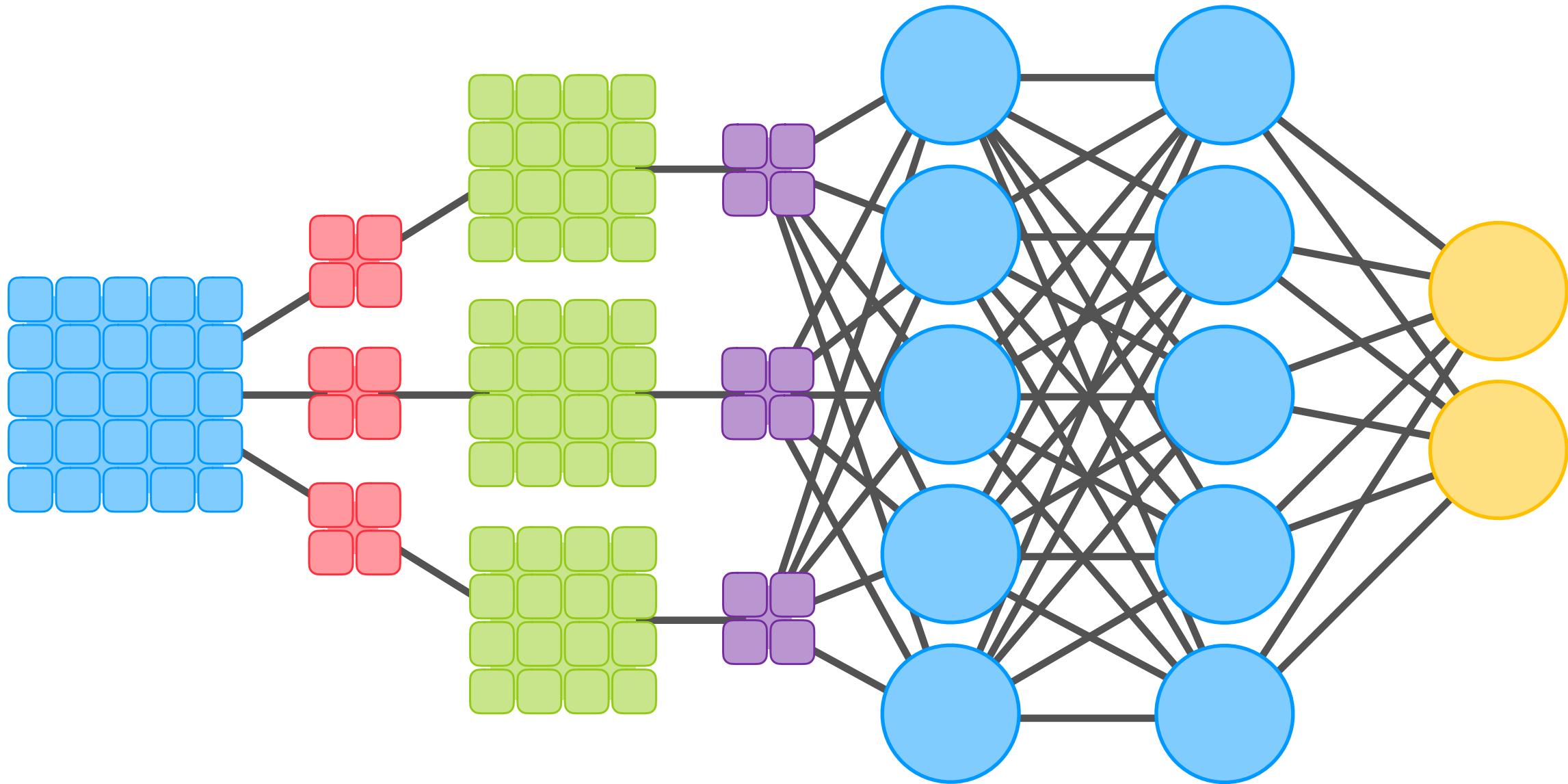




Fully Connected



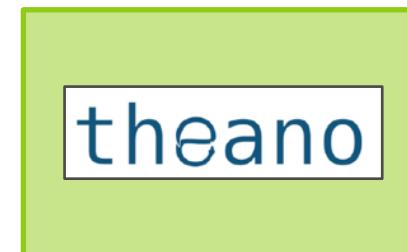
Convolutional Neural Networks







Keras



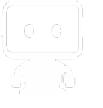
```
model = Sequential()

model.add(Conv2D(48, (3,3), activation='relu', input_shape=(1,24,24)))
model.add(MaxPooling2D(pool_size=(2,2)))
model.add(Conv2D(24, (3,3), activation='relu'))
model.add(MaxPooling2D(pool_size=(2,2)))
model.add(Flatten())
model.add(Dense(128, activation='relu'))
model.add(Dense(16, activation='softmax'))

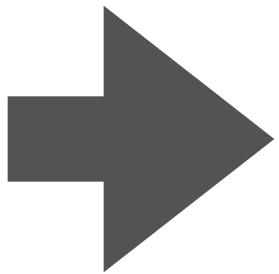
model.compile(loss='categorical_crossentropy', optimizer='adam', metrics=['accuracy'])

model.fit(X_train, Y_train, batch_size=32, epochs=20, verbose=1)
```





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Demo

(Tima)



Resources

Keras

<https://keras.io/>

Microsoft CNTK

<https://www.microsoft.com/en-us/cognitive-toolkit/>

TensorFlow

<https://www.tensorflow.org/>

Theano

[http://wwwdeeplearningnetsoftwaretheano/](http://wwwdeeplearningnetsoftwaretheano)

Flask

<http://flask.pocoo.org/>

VanillaJS

<http://vanilla-js.com/>

Younger Futhark

https://en.wikipedia.org/wiki/Younger_Futhark

Neural Network Zoo

<http://www.asimovinstitute.org/neural-network-zoo/>

A Beginner's Guide to to Neural Networks

<https://towardsdatascience.com/a-beginners-guide-to-neural-networks-b6be0d442fa4>

Hacker's Guide to Neural Networks

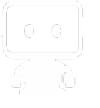
<http://karpathy.github.io/neuralnets/>

CS231n Convolutional Neural Networks for Visual Recognition

<http://cs231n.github.io/convolutional-networks/>

An Intuitive Guide to Convolutional Neural Networks

<https://medium.freecodecamp.org/an-intuitive-guide-to-convolutional-neural-networks-260c2de0a050>



**[https://github.com/guyroyse/
deep-learning-like-a-viking](https://github.com/guyroyse/deep-learning-like-a-viking)**



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