

Learning  
**NEURAL NETWORKS**  
An online comic from Google AI

Starring  
**MARTHA**,  
who is getting  
the hang of this.

With  
**FLIP**...

And  
**BIT**!

and introducing  
**OCTAVIUS!**

Hello!

I think  
I know what's  
happening?

**NEURAL NETWORKS**  
are made up of simple building  
blocks, and the simplest is  
"THE NEURON."

Oh, hi, Flip!  
Hi, Bit!

Yo.

Hey,  
Doc.

Just like their *biological* namesake,  
these "neurons" accept multiple **inputs**,  
and combine them to produce **outputs**.

DENDRITES  
NUCLEUS  
AXON

NODE  
EDGES

"Inputs," as in...?

Nearly anything,  
as long as you  
can measure it  
numerically.

Think of your  
inputs as like  
properties in a  
spreadsheet!

	HEIGHT	WEIGHT	COLOR	SHAPE	SPEECH
1					
2					
3					
4					

This is where it  
starts—our first  
**layer of inputs**.

Those "hidden"  
layers in between are  
performing a simple  
classification task,  
but  
across a complex,  
multi-dimensional  
dataset!

INPUT → HIDDEN LAYERS → OUTPUT

Each feature's  
numeric value ( $x$ )  
is simply added up  
in the neuron.

And  
that sum ( $\Sigma$ )  
helps determine  
the slope of  
the line.

But some  
features deserve  
more **weight**  
than others,

so first those  
inputs are adjusted  
up or down in  
strength.

Another is  
the **bias**; an offset  
to the whole sum that's  
also adjustable  
by weight.

Then we squash that  
linear classifier into a  
**nonlinear** form like a  
sigmoid function...

This "Activation Function"  
puts it all in a manageable  
range, like 0 to 1,  
or 1 to -1...

...and allows  
for smooth  
adjustments  
in the learning  
process...

Huh.

So, when we train  
neural networks using  
**backpropagation** and  
**gradient descent**\*...

...that process  
adjusts those  
weights and  
biases?

Yup!