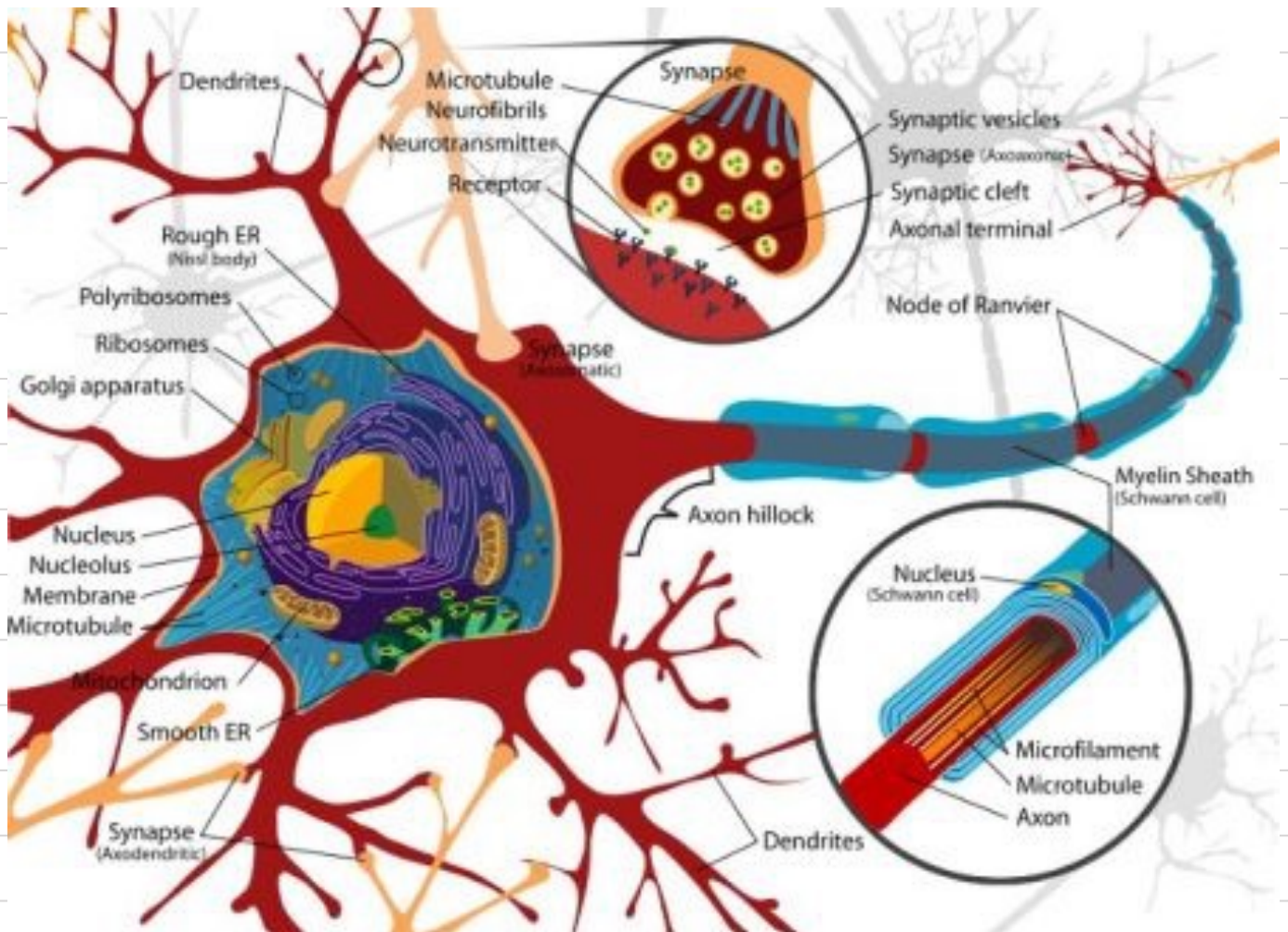


# Real Neural Network



Animal

worm

mouse

HUMAN

ELEPHANT

#

302

71,000,00

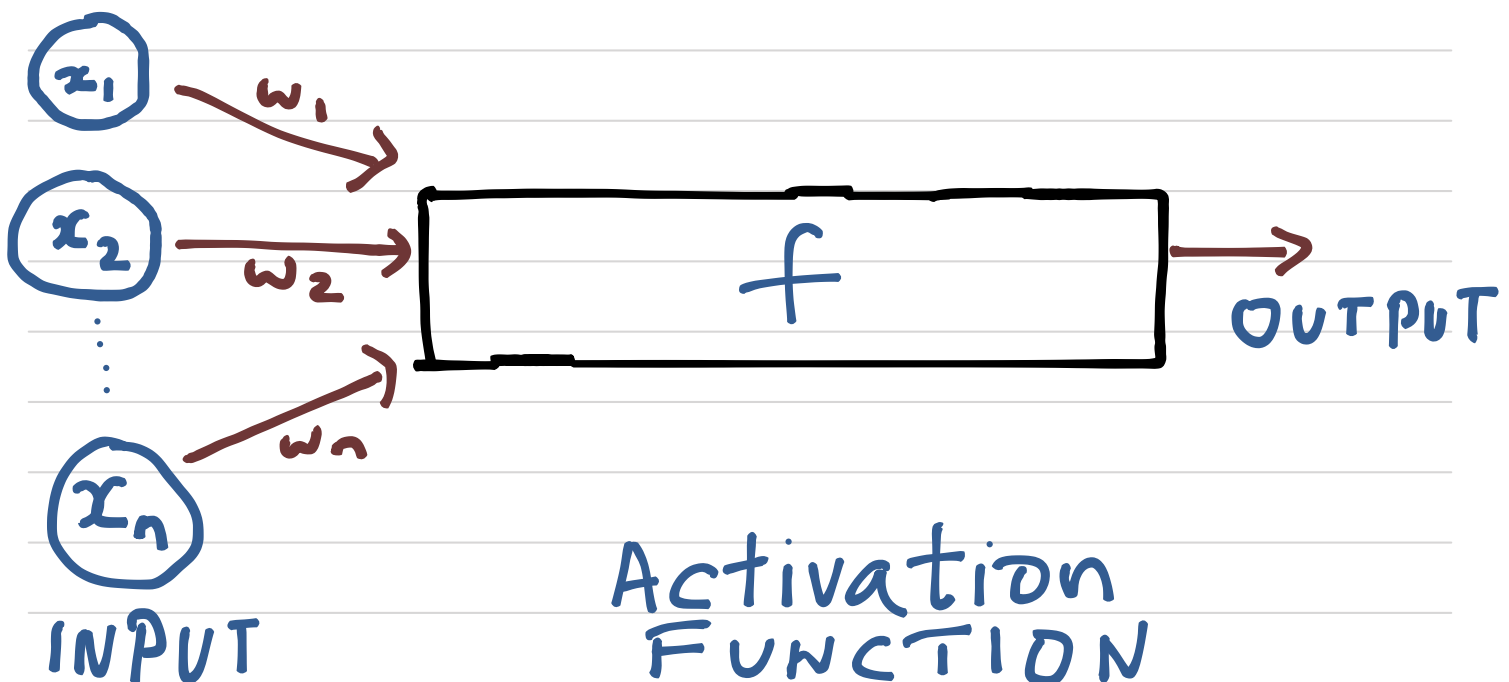
86,000,000,000

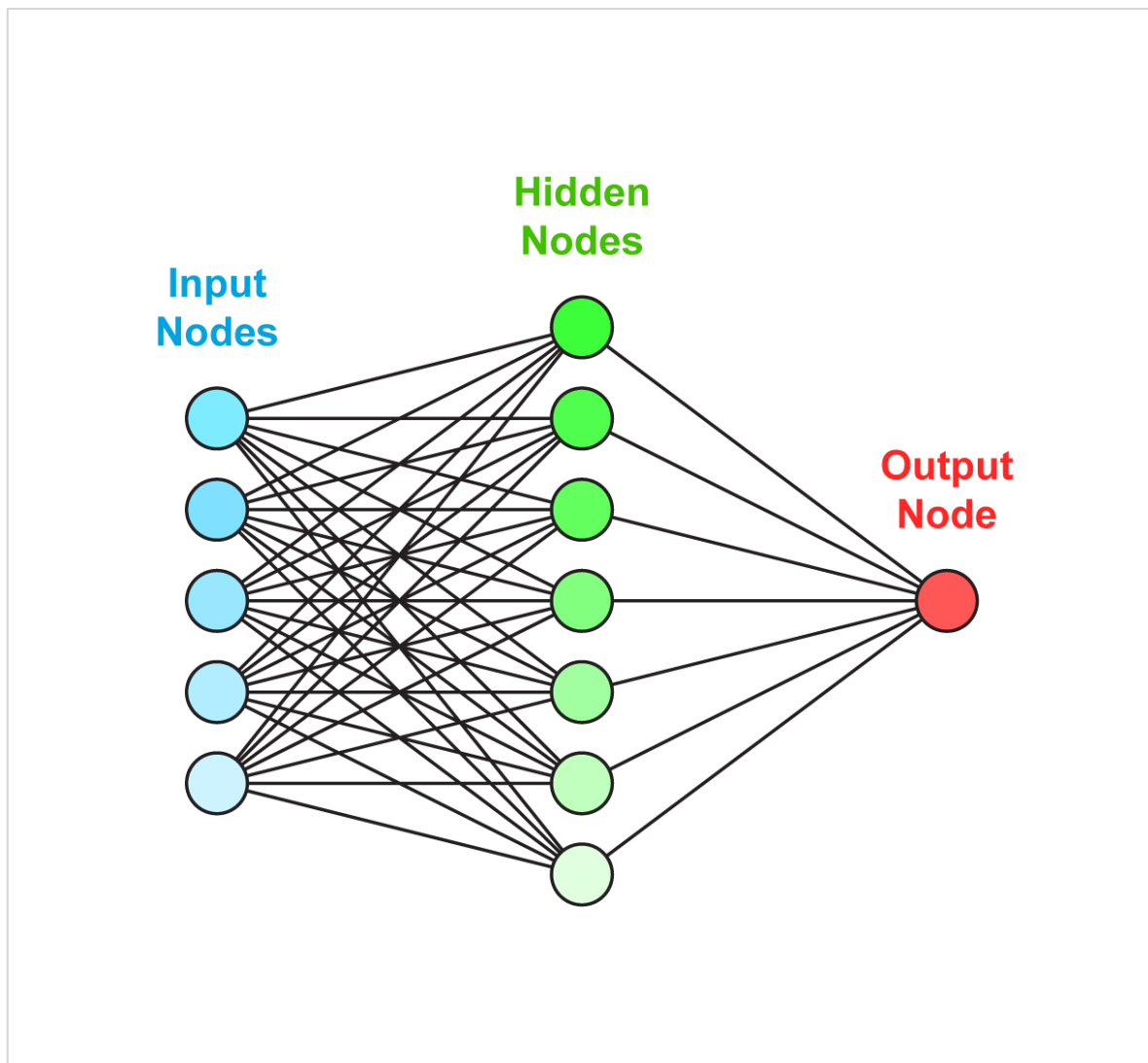
210,000,000,000

# ARTIFICIAL NEURON

$\{w_i\}_{i \leq n}$  - weights

$f$  - (non-linear) activation function





# ARTIFICIAL NEURAL NETWORK

- large class of non-linear functions
- parametrised by weights
- fix loss function, Gradient descent.

# Universal Approximation Theorem

A single layer

feed forward network can

approximate *any* function

to any arbitrary degree of

precision, given *enough*

hidden neurons.

## There's No Such Thing as a Free Lunch

The Bias-Variance Dilemma

*Vivek S Borkar*



Vivek S Borkar is with the Department of Computer Science and Automation, Indian Institute of Science, Bangalore. He is one of those who do not know much statistics, but wish they did.

A much publicised (but rarely explained) dilemma in empirical model building is described. Techniques for 'balancing on its horns' are outlined. In particular, it is argued that one can get an edge over it by not going over the edge.

### The Razor's Edge

Many years ago when I was with an institution inhabited by mathematicians and astronomers, a story was making the rounds of the place. Once an astronomer and a mathematician went hiking in the western ghats and saw a black cow in profile at a distance. "All cows in the western ghats are black", exclaimed the astronomer. "No", said the mathematician, "on date such and such and time so and so, there existed in the Western Ghats a cow the left side of which was not black at that time".

Resonance  
Vivek S. Borkar

June  
-1998

[WOLPERT - 1996]

No learning algorithm is universally any better than any other.