



"ALL about A.I. Training"™

A.I. Learning Labs

Presents

"Demystifying Convolutional Neural Networks"

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"Demystifying Convolutional Neural Networks"

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Demystifying Convolutional Neural Networks

- **Introduction To Artificial Neural Networks (ANN) Fundamentals**
- Benefits And Challenges With ANNs
- Along Comes Convolutional Neural Networks (CNN)
- Benefits And Challenges With CNNs
- The Less Than Obvious Aspects Of CNNs
- Conclusion and Q & A

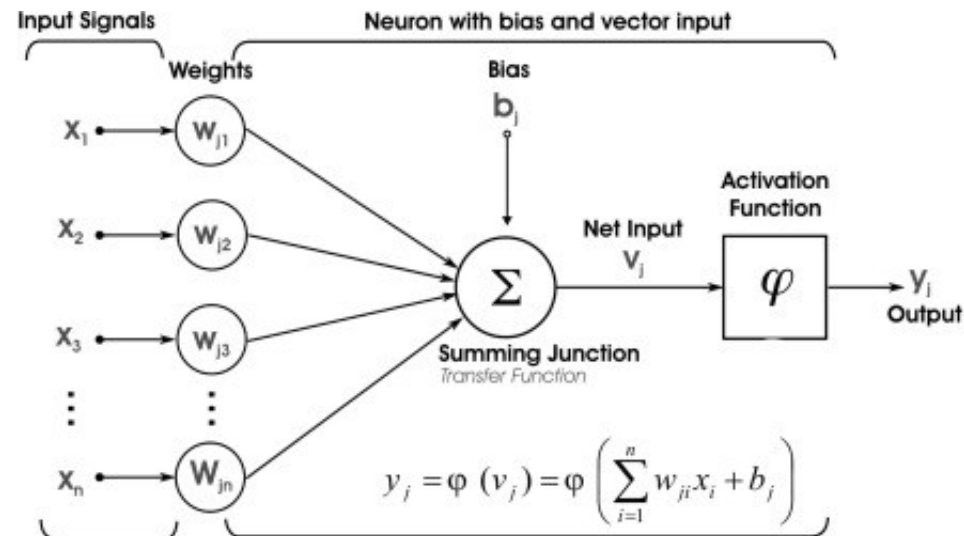
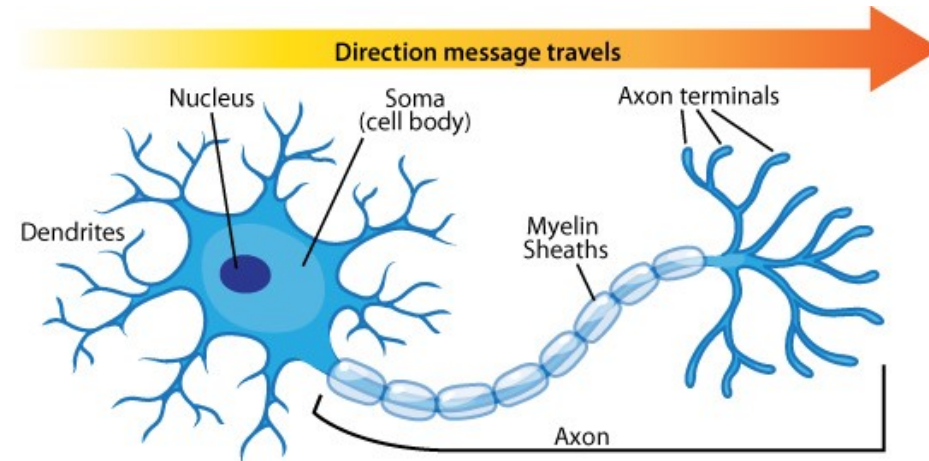


Introduction To Artificial Neural Networks (ANN)

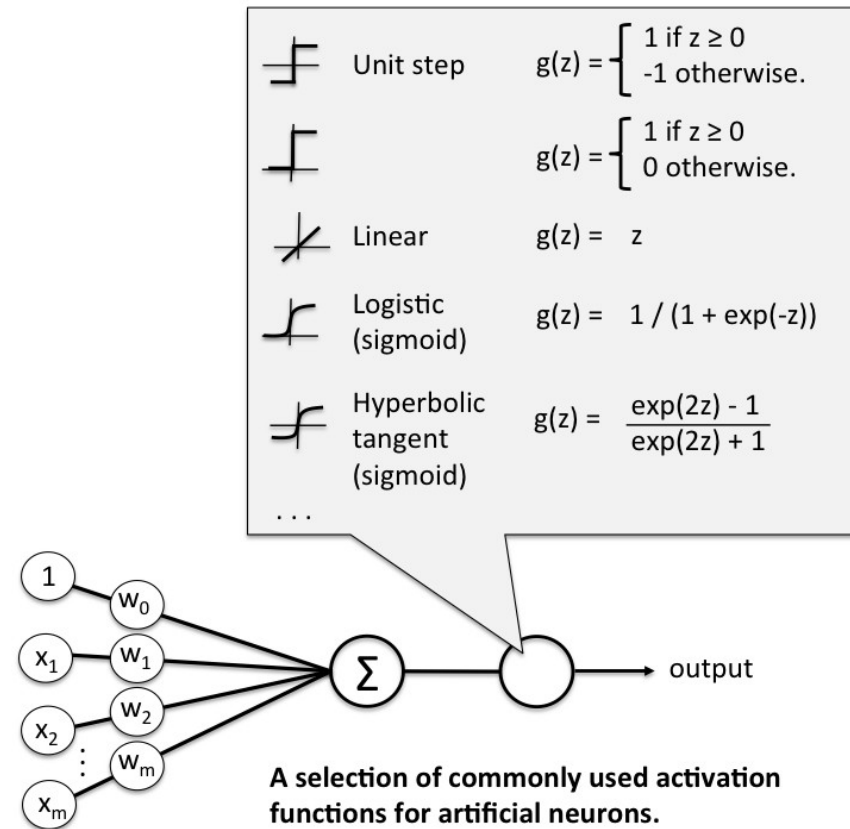
- History/Origins
 - NN development started back in **1943** thanks to Warren McCulloch & Walter Pitts while doing research into understanding how the brain works.
 - McCulloch & Pitts came up with a mathematical model of Neurons which is the basis for a significant portion of the current progress in A.I. today!
- Applications of NN
 - Business Analytics (Fraud Detection, Loan Analysis, Consumer Trends, etc.)
 - Natural Language Processing (Text Predictions, detecting “negative” forum postings and document analysis)
 - Speech Recognition (You know the deal here...is it cool or what?)
 - Image Analysis (Face recognition, Categorization, produce sorting, etc.)
 - ...with many more not listed here and many more to come!



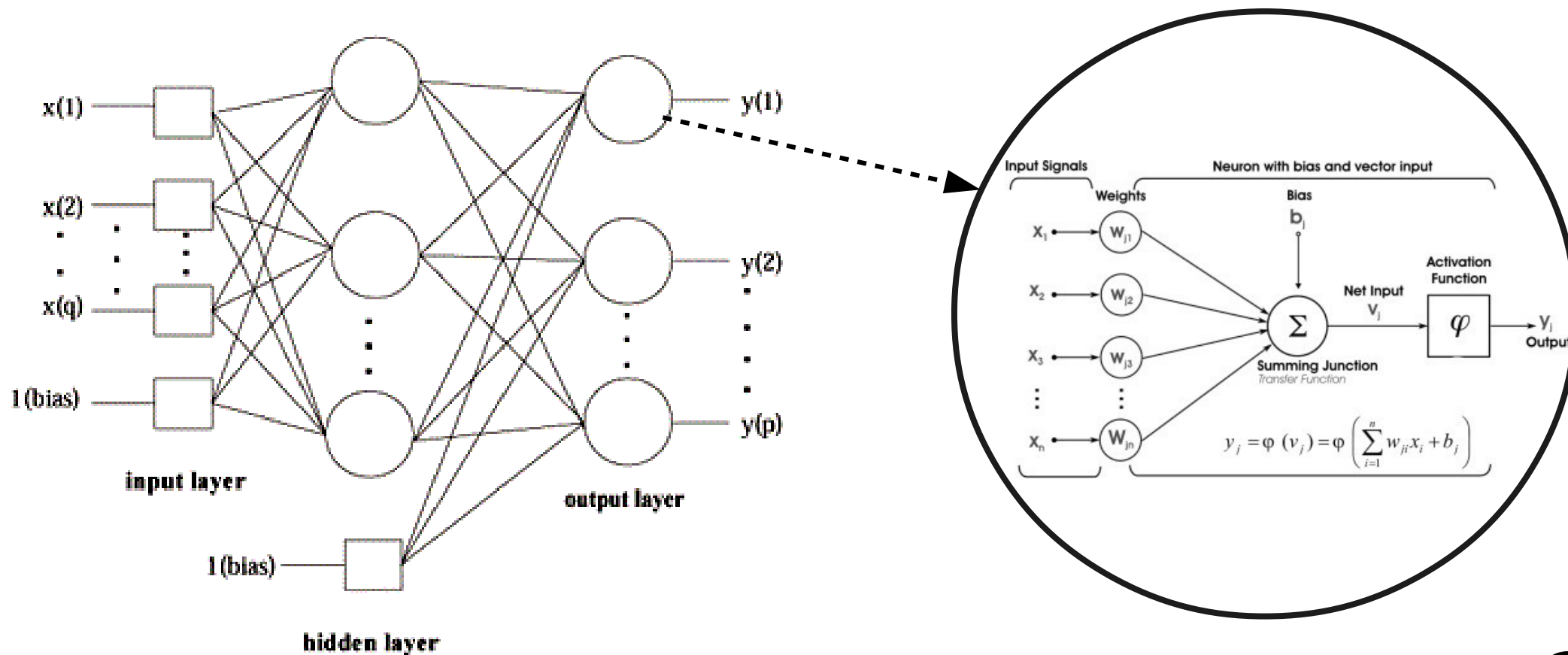
The Neuron – Building Blocks For Artificial NN



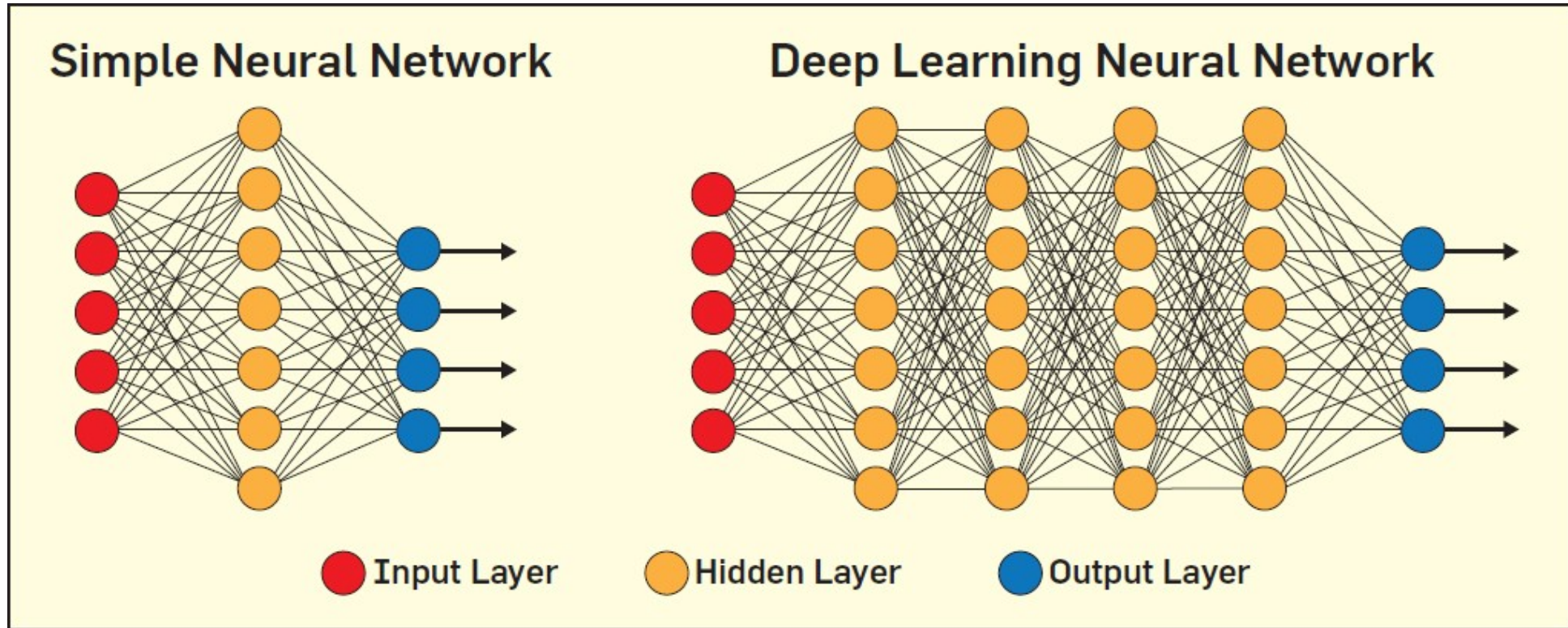
Neuron Model's Activation Function



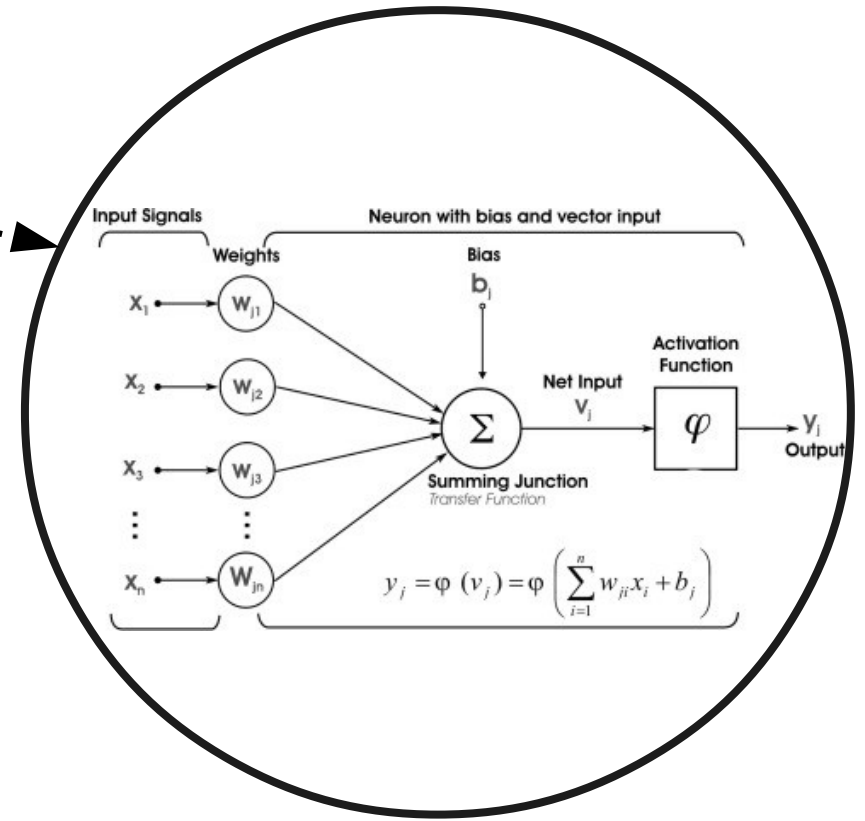
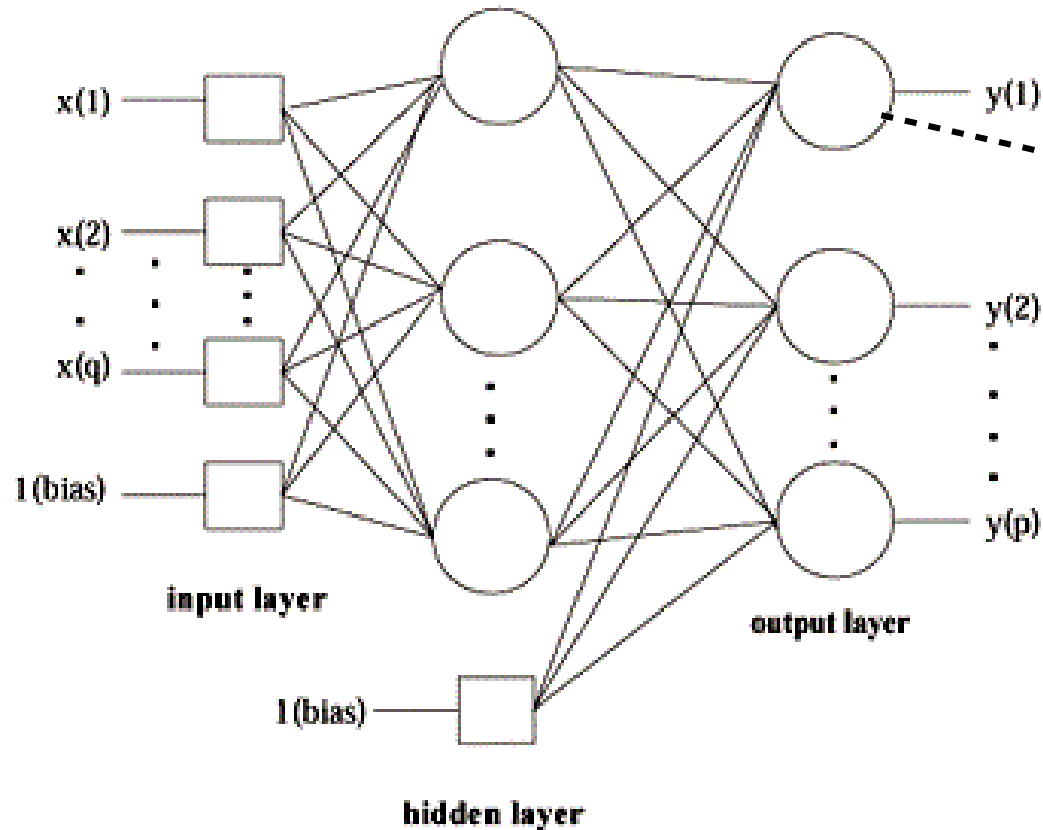
A Basic Artificial Neural Network Structure



Deep Learning NN => 2+ Hidden Layers



Lots Of Weights And Biases To Solve For



Based on my experiences, it is my belief, that the **weights** and **bias values** that result from ML **WILL**, *in all likelihood*, become the new “software”!



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- Q & A



Benefits And Challenges Of ANNs

- **BENEFITS:**

- **Complex Problems Solved With Training** – Training replacing complex and time consuming traditional computer programming techniques
- **Provides A Good Generalized Solution** – Instead of having to anticipate all possibilities to given problems, a more reliable solution can be realized to better handle unknown input conditions.
- **More Fault Tolerant Compared To Traditional Approaches** – An ANN solution can have a portion of the neurons fail, but still produce satisfactory results, i.e. it is less fragile

- **CHALLENGES:**

- **Large Data Sets** - In the quest for a more generalized solution some NN Training techniques can cause large data sets to become larger. For image applications the data set can easily grow by 4X or more of the base image data set!
- **Still A Lot Of Unknowns** - The optimal # of Nodes in an ANN System is still a TBD...INDUSTRY Wide!!!
- **Large Number Of Parameters To Solve For AND Needing To Store Them In Memory**
 - Reference Point: MNIST Handwritten Digits – Yann LeCun et. al....A very SMALL example!!!
 - Structure: 28x28-500-150-10 (or 784-500-150-10) => **588,000,000 Weights & 660 Bias Values.**
 - Data Set Size: 60,000

- **OTHER BENEFITS AND CHALLENGES ARE YET TO BE DISCOVERED...**

- **SHOW DEMO:** <https://playground.tensorflow.org>

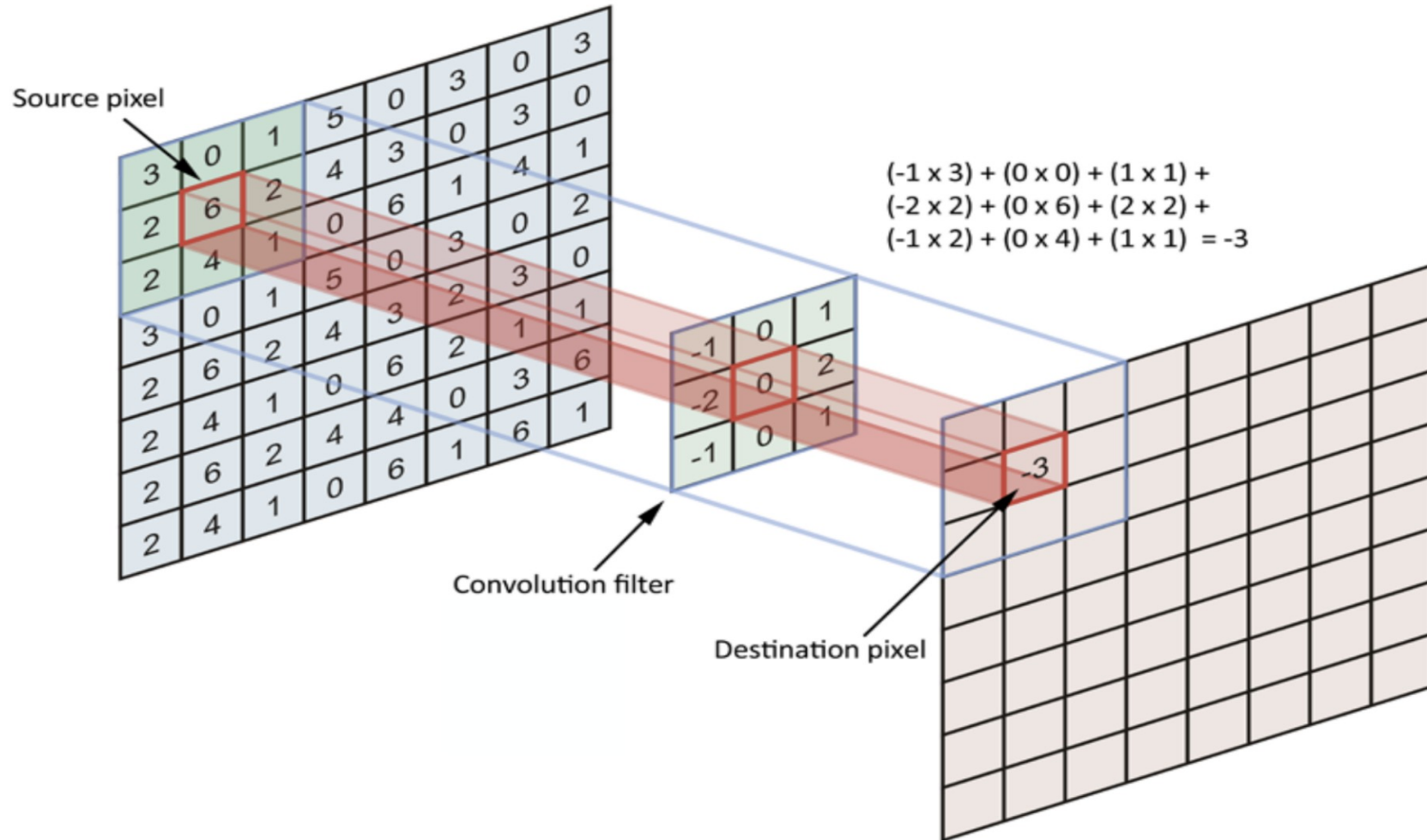


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Along Comes Convolutional Neural Network (CNN)



1 _{x1}	1 _{x0}	1 _{x1}	0	0
0 _{x0}	1 _{x1}	1 _{x0}	1	0
0 _{x1}	0 _{x0}	1 _{x1}	1	1
0	0	1	1	0
0	1	1	0	0

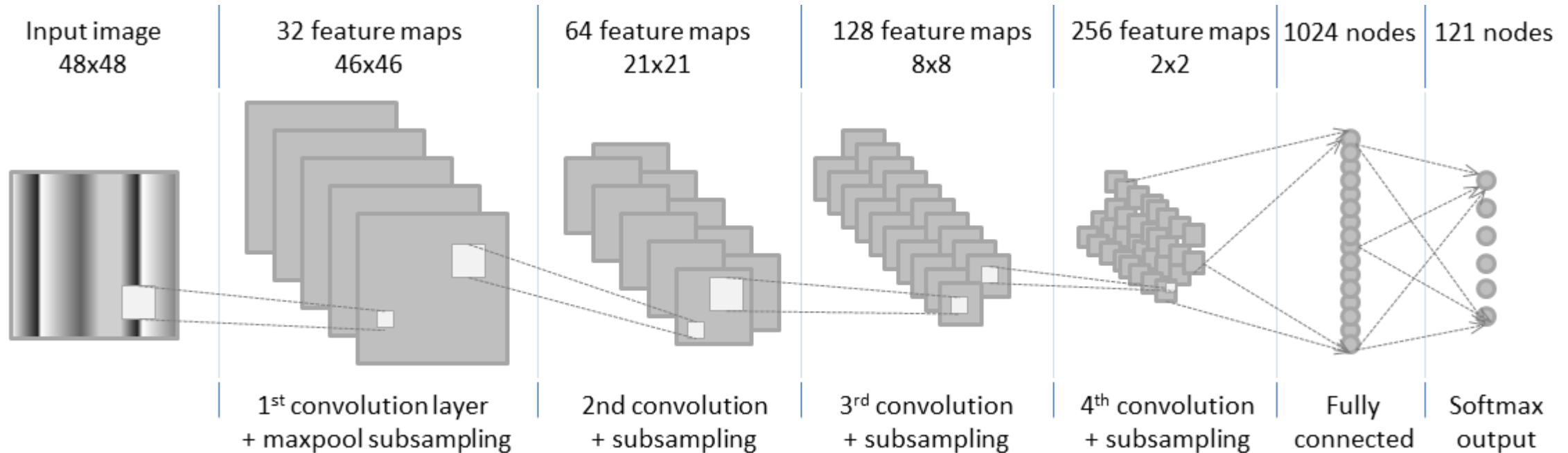
Image

4		

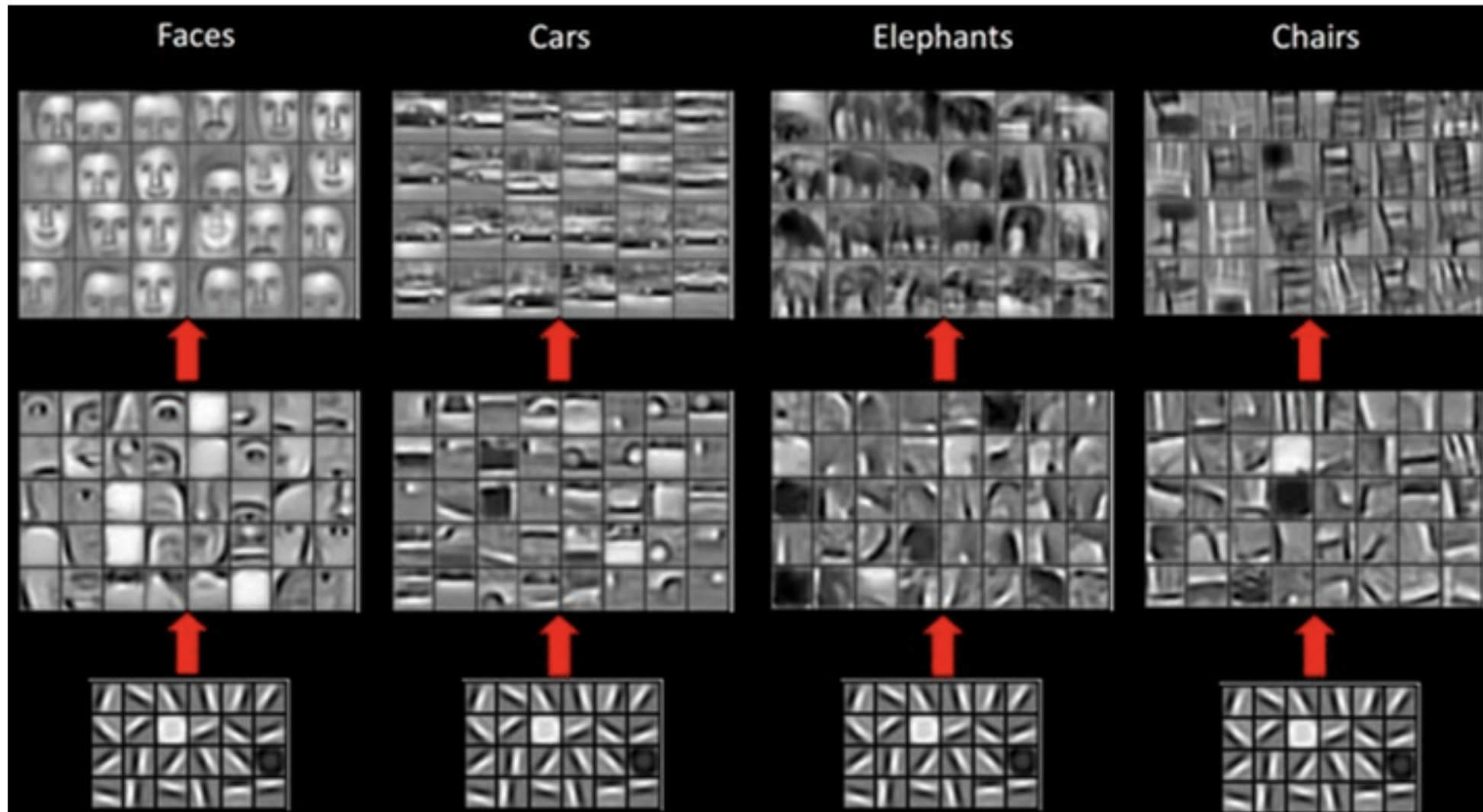
Convolved Feature



A Convolutional Neural Network (CNN) Structure



A Look At The Feature Maps Of CNN



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Benefits And Challenges Of CNNs

- **BENEFITS:**

- **SAME AS ANNS:** * Complex Problems Solved With Training * Provides A Good Generalized Solution * More Fault Tolerant Compared To Traditional Approaches
- **Significantly Reduced # Of Training Parameters** – This is one of two MAJOR benefits of CNNs over ANNs, particularly in that by reducing the parameters, significant gains are made in the deployment and training of models.
- **Invariance Tolerant** – Due to the convolutional filters being repeated variations of the input data is handled more easily, think a base image is shifted or rotated. This is the other MAJOR benefit of CNNs over ANNs.
- **Workload Is More Easily Distributable And Thus Scales Easily** – While the number of computations for CNNs increased, having a smaller number of shared parameters and more manageable dependencies, the computations can be easily distributed and scaled across multiple platforms and multiple systems.

- **CHALLENGES:**

- **SAME AS ANNs:** * Large Data Sets * Still A Lot Of Unknowns
- **Additional Unknowns** - The optimal # of feature maps AND “reticle” size for feature maps are a bit of an unknown...along with many concepts yet to be explored and tried.
- **Increased # of Computations Needed and Data Managements Complexities** – When compared to ANNs, while the number of training parameters were reduced, computations increased along with data retrieval complexities

- **LIKE ANNs, OTHER BENEFITS AND CHALLENGES ARE YET TO BE DISCOVERED...**



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The Less Than Obvious Aspects of CNNs

- I read many books and web sources about CNNs, but things were still not clear in my mind! :-)
- Then, I re-discovered the AMAZING **Andrew Ng** and listened to his course on CNNs at Coursera:

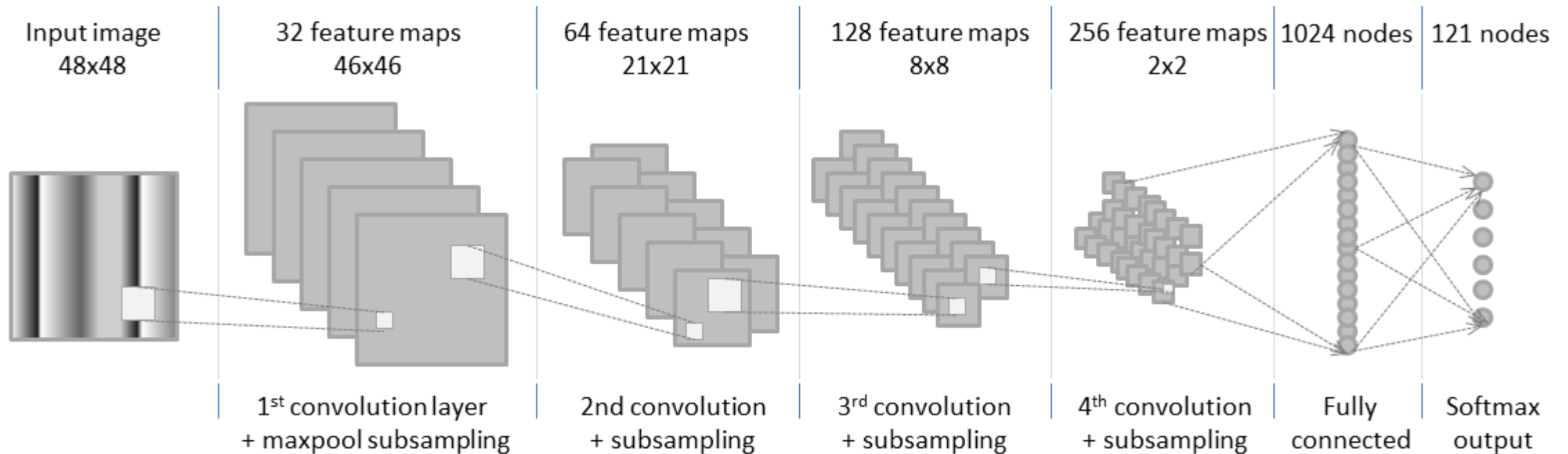
<https://www.coursera.org/learn/convolutional-neural-networks>

- Based on all my prior reading, what follows are some aspects of CNNs that were not totally obvious to me, which made learning about them more challenging than I felt they should have been
- As the saying goes...“the devil is in the details”...and I needed the details.



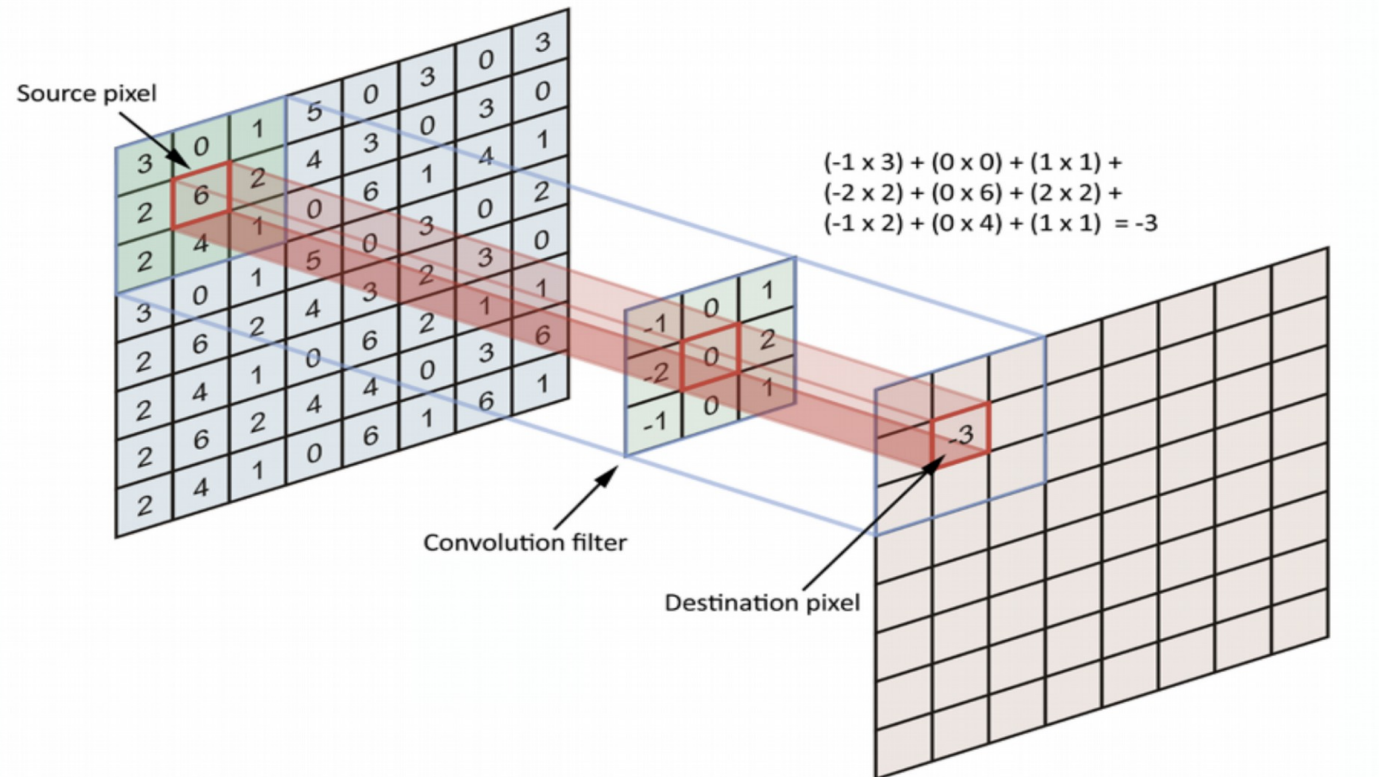
Less Than Obvious Aspect Of CNNs # 1 & # 2:

1) All prior feature maps are used to generate each individual and subsequent feature map **AND** 2) the # of feature maps NEED to increase in number as the source data item information decreases in size.



Less Than Obvious Aspect Of CNNs # 3:

If a CNN solution is not implemented properly, due to the many data arrays involved and repetitive accesses to individual source elements, both the training and deployment of a CNN system can be extremely time consuming and inefficient over what is possible; be it a purely software or hardware implementation.



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CONCLUSION:

While CNNs are typically associated with imaging applications, CNNs are also used in other applications such as speech, finance, etc. There really are not limits to where or how CNNs

A.I. is still in its' infancy and the possibilities seem innumerable, but there are challenges on both technical and societal levels. However, I believe that we can easily face and overcome them with the proper knowledge and understanding of how this amazing technology can bring about a better world, in much the same way that computers made our world better compared to previous technological generations. In general, any technology is just a tool, it is up to us collectively how we use it...hopefully for the betterment of ALL life forms!

I want to give a **special thanks** to PyData and their supporters for allowing me to present today and for everyone who attended today's talk, **thank you** for your time and attention!!!

Now let's open up for some....

Q & A



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