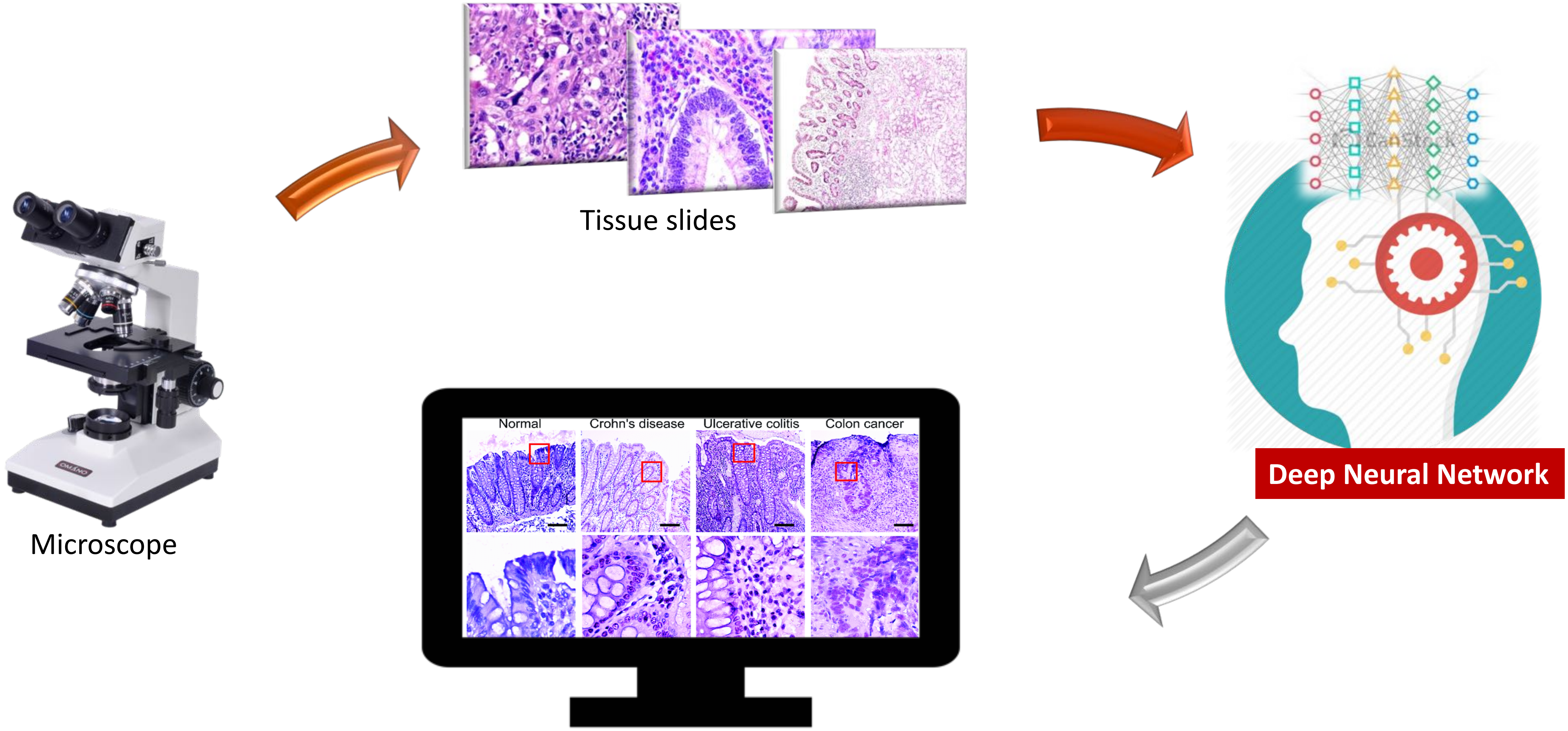
Recap – Thursday Oct 18

1	Early detect disease/cancer
	Predict disease/cancer growth
2	Reconstruction and Image quality

Purpose: Detecting Disease/Cancer at an early stage

A deep neural network was trained to detect disease/cancer by analysing images



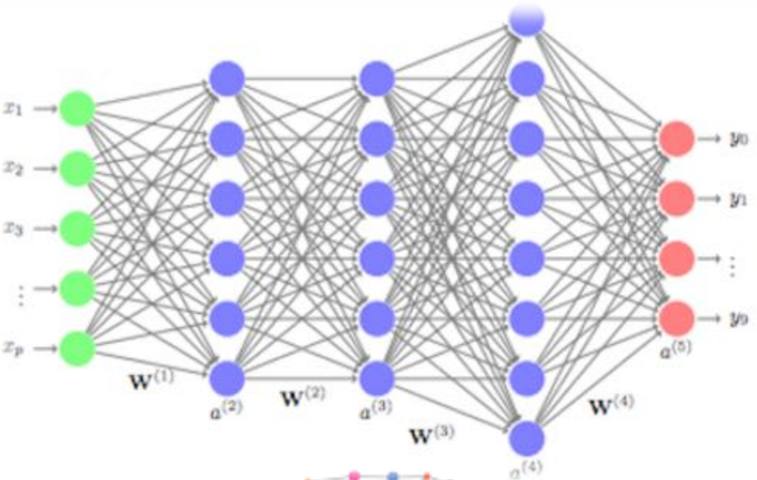
Purpose: Detecting Disease/Cancer at an early stage

Inquire from different equipment

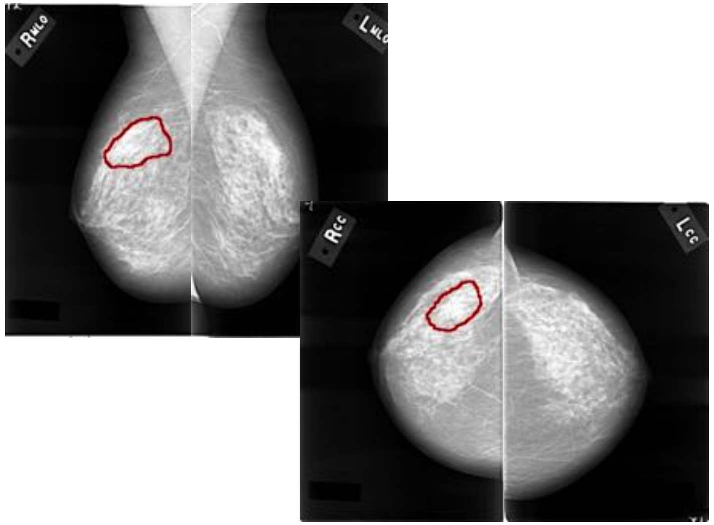
Screening Mammography

Xray – CT scan

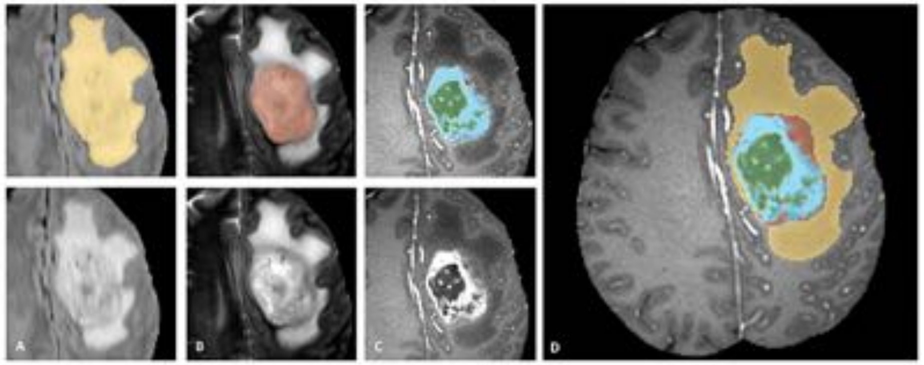
Deep Network Learning



Detecting Results

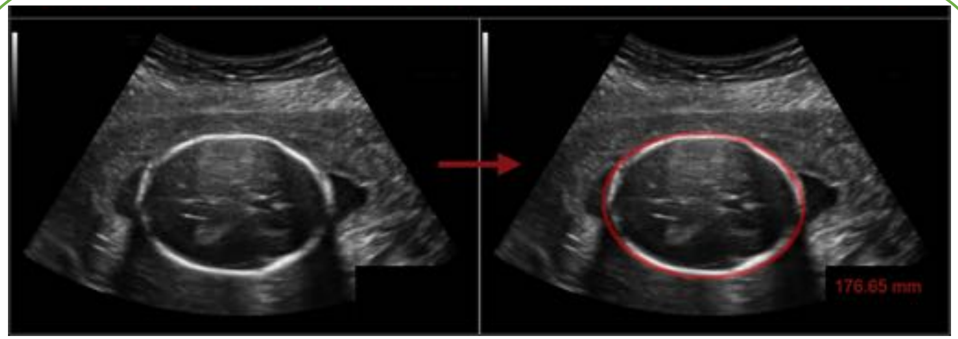


What can we do?

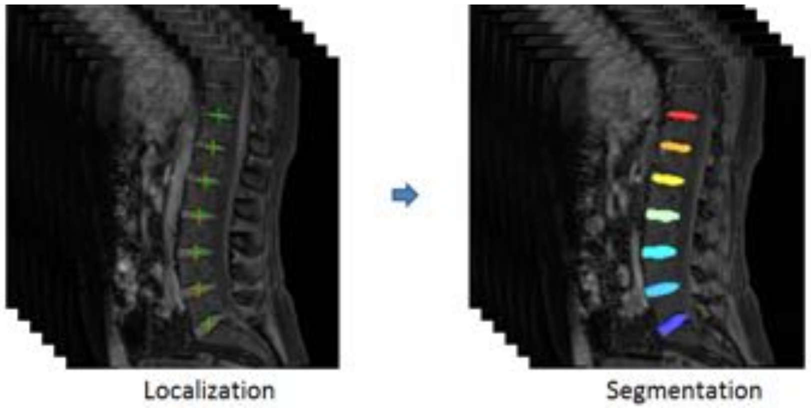


Segmentation of gliomas in pre-operative MRI scans

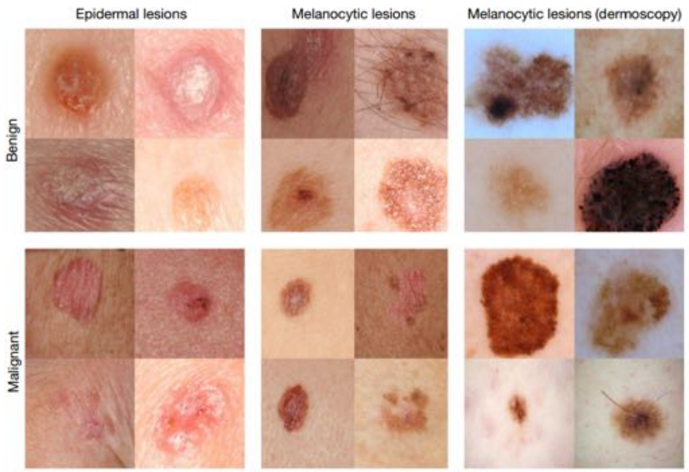
Prediction of patient overall survival (OS) from pre-operative scans



Automatically measure the fetal head circumference given a 2D ultrasound image.

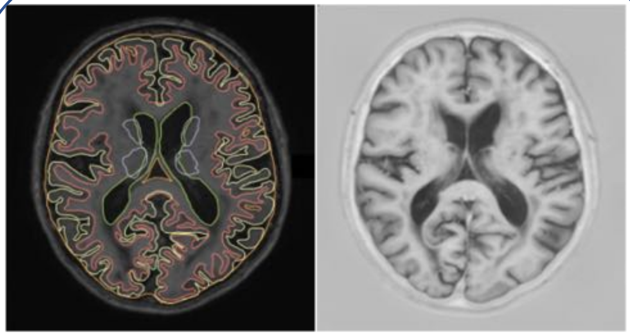


Automatic IVD Localization and Segmentation from 3D Multi-modality MR (M3) Images

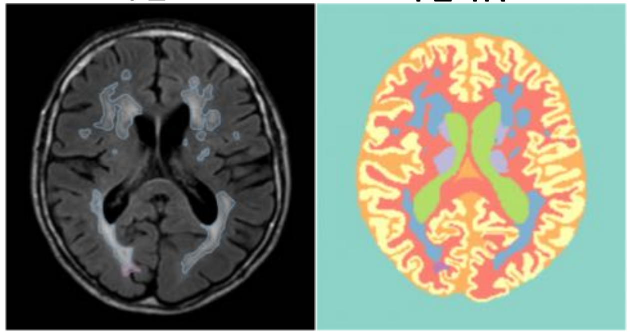


Diagnoses skin cancer

What can we do?



T1 T1-IR



T1-Flair Segmentation

Segmentation of gray matter, white matter, cerebrospinal fluid, and other structures on multi-sequence brain MR images

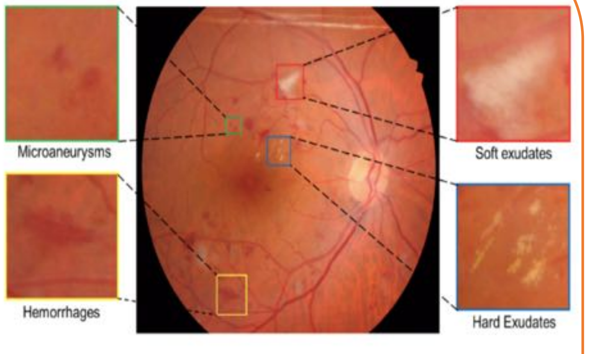
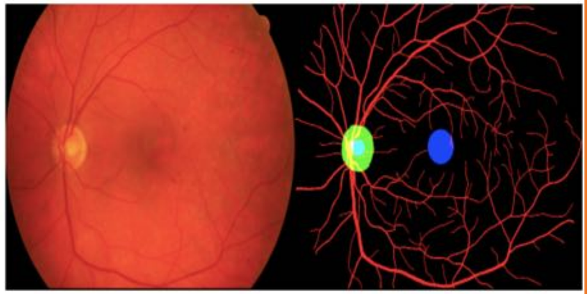
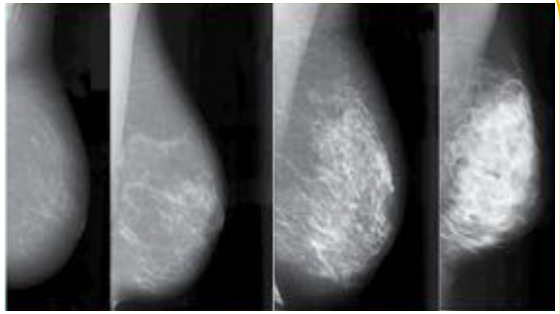
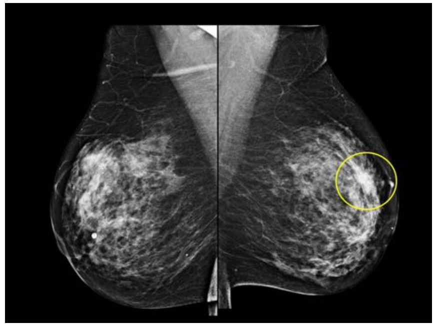


Fig. 2 Clinical Signs of DR

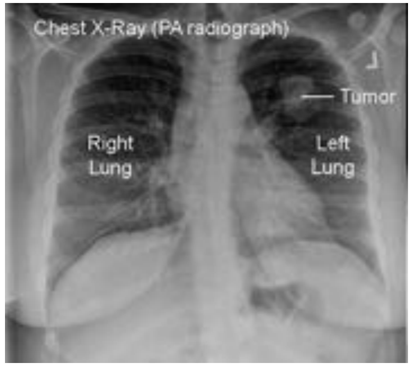


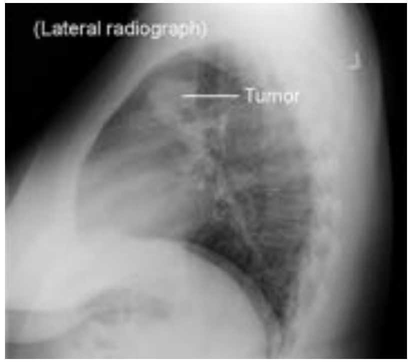
Retina Image Segmentation and Grading Based





Breast Cancer Detection & Prediction

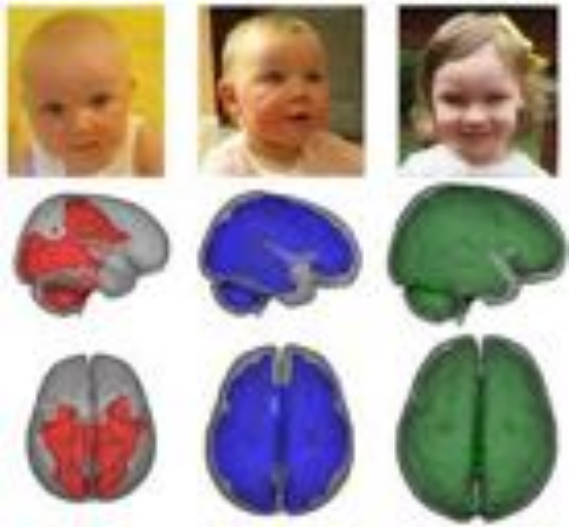




Lung Tumor detection

What can we do?

Alzheimer forecasting



Baby Brain Growth forecasting

Purpose

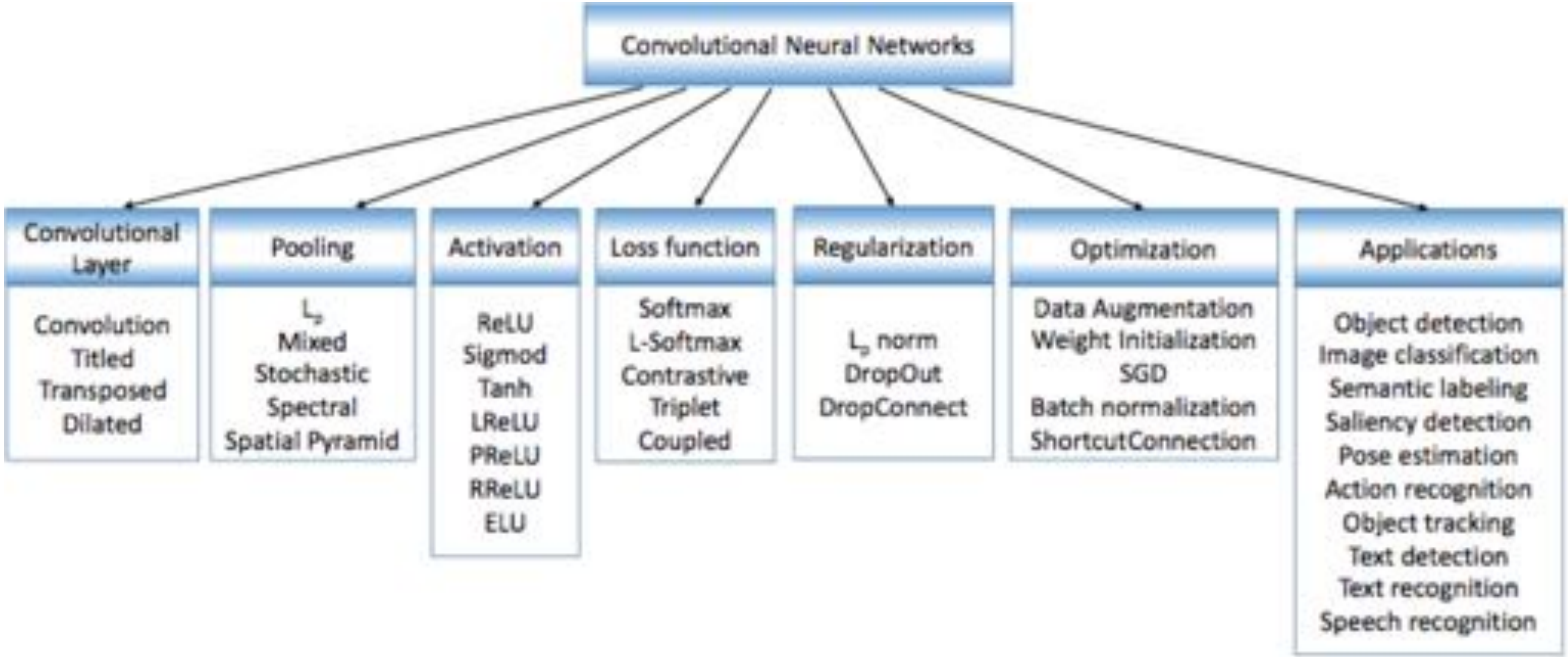
- Assist doctor
- Don’t think replace

Challenging

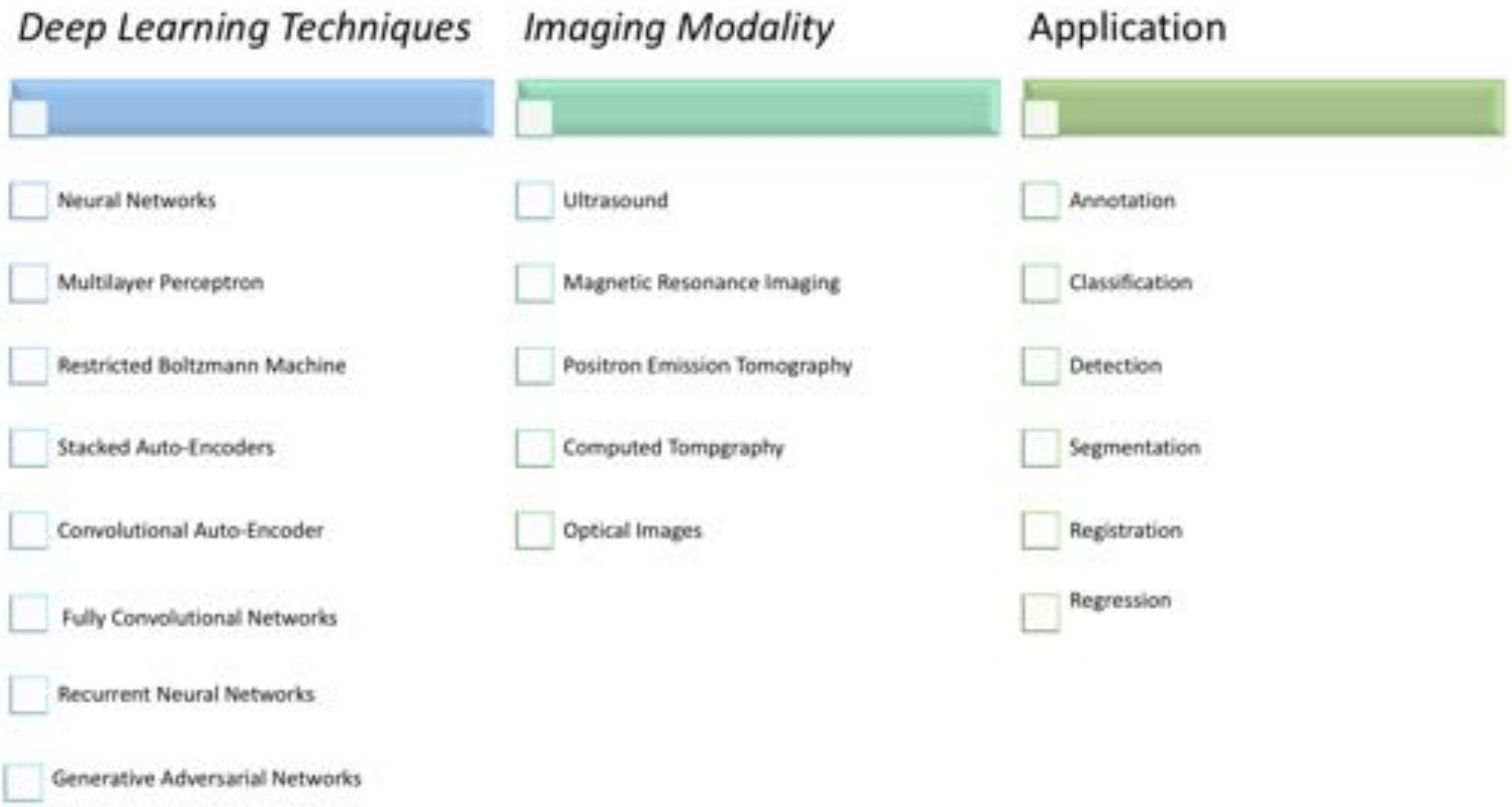
(different from natural images and face images)

Acquiring, annotating and distributing medical image data sets are costly
Requires high levels of expertise from clinicians with limited time
Capturing high-resolution data in multiple dimensions Data dimensionality: 2D – 5D
Stored in different formats than in many computer vision tasks, e.g DICOM, NIfTI, Analyze
Due to privacy concerns, sharing data sets between institutions, let alone internationally, is logistically and legally challenging
Typical data sets remain small

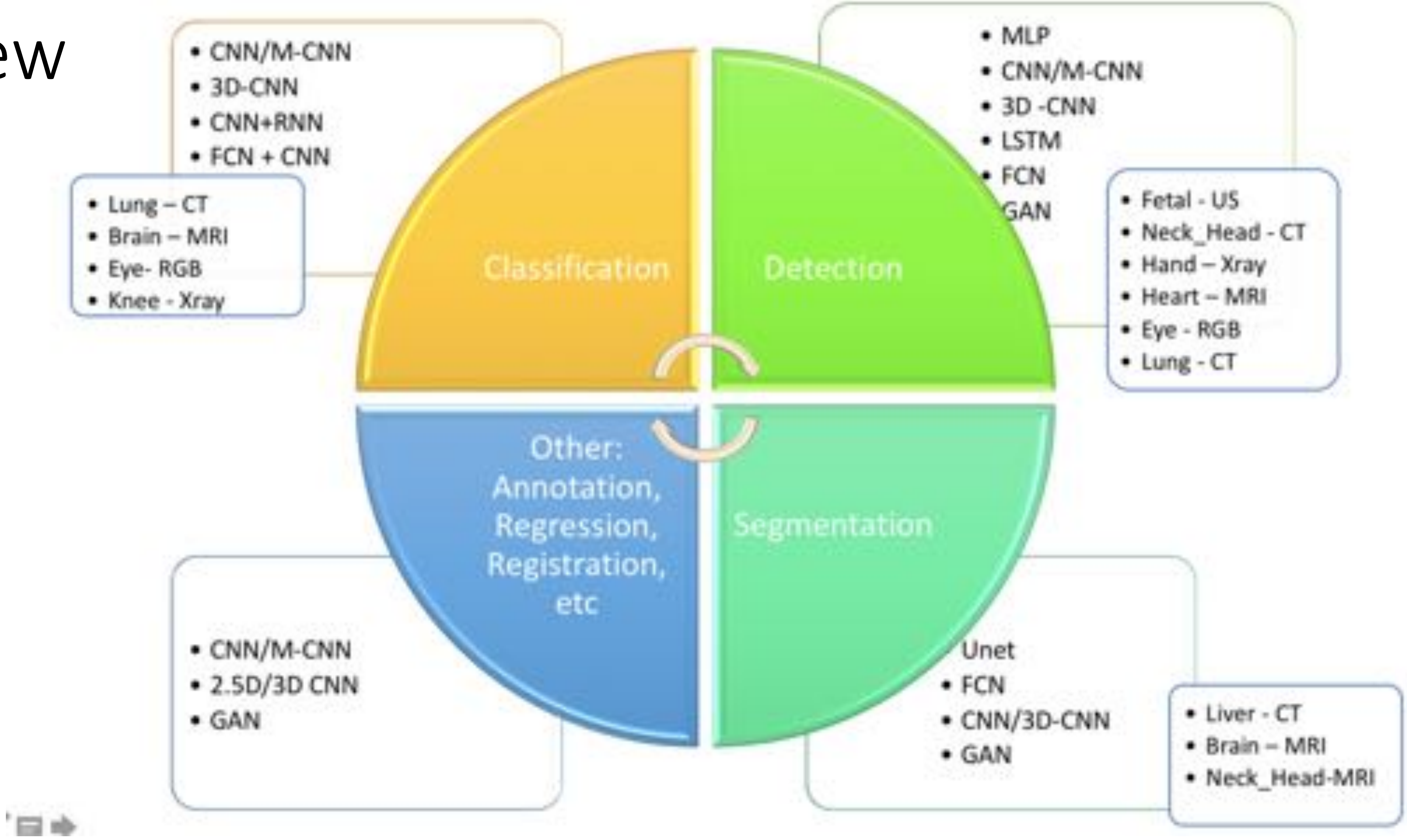
What need to consider when design a network



Review


Deep Learning Techniques
Imaging Modality
Application
Neural Networks
Multilayer Perceptron
Restricted Boltzmann Machine
Stacked Auto-Encoders
Convolutional Auto-Encoder
Fully Convolutional Networks
Recurrent Neural Networks
Generative Adversarial Networks
Ultrasound
Magnetic Resonance Imaging
Positron Emission Tomography
Computed Tompgraphy
Optical Images
Annotation
Classification
Detection
Segmentation
Registration
Regression

Review



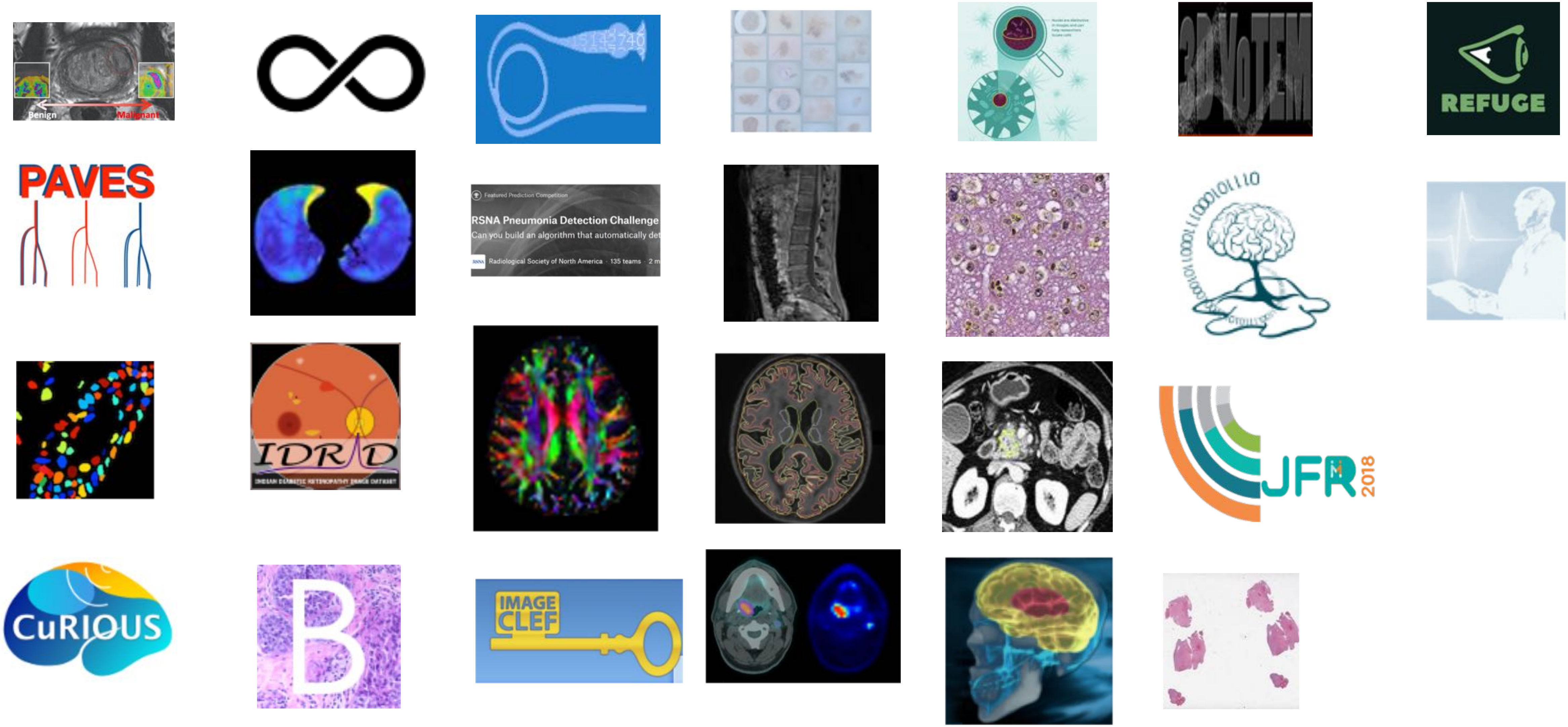
CNN/M-CNN
3D-CNN
CNN+RNN
FCN + CNN
Lung – CT
Brain – MRI
Eye- RGB
Knee - Xray
Classification
MLP
CNN/M-CNN
3D -CNN
LSTM
FCN
GAN
Fetal - US
Neck_Head - CT
Hand – Xray
Heart – MRI
Eye - RGB
Lung - CT
Detection
Other:
Annotation,
Regression,
Registration,
etc
CNN/M-CNN
2.5D/3D CNN
GAN
Segmentation
Unet
FCN
CNN/3D-CNN
GAN
Liver - CT
Brain – MRI
Neck_Head-MRI

Deep learning libraries and platforms

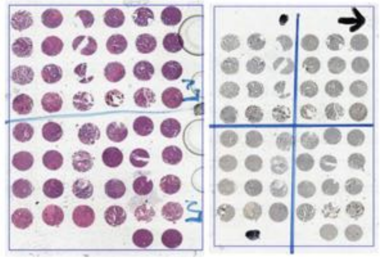
Flatform	Language	Pros/Cons	Speed	By
Tensorflow	Python, C	• Good amount of documentation • Has the ability to do partial subgraph computation • Theano frameworks, Keras, supports TensorFlow	Slower than Theano and Torch	Google
Caffe	C	• Benefits from having a large repository of pre-trained neural network models	Slower than Theano & torch	BVLC
Torch	Lua	• easy to set up • large amount of sample code and tutorials • can import trained NN models from Caffe's Model Zoo • difficult to set up in CentOS	Competitive with Theano	NYU
Theano	Python	• Large amount of sample code and tutorials	competitive with Torch	MILA
Spark SystemML	Java, Python	• It is a whole platform – from OS to programming frameworks (not single) • Made open source through Apache Incubator	No examined	IBM
Neon	Python	• has a syntax similar to Theano's high-level frameworks (Keras)	fastest	Intel

Where to find databases and toolkits

https://grand-challenge.org/challenges/

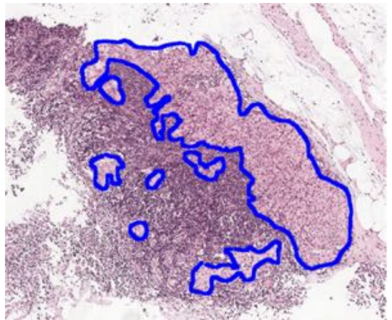


Liver Tumor Segmentation Challenge



Tissue Microarray Analysis in Thyroid Cancer Diagnosis

Skin Lesion Analysis Towards Melanoma Detection



CAMELYON17

3-D Validation of Tractography with Experimental MRI (3D VoTEM)

Diabetic Retinopathy – Segmentation and Grading Challenge

Lung Nodule Malignancy Prediction, Based on Sequential CT Scans

DREAM CHALLENGES
powered by Sage Bionetworks

http://dreamchallenges.org

Centers for Disease Control and Prevention
CDC 24/7: Saving Lives. Protecting People.™

https://data.cdc.gov/browse

Stanford ML Group
MURA
Bone X-Ray Deep Learning Competition

https://stanfordmlgroup.github.io/competitions/mura/

Toolkits

NifTK

https://github.com/NifTK

https://github.com/MITK/MITK

NiftyNet

https://github.com/NifTK/NiftyNet

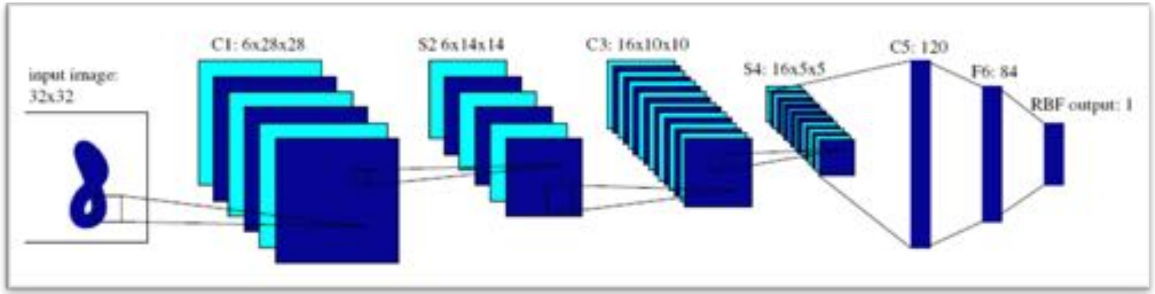
https://github.com/DLTK/DLTK

https://github.com/InsightSoftwareConsortium/ITK

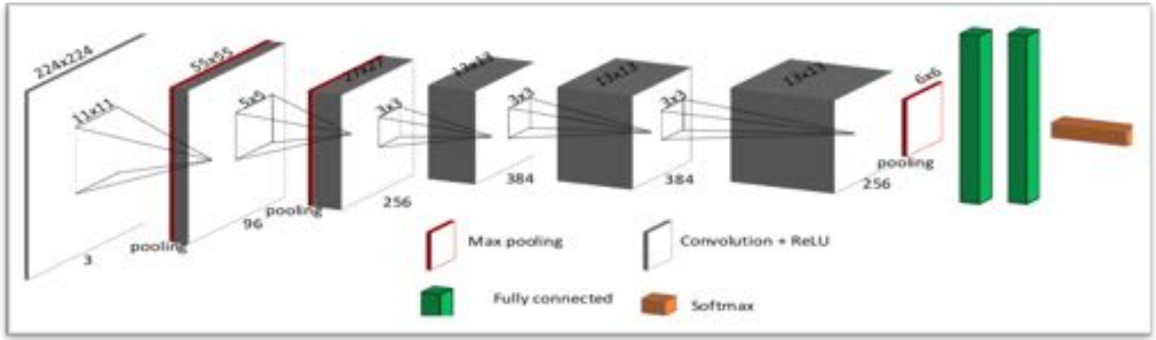
What are common networks in computer vision and in medical imaging?

computer vision

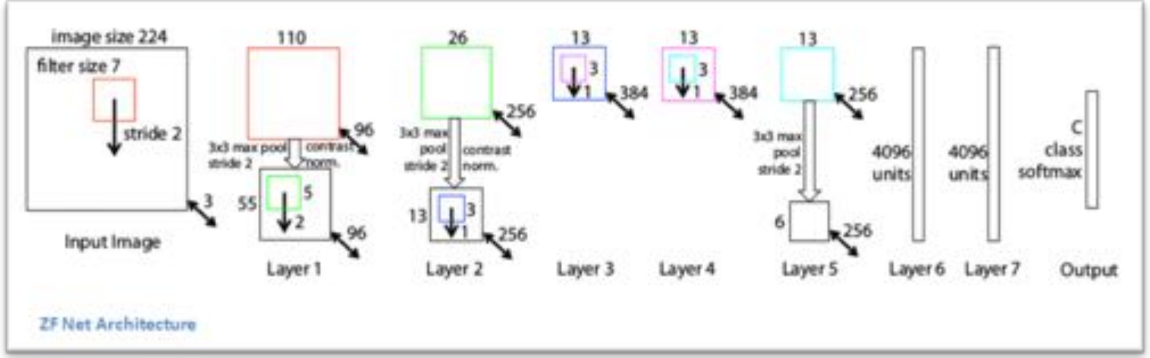
Lenet, 1990



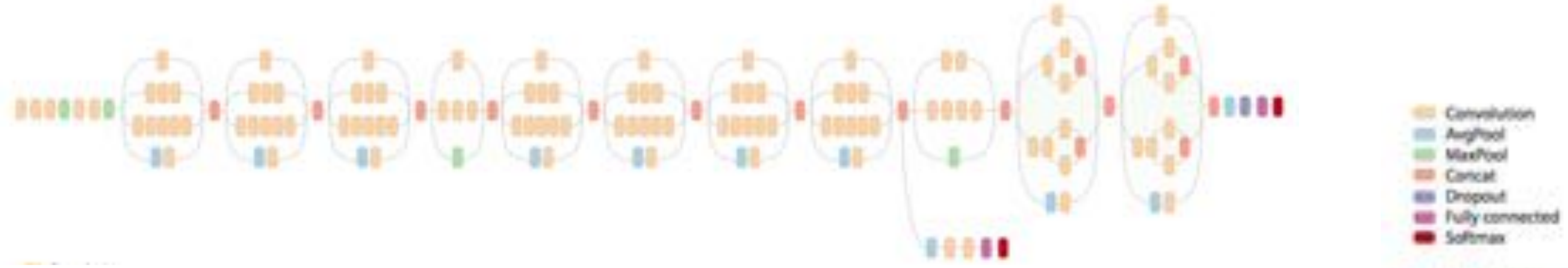
Alexnet,
ILSVRC 12: 15.3% top 5 error



ZFNet
ILSVRC 13: 11.2% top 5 error

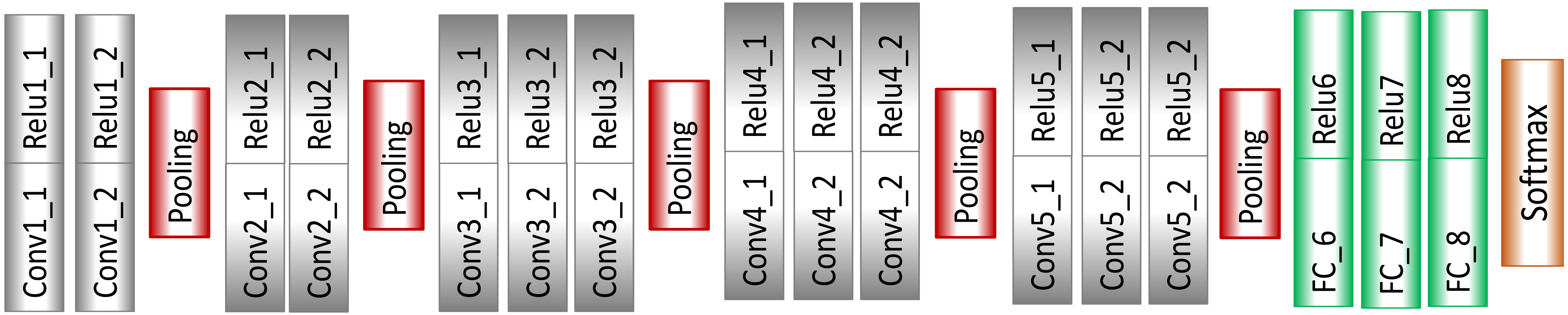


GoogLenet
ILSVRC 14: 6.7% top 5 error

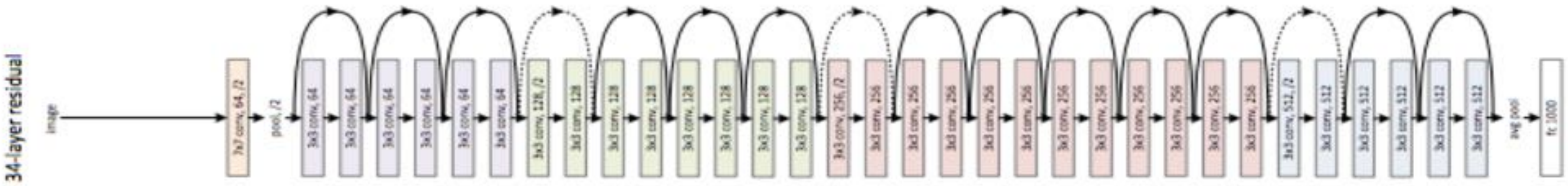


computer vision

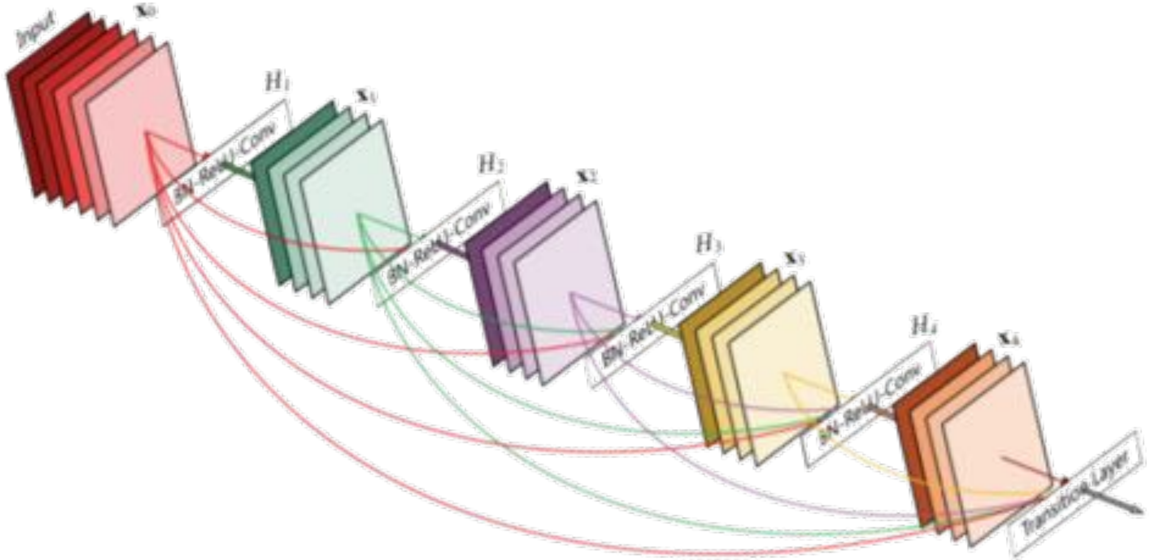
VGG-16
ILSVRC 14: 11.2% top 5 error



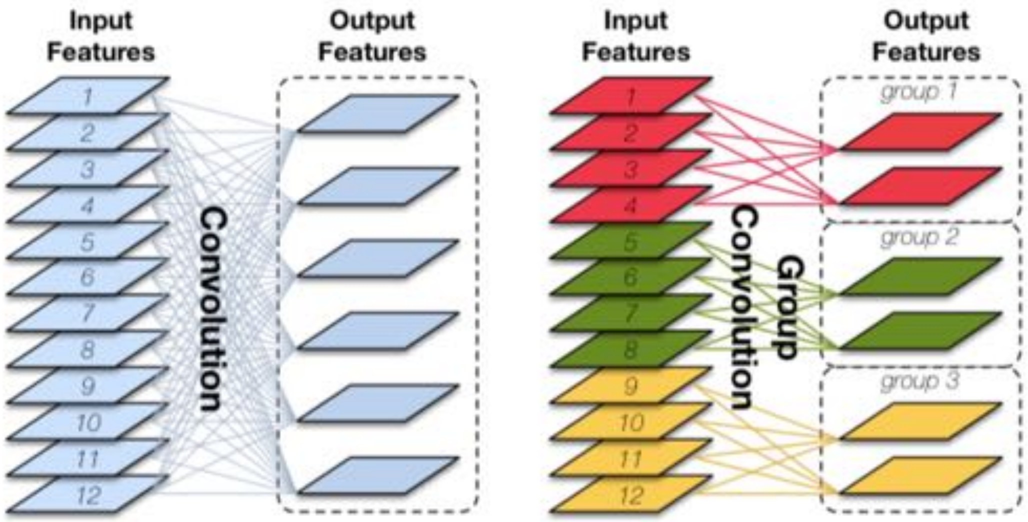
Resnet
ILSVRC 15: 3.6% top 5 error



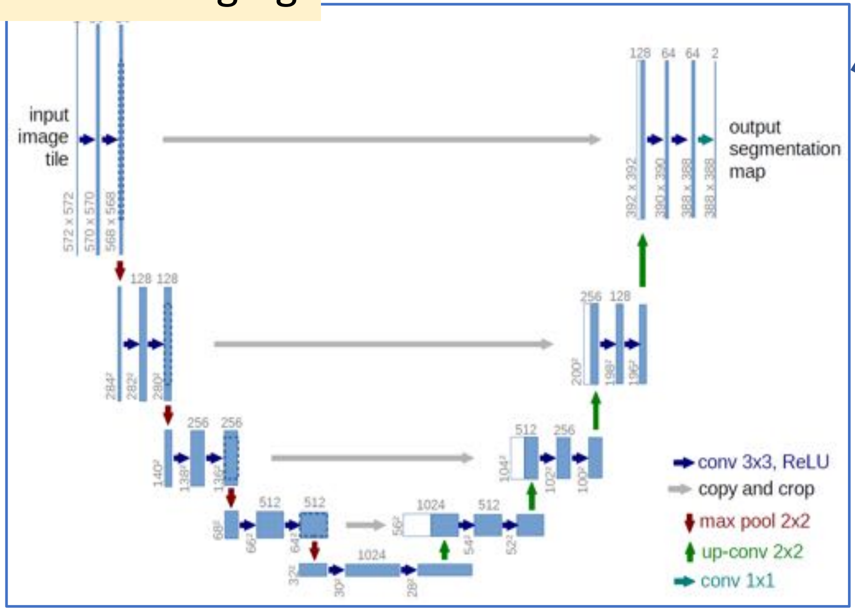
DenseNet



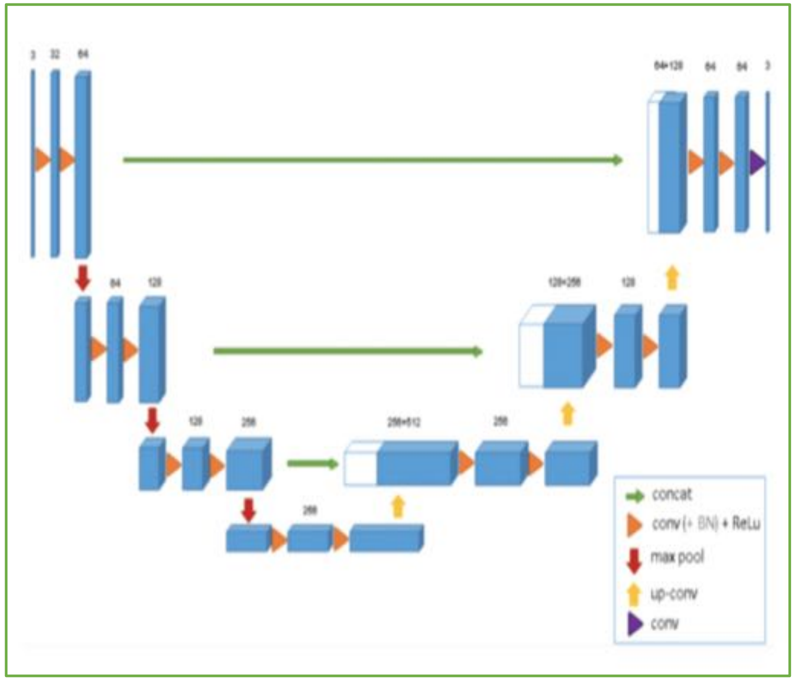
Condensenet



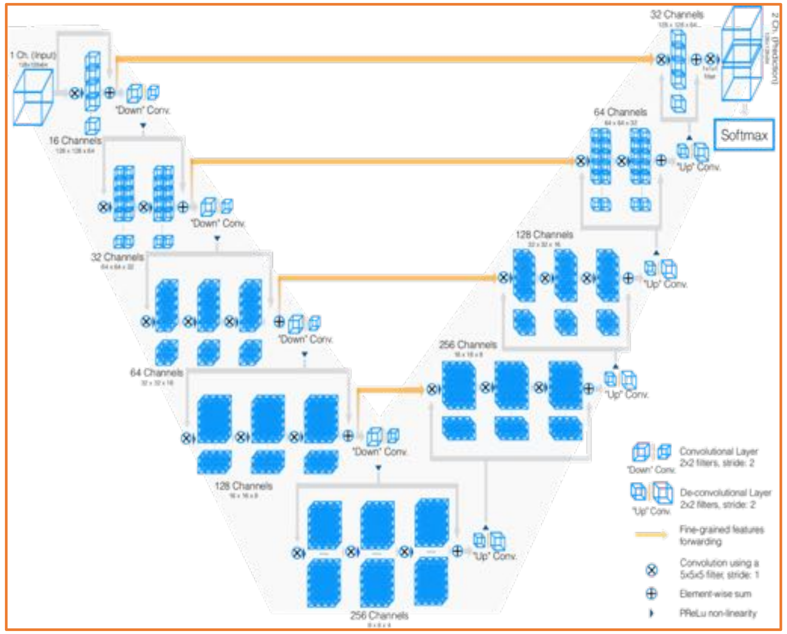
Medical imaging



Unet, 2015

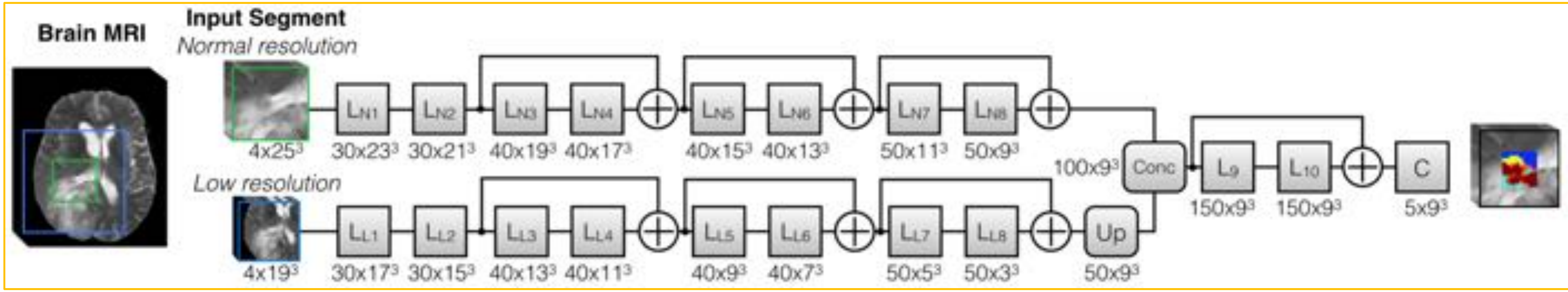


3D-Unet, 2016

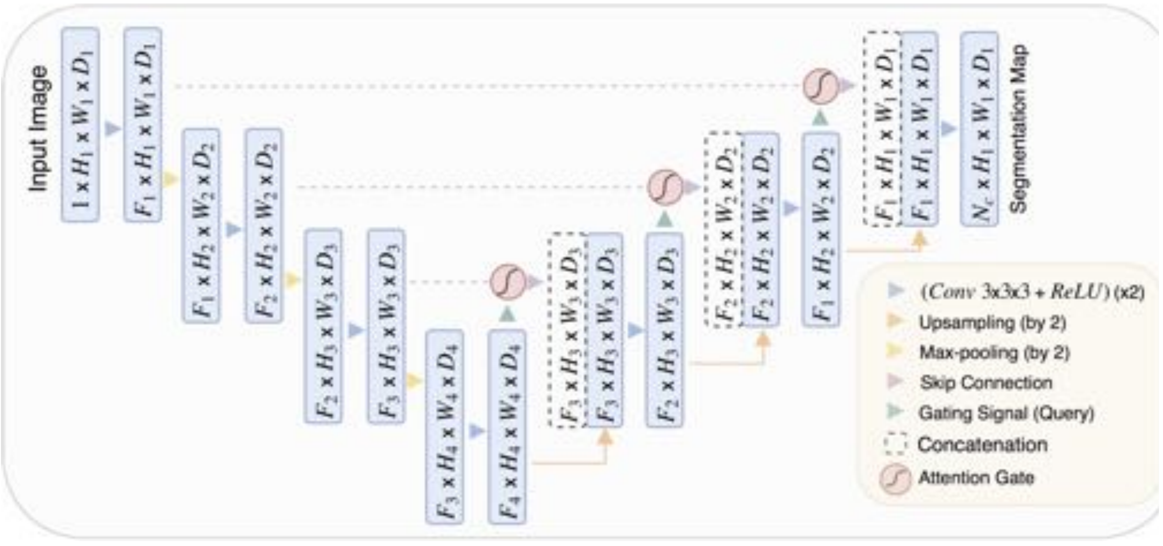


Vnet, 2016

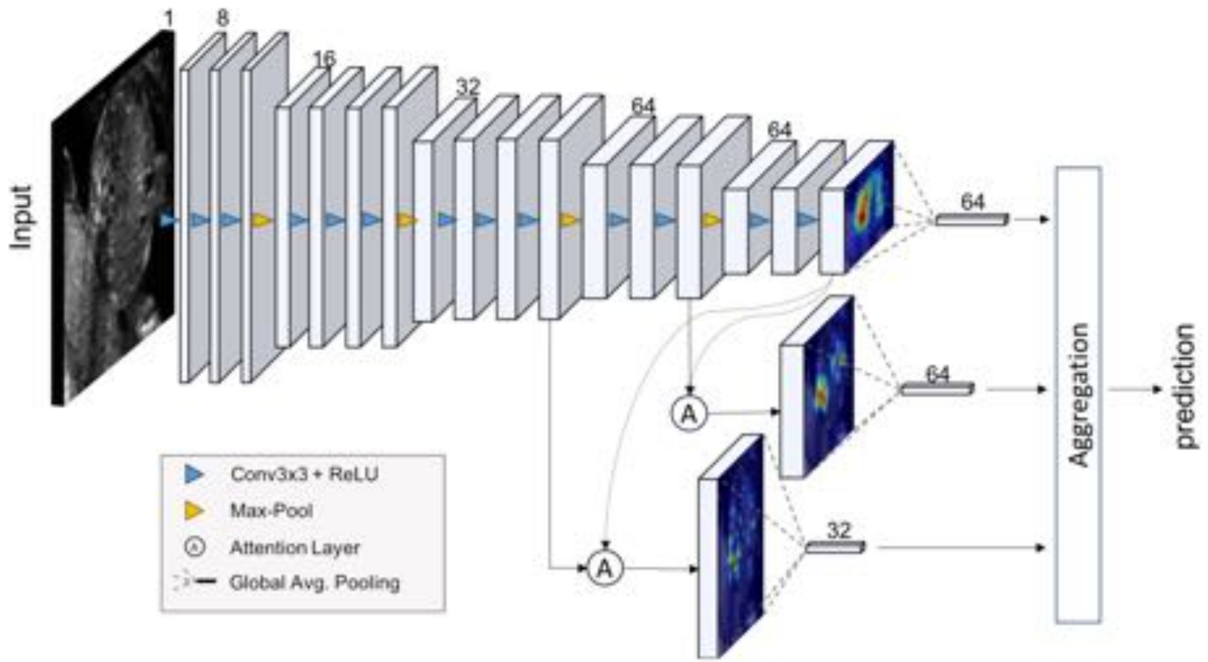
DeepMedic, 2016



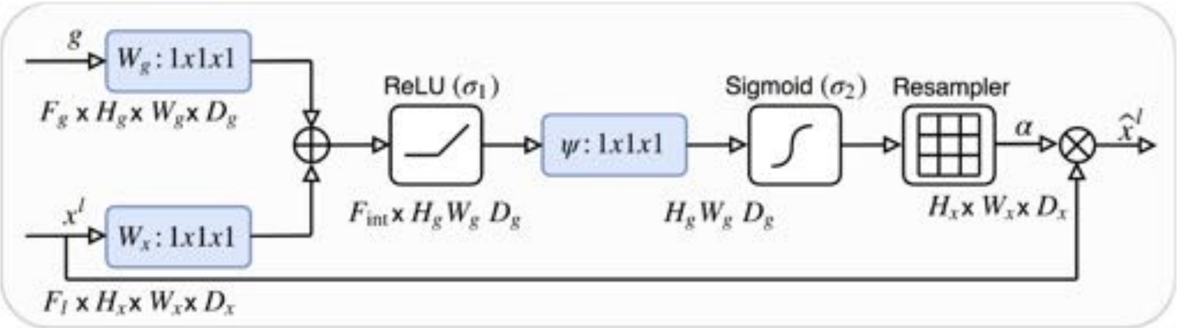
Medical imaging



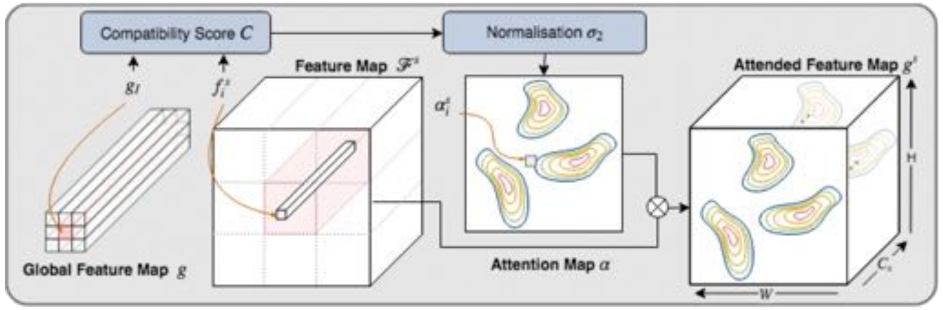
Attention U-net, 2017



Attention Gated Network, 2017



Attention gate



Attention unit