

# Tumor Detected!

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MARVLVS

# Challenge

Come up with a software solution to a problem of **accidental tumor findings** being missed on regular brain CT scans when visiting the emergency room

Single out slices that have **abnormalities** for the doctor to examine in more detail.

Browser **application** used on the data from emergency room. P

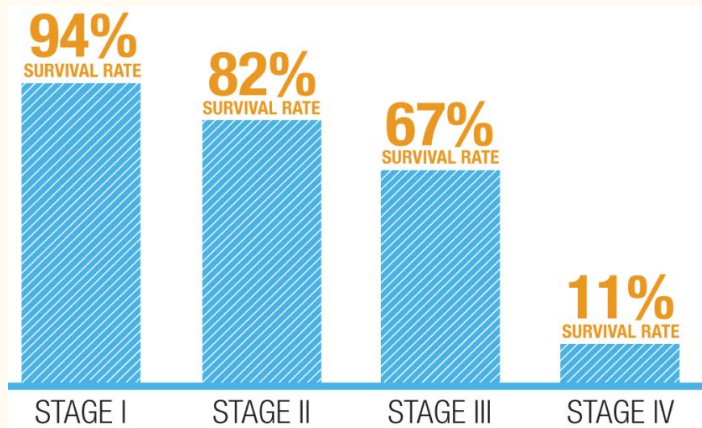
CT is cheaper and faster than MRI.

# Practical application

Screening software would single out suspicious slices

Slices are then sent to a **radiologist/oncologist** for further review

Large scale screening method could greatly increase the **cancer survival rate**



# Comparison of two used methods

	Supervised slice classification with CNN	Unsupervised slice ordering based on brain symmetry
Labels required	Yes	No
Data hungry	Yes	No
Recognizes tumors	Yes	No
Robust towards rotation	Yes	No
Train time	Long	Short

# Deep Learning Approach

# Accessing the data

★ dicompyler  
File Tools Help

Open Patient Open Quickly

Plan  
Plan Name: -  
Rx Dose: - cGy

Structures Isodoses

Patient  
Name: 029 ID: 029  
Gender: Male DOB: 19530514

2D View DICOM Tree

RT Structure Set

Name	Value	Tag	VM	VR
RT Structure Set Storage				
Specific Character Set	ISO_IR 192	(0008, 0005)	1	CS
Instance Creation Date	20181018	(0008, 0012)	1	DA
Instance Creation Time	065432	(0008, 0013)	1	TM
SOP Class UID	RT Structure Set Storage	(0008, 0016)	1	UI
SOP Instance UID	1.2.246.352.205.56828260.20265889765	(0008, 0018)	1	UI
Study Date	20170706	(0008, 0020)	1	DA
Study Time	115813.197	(0008, 0030)	1	TM
Accession Number		(0008, 0050)	1	SH
Modality	RTSTRUCT	(0008, 0060)	1	CS
Manufacturer	Varian Medical Systems	(0008, 0070)	1	LO
Referring Physician's Name		(0008, 0090)	1	PN
Station Name	variancombo	(0008, 1010)	1	SH
Study Description	Head~Stereo (Adult)	(0008, 1030)	1	LO
Series Description	ARIA RadOnc Structure Sets	(0008, 103e)	1	LO
Physician(s) of Record	Bajcsay~Andras	(0008, 1048)	1	PN
Manufacturer's Model Name	ARIA RadOnc	(0008, 1090)	1	LO
Patient's Name	029	(0010, 0010)	1	PN
Patient ID	029	(0010, 0020)	1	LO
Patient's Birth Date	19530514	(0010, 0030)	1	DA
Patient's Birth Time	000000	(0010, 0032)	1	TM
Patient's Sex	M	(0010, 0040)	1	CS
Other Patient IDs	C7930	(0010, 1000)	1	LO
Device Serial Number	459186805940	(0018, 1000)	1	LO
Software Version(s)	13.7.33	(0018, 1020)	1	LO
Study Instance UID	1.3.12.2.1107.5.1.4.65763.3000001707	(0020, 000d)	1	UI
Series Instance UID	1.2.246.352.71.2.459186805940.33310	(0020, 000e)	1	UI
Study ID	1	(0020, 0010)	1	SH
Series Number	7	(0020, 0011)	1	IS
Structure Set Label	Plan_1	(3006, 0002)	1	SH
Structure Set Name	POIandRtOandBOLUS	(3006, 0004)	1	LO
Structure Set Date	20181018	(3006, 0008)	1	DA

Structure Information

Volume: - cm³  
Min Dose: - %  
Max Dose: - %  
Mean Dose: - %



# Preprocessing the data

- 1) Starting and ending point of each tumor in a CT
  - 2) Resizing (w/ Aspect Ratio) - 224x224 px
  - 3) Associating slices with CT data (FrameOfRefUID)
  - 4) Assigning “Tumor” or “Not Tumor” to slices
- And muuuch more

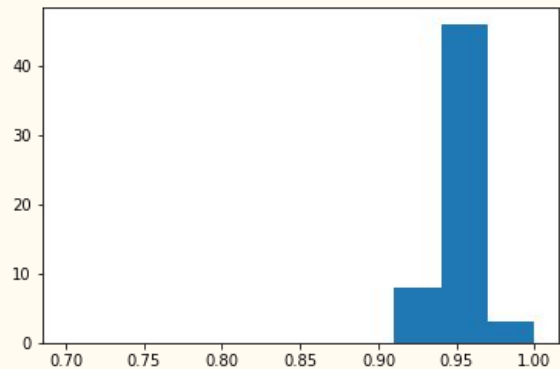
# Feeding the neural net

- ConvNets - standard for supervised learning with images
- VGG16
- Hungry for data

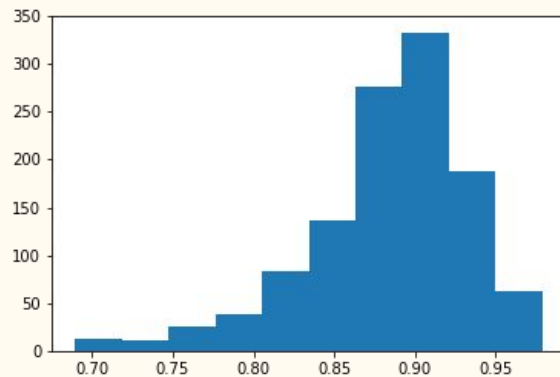


# Brain Symmetry Approach

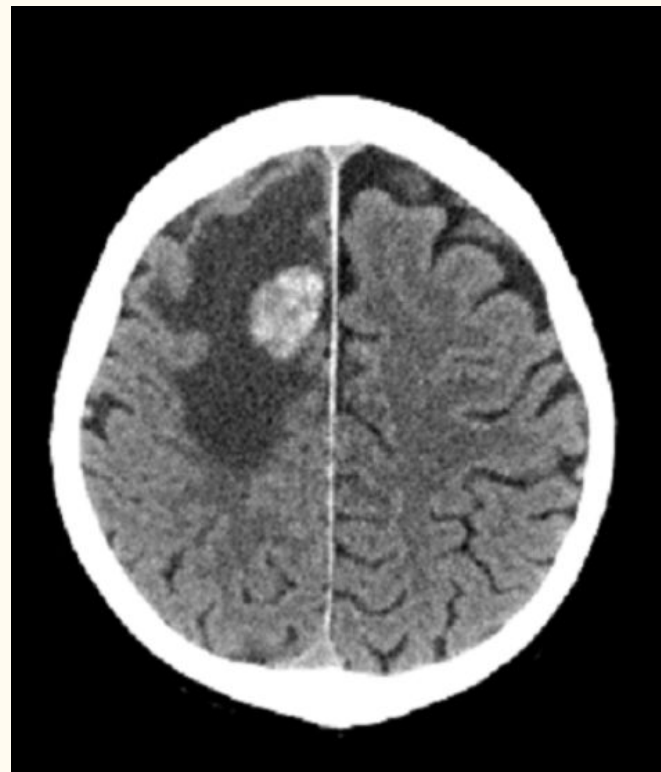
# Using brain symmetry for tumor detection



Healthy



With tumors



# Using brain symmetry for tumor detection

Recovery of symmetry axis of a mass.

Recovery of linear dependency of two splitted parts.

TABLE 2: Comparison of different segmentation techniques.

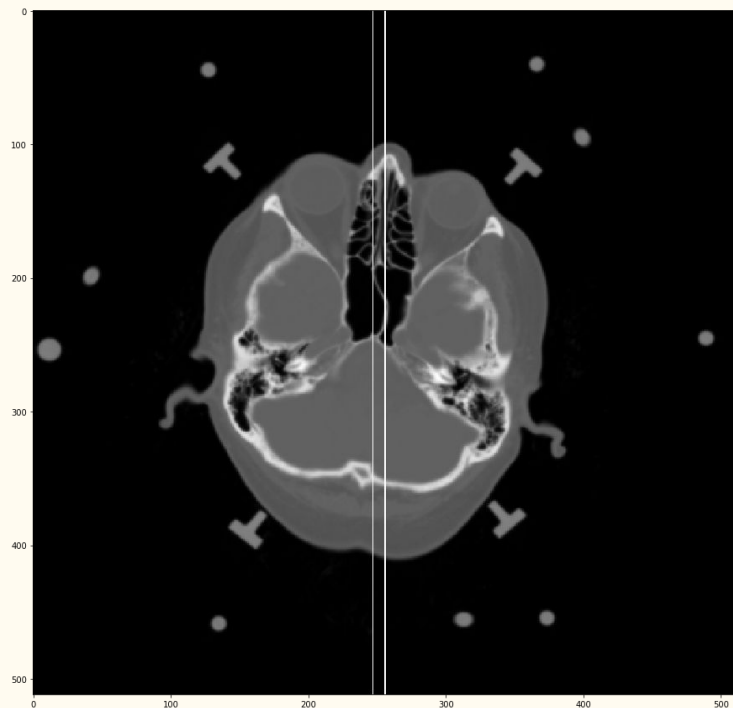
Techniques	Prior knowledge	User interaction required	Work in presence of noise	Simple
Supervised	Yes	Yes	Yes	No
Unsupervised	Yes	Yes	Yes	Yes
Registration	Yes	No	No	Yes
Symmetry	No	No	Yes	Yes

\* <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3966434/pdf/CMMM2014-712783.pdf>

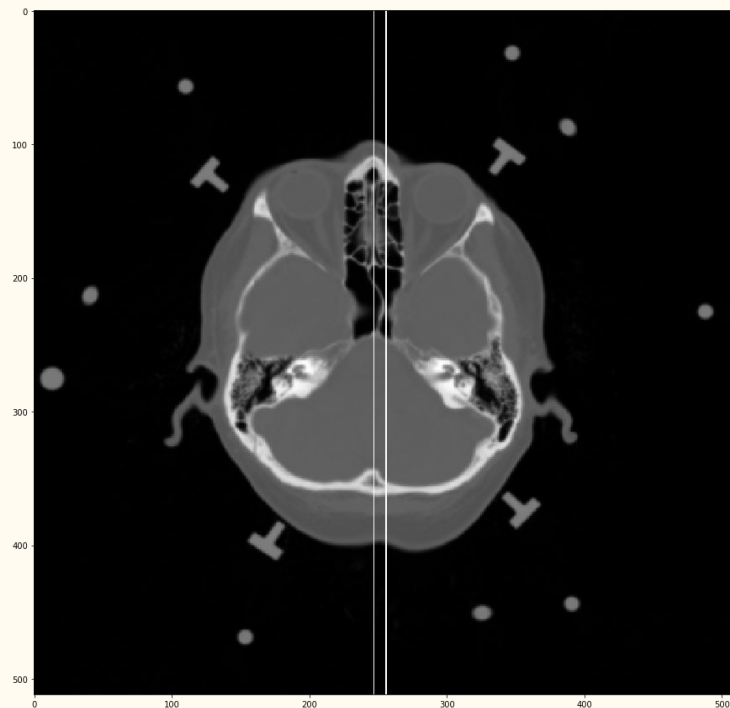
Saddique, Mubbashar, Jawad Haider Kazmi, and Kalim Qureshi. "A Hybrid approach of using symmetry technique for brain tumor segmentation." *Computational and mathematical methods in medicine* 2014 (2014).

# Challenges - Rotation

Original

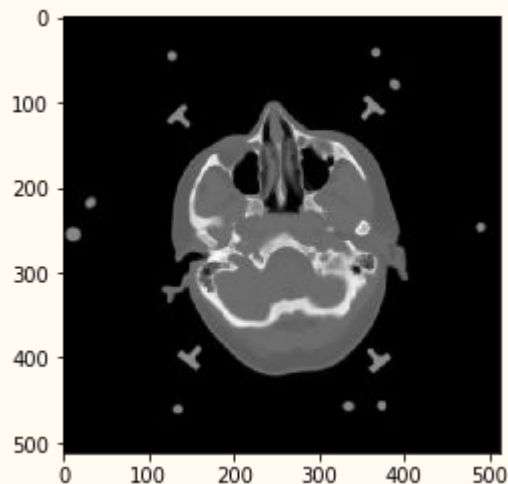


Rotated

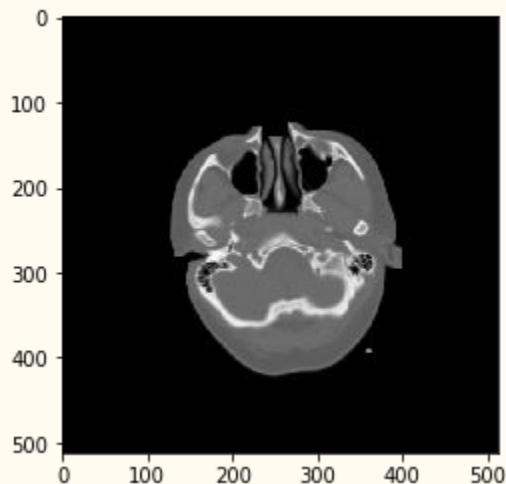


# Challenges - Noise, Extreme values

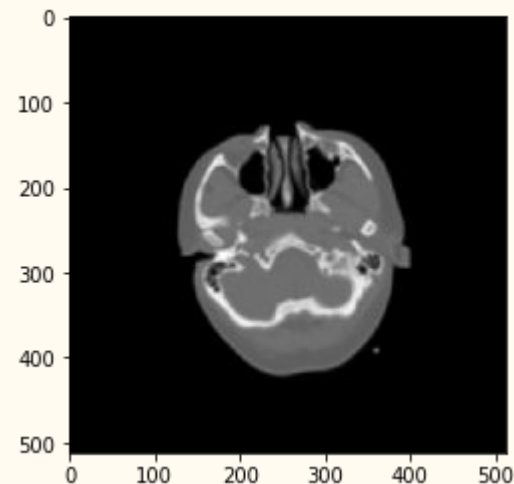
Original



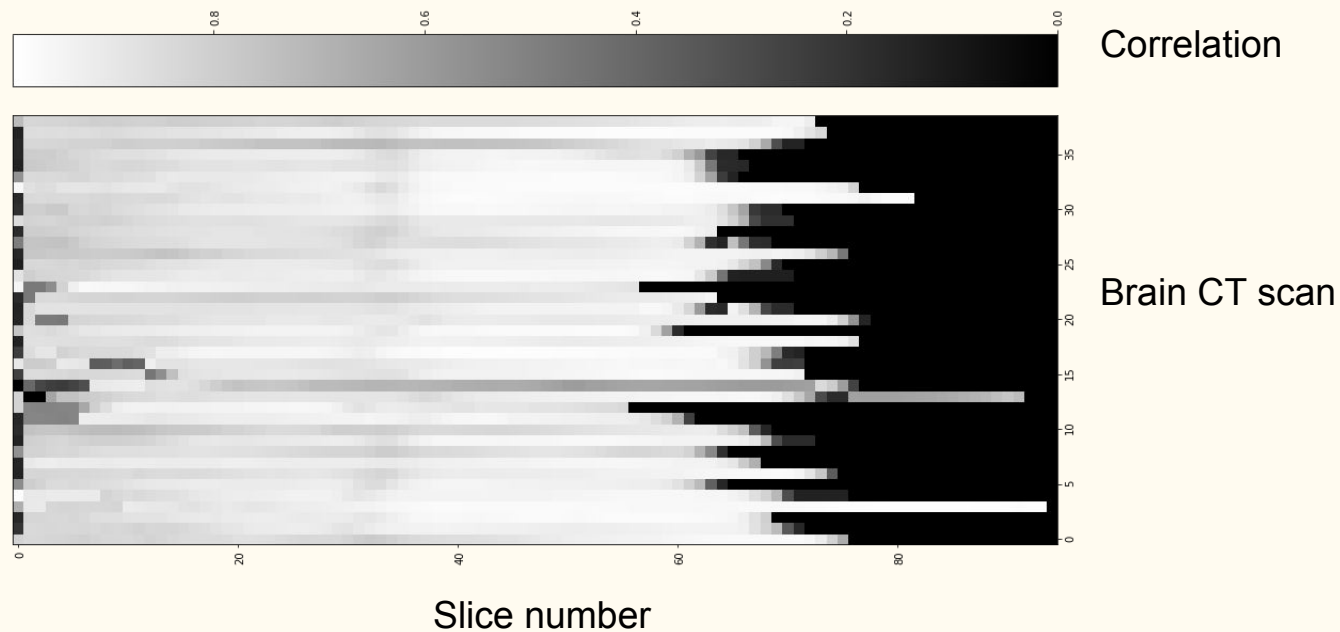
Noise removed



Extreme values smoothed

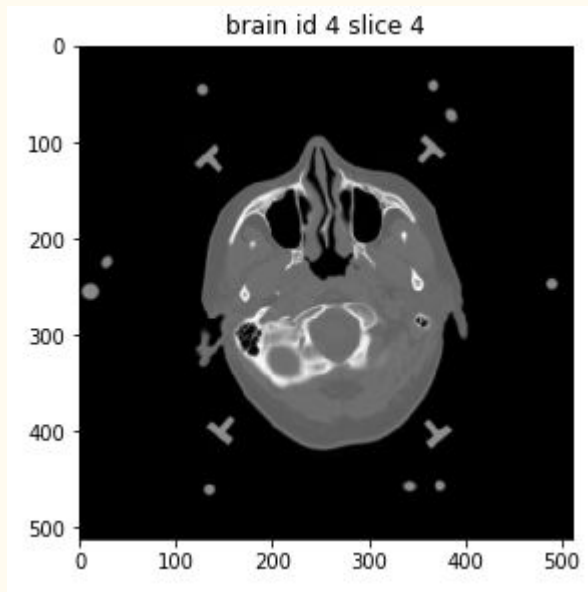


# Summary results - all tumor brains

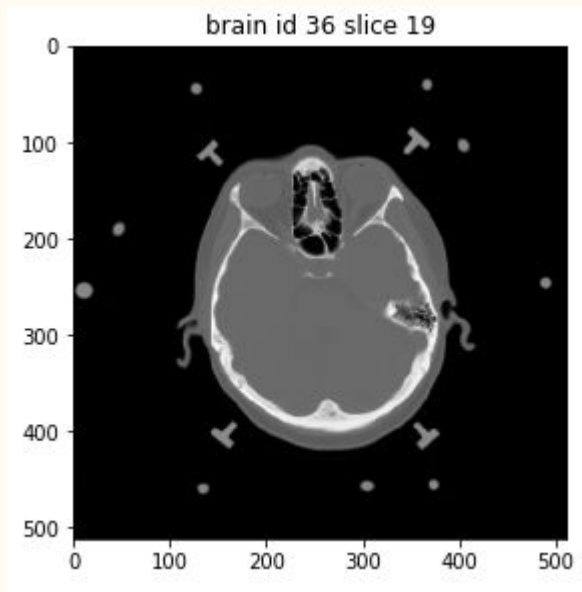


# Symmetry results- examples

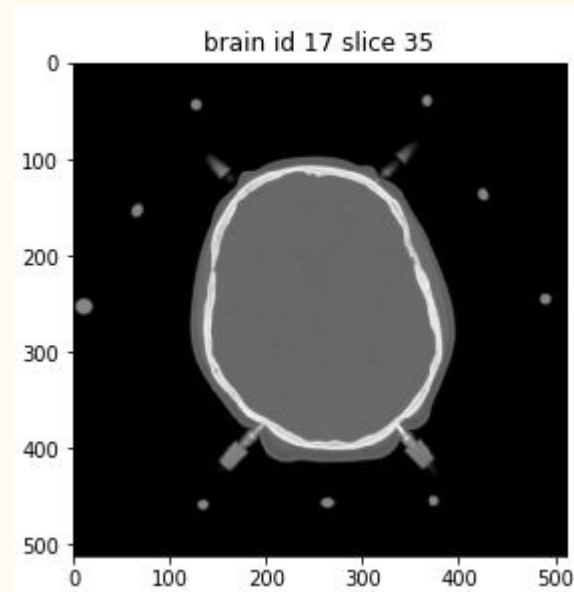
Improperly rotated slice,  
with noise, very low  
correlation



Slice with tumor. Correlation  
coefficient in lower middle interval



Slice with high correlation  
coefficient



# Software interface

## Brain CT Screening System

Upload

Input data

- CT.339663.Image 22.dcm
- CT.339663.Image 23.dcm
- CT.339663.Image 24.dcm
- CT.339663.Image 25.dcm
- CT.339663.Image 26.dcm
- CT.339663.Image 27.dcm
- CT.339663.Image 28.dcm
- CT.339663.Image 29.dcm
- CT.339663.Image 30.dcm
- CT.339663.Image 31.dcm
- CT.339663.Image 32.dcm
- CT.339663.Image 33.dcm
- CT.339663.Image 34.dcm
- CT.339663.Image 35.dcm
- CT.339663.Image 36.dcm
- CT.339663.Image 37.dcm
- CT.339663.Image 38.dcm
- CT.339663.Image 39.dcm
- CT.339663.Image 40.dcm
- CT.339663.Image 41.dcm
- CT.339663.Image 42.dcm
- CT.339663.Image 43.dcm
- CT.339663.Image 44.dcm
- CT.339663.Image 45.dcm
- CT.339663.Image 46.dcm

Detect

Output data

Clear

- CT.339663.Image 71.dcm
- CT.339663.Image 72.dcm
- CT.339663.Image 73.dcm
- CT.339663.Image 74.dcm
- CT.339663.Image 75.dcm
- CT.339663.Image 76.dcm
- CT.339663.Image 94.dcm
- CT.339663.Image 95.dcm
- CT.339663.Image 96.dcm