



Indian Statistical Institute
Directors Report
2nd Meeting of the Council (2018-2020)
November 5, 2018



Workshops/Conferences

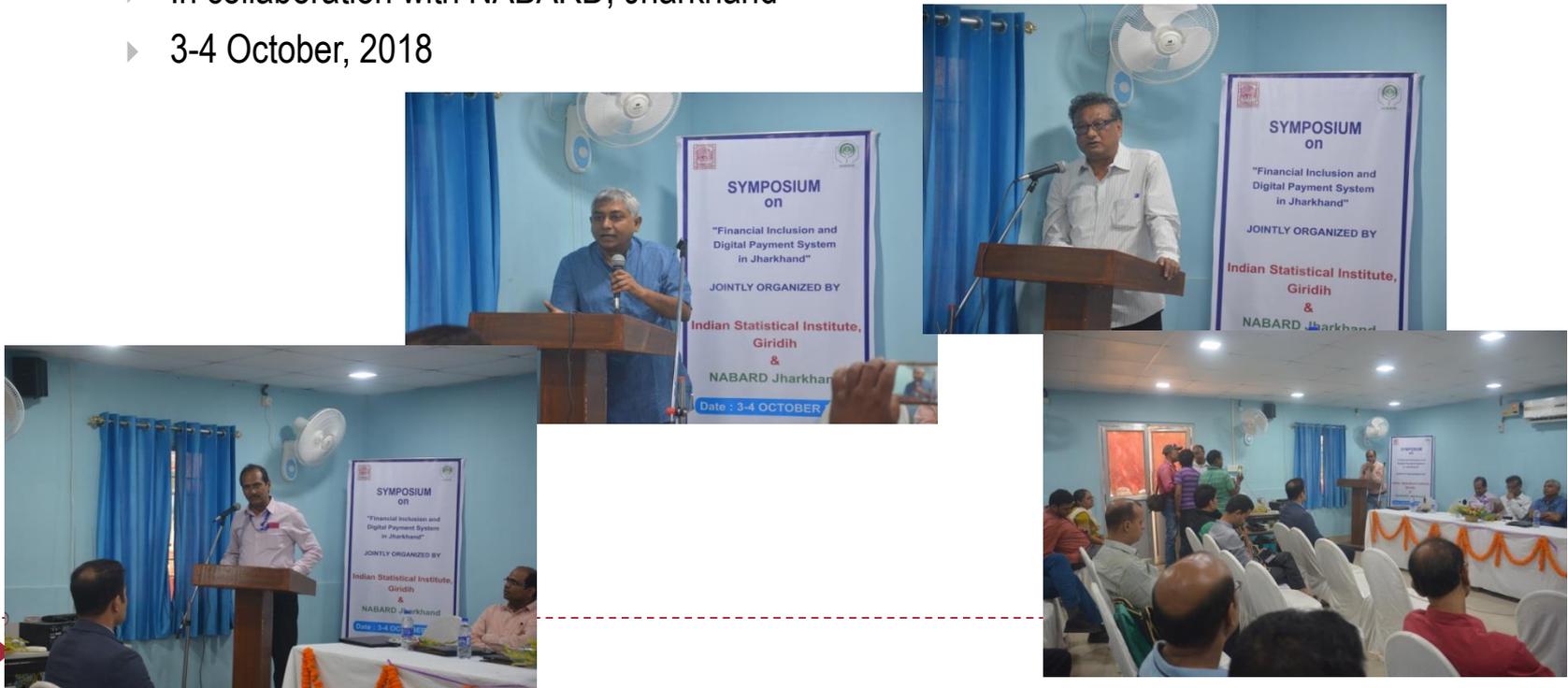
▶ SOSU, ISIK

- ▶ Workshop on Gross Domestic Knowledge Product, Oct 23, 2018
 - ▶ Keynote Address: Shri Pravin Srivastava, Secretary & CSI, MOSPI,
 - ▶ interaction between
 - Official Statisticians of Government of India and
 - academicians of ISI on the proposed project for computation of Gross Domestic Knowledge Product offered by MOSPI, Government of India at the behest of Niti Aayog.



Workshops/Conferences

- ▶ ISIBC: Academic Block Foundation Day
 - ▶ A special lecture by Shri Bibek Debroy, President, ISI
 - ▶ “The Importance of Law Reform” on 31st October 2018
- ▶ SRU, ISI, Giridih
 - ▶ Symposium on *Financial Inclusion and Digital Payment System in Jharkhand*
 - ▶ In collaboration with NABARD, Jharkhand
 - ▶ 3-4 October, 2018



Honors/Achievements

- ▶ Sushmita Mitra, CCSD, ISIK
 - ▶ Fellow of INSA
- ▶ Pradipta Maji, CCSD, ISIK
 - ▶ Elected Fellow of NASI
- ▶ Professor T.S.S.R.K. Rao, SMD, ISIBC
 - ▶ elected Fellow of NASI
- ▶ Prof. Amartya K. Dutta, SMD, ISIK
 - ▶ INSA Teachers Award 2018
 - ▶ Inaugural Professor Satish C. Bhatnagar award
 - ▶ Indian Mathematical Society
 - ▶ For the Paper ``Weighted Arithmetic Mean in Ancient India'', BhAvanA 1 (4) (2017), 24-36

Honors/Achievements

- ▶ Nabajyoti Pathak, ISI-NE
 - ▶ former student of PGDSMA
 - ▶ received the *Star of the Month* award in TCS



- ▶ Tarun Kabiraj, SSD, ISIK
 - ▶ Emerald Outstanding Paper Award 2018
 - ▶ “Outsourcing under Incomplete Information”
 - ▶ co-authored by Uday Bhanu Sinha
 - ▶ Indian Growth and Development Review



Important Results/Publications

▶ S. Banerjee, S. Mitra, and B. Uma Shankar, CCSD, ISIK

- ▶ Multi-planar spatial-ConvNet for segmentation and survival prediction in brain cancer
- ▶ Proc. MICCAI BrainLes (Lesion) workshop, Brain Tumor Segmentation Challenge, Granada, Spain, Sep. 2018
- ▶ Among the top performing methods, according to the leaderboard score

▶ TSSRK Rao, SMD, ISIBC

- ▶ Article in the Journal of Mathematical Analysis and Applications
 - ▶ With late AK Roy
- ▶ a 35 year old open problem on norm attaining operators valued in a Uniformly convex Banach space was settled positively

Multi-Planar Spatial-ConvNet for Segmentation and Survival Prediction in Brain Cancer

Subhasmita Banerjee, Subhmita Mitra, and B. Uma Shankar, Machine Intelligence Unit, Indian Statistical Institute, Kolkata, INDIA

1. Introduction

- Gliomas are the most commonly occurring type of brain tumors and are potentially very "dangerous", with about 80% of Gliomas belonging to a highly aggressive class of cancerous tumors known as Glioblastoma Multiforme (GBM).
- Multi-sequence Magnetic Resonance Imaging is the primary method of screening and diagnosis for Gliomas.
- Tumor regions currently are segmented by expert radiologist, which is time-consuming and expensive.
- Inspired by the success of Convolutional Neural Networks (ConvNets), we developed a novel ConvNet model with spatial pooling for automated segmentation of gliomas from multi-sequence MRI data.
- Accurate delineation of tumor region in MRI sequences is of great importance since it allows: i) volumetric measurement of the tumor, ii) monitoring of tumor growth in the patient between multiple MRI scans, and iii) treatment planning with follow-up evaluation, including the prediction of overall survival (OS).

2. Problem Statement and Dataset

- Brain tumor MRI scan datasets and patient Overall Survival (OS) data, used in this research, were provided by BraTS 18 challenge^{1, 2, 3}.
- **Training Dataset** consists of 210 HGG/GBM and 75 LGG glioma cases.
- **Validation Dataset:** 66 combined cases of HGG/GBM and LGG as validation dataset.
- The OS data was included for 163 patients with correspondences to the pseudo-identifiers of the GBM/HGG imaging data, with 163 and 53 as training and validation data points.
- **Image size:** 240x240x155 voxels, contain 4-channels T1, T1 contrast enhanced, T2, and FLAIR images.
- **Goal:**
 - **Segmentation task:** classify every voxel in the image as either (i) healthy tissue, (ii) necrotic or non-enhancing tumor (NCR/NET) (red), (iii) edema (ED) (green), or (iv) enhancing tumor (ET) (yellow).
 - **OS Prediction task:** Predict the number of survival days based on the radiomic features extracted from the segmented Volume of Interest.



Figure 1: Glioma sub-regions segmentation (A) axial, (B) sagittal and (C) coronal planes for a sample patient from BraTS 2018 dataset.

3. Multi-Planar ConvNet with Spatial-Pooling for Segmentation

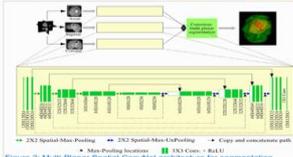


Figure 2: Multi-Planar Spatial-ConvNet architecture for segmentation.

4. Handling Class Imbalance

- Since the dataset is highly imbalanced therefore standard loss functions used in literature are not suitable for training and optimizing the ConvNet.
- Classifiers focus on learning the larger classes — poor classification accuracy for the smaller classes.
- We propose a new loss function, which is a sum of two losses viz. Generalized Dice Loss (GDL) and Weighted Log Loss (WLL).

5. Overall Survival Prediction

- For the OS prediction task we have extracted two types of Radiomic features, viz. (i) semantic and (ii) agnostic.
- We extracted 23 semantic and 60 agnostic features from the each segmented VOI.
- Multilayer Perceptron (MLP) is used to predict the number of survival days based on the 83 radiomic features which is further used to determine the survival class (short, mid or long).

6. Preliminary Results

- The ConvNet models were developed using *Intel optimized TensorFlow and Keras in Python*. The experiments were performed on the *Intel AI DevCloud platform* having cluster of Intel Xeon Scalable processors.
- The proposed segmentation model was trained, validated and tested on the corresponding datasets provided by the BraTS 2018 organizers.
- Fig. 4 reports the preliminary quantitative evaluation results obtained by the proposed segmentation model on the BraTS 2018 validation dataset (66 patients).
- Quantitative metrics used for evaluating the segmentation results are: (i) Dice score, (ii) sensitivity, (iii) specificity and (iv) Hausdorff distance computed for WT, TC and ET.
- Qualitative segmentation result obtained by the proposed method for five sample patient from the training dataset is shown in Fig. 5.

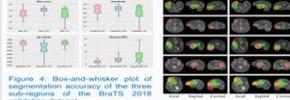


Figure 4: Box-and-whisker plot of segmentation accuracy of the three sub-regions of the BraTS 2018 validation dataset.

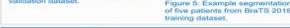


Figure 5: Example segmentation of five patients from BraTS 2018 training dataset.

7. Validation Phase Leaderboard

Validation Phase: Segmentation	Validation Phase: Survival			
	ET	WT	TC	Std
Dice	0.78	0.68	0.80	SE
Sensitivity	0.88	0.80	0.82	340939.9
Specificity	0.95	0.95	0.95	
Hausdorff95	4.29	4.90	6.59	

ET: Enhancing tumor
WT: White Matter (T1 + T1 + T2 + FLAIR)
TC: Tumor Core (ET + ED)

8. Conclusion

- The ConvNet architecture, used for slice wise segmentation along each plane, is an encoder-decoder type of network.
- The encoder or the contracting path uses pooling layers to downsample an image into a set of high-level features, followed by a decoder or an expanding part which uses the feature information to construct a pixel-wise segmentation mask.
- During the down sampling or the pooling operation network loses the spatial information.
- Up sampling in the decoder network through interpolation produces segmentation error around the object boundary.
- **Solution:** we introduce a novel layer called "Spatial-Max Pooling", which can retain the max features to be subsequently used in the up-pooling operation in the decoder through the Spatial-Max Unpooling layer.

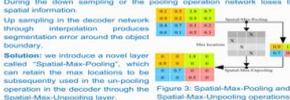


Figure 3: Spatial-Max Pooling and Spatial-Max Unpooling operations.

References

1. Louis, David N., et al. "The 2007 WHO classification of tumors of the central nervous system." *Acta neuropathologica* 114.2 (2007): 97-109.
 2. Menze, Benoit B., et al. "The multimodal brain tumor image segmentation benchmark (BRATS)." *IEEE transactions on medical imaging* 34.10 (2015): 1953.
 3. Bakas, S., et al. "Adaptive deep learning for brain tumor MRI collections with expert segmentation labels and radiomic features." *Scientific data* 4 (2017): 170117.
 4. Lachaux, Yann, Yohann Benig, and Geoffrey Hinton. "Deep learning." *arXiv preprint arXiv:1611.01566* (2016).
 5. Bakas, S., et al. "Segmentation labels and radiomic features for the pre-operative scans of the TCGA-GBM collection." *The Cancer Imaging Archive* 2018.00117.

Intel AI DevCloud
INTEL AI STUDENT AMBASSADOR

▶ 7

Important Results/Publications

- ▶ S. Santra, R. Mondal and B. Chanda, CSD, ISIK
 - ▶ Learning a Patch Quality Comparator for Single Image Dehazing, *IEEE Trans on Image Processing*, 27(9), 2018 – [IF: 5.071](#)
 - ▶ Given two patches in an image,
 - ▶ CNN based model is trained with synthetically hazed patches to compare quality of two patches automatically
 - ▶ Only patches used as input – requires less computing resources
 - ▶ A customized version of this technique has brought a special mention and a cash prize from an international competition.



New Initiatives

▶ NIRF

- ▶ Fund availability in India is gradually getting linked to NIRF
 - ▶ IMPRINT, SPARC
- ▶ ISI is looking at the possibility of participating in NIRF 2019
- ▶ A committee, chaired by Anjana Dewanji, has been constituted to collect and analyze NIRF data

▶ Record Cell

- ▶ A record cell under Chief Librarian has been created
- ▶ To store up-to-date data on various matters pertaining to ISI

▶ ISI Data Repository

- ▶ Repository to be created in ISI for storing datasets created or used in data
- ▶ Data will be made online, accessible either freely or on payment depending on
 - ▶ the costs incurred to generate the data
 - ▶ Its usage
- ▶ Purpose is to provide access to other researchers/students
- ▶ Committee working on creating the modalities

SyMeC-ISI Data Centre: *Funded by DBT*

- ▶ High Performance Computing Cluster
 - ▶ Three type of servers to address various kind of user requirements.
 - ▶ A powerful virtualization server with 4TB of RAM
 - ▶ 17 parallel computing server
 - Each server with 40 cores, 2.4GHz, 192GB RAM
 - Total : 680 cores, 3264 GB RAM
 - ▶ 2 GPU servers with 4 GPU cards total
 - Nvidia P100 card with 16GB RAM and 3584 cores, 4.7TF per GPU
 - Total : 14336 cores, 18.8TF
 - ▶ 100Gbps network interconnect
 - ▶ Total Performance (theoretical): ~75TF, Cost: 2.23 Crore (approx)
- ▶ Other components
 - ▶ 2 UPS, 80KVA each, 88 batteries with backup of 30 min
 - ▶ 3 Precision ACs with 10TR (Tonnes of Refrigeration) each
 - ▶ 6 Server Racks, each with capacity of 42 servers
 - ▶ 2PB Storage with speed of at least 20Gbps read and write to be procured

SyMeC-ISI Data Centre



Racks and ACs



UPS



Battery Bank and Electrical Panel



Projects/Consultancy

- ▶ Sushmita Mitra, CCSD, ISIK
 - ▶ Intel Gift fund for research project “Deep Learning for Handling Imbalance in Diabetic Retinopathy”
- ▶ N. Chattopadhyay (SOSU) and collaborators, ISIK
 - ▶ Development of Browser-based Application of CAP1 for NSSO 77th Round Schedule
 - ▶ Expected to bring significant changes in the data collection methods practised by NSSO
 - ▶ Funded by MOSPI, Govt of India
 - ▶ Developing E-Module on Official Statistics
 - ▶ The unique endeavour in India, disseminating knowledge on official Statistics
 - ▶ Funded by MOSPI, Govt of India
 - ▶ Fraud Risk Management study for Payment Corporation of India
 - ▶ Funded by RS Software
 - ▶ Upcoming:
 - ▶ Training Programme for ISS Probationary Officers (40 th Batch) funded by MOSPI
 - ▶ Mid-career Training Programme for In-Service Officers
 - domestic component in collaboration with IIT and IIM and
 - Overseas component in collaboration with Statistics Netherlands

Projects/Consultancy

- ▶ Molly Chattopadhyay and Madhura Swaminathan, SSD, ISI BC
 - ▶ Will be initiating a project on price stability of key agricultural crops
 - ▶ Ministry of Agriculture and MSSRF
- ▶ Bimal Roy, RCBCCS & ASD, ISIK
 - ▶ International Collaboration Awards 2018 scheme of the Royal Society
 - ▶ Collaborator: Prof. Hao Feng, UK
 - ▶ improving electronic voting system in India
 - ▶ grant value of of £224,333.60, approx 2.12 crore

Thank you!