Multi-loss Function to Improve the Text Detection and Segmentation

Problem Statement –

"Slidin' videos": Slide Transition Detection and Title Extraction in Lecture Videos

ITU AI/ML in 5G Challenge 2022

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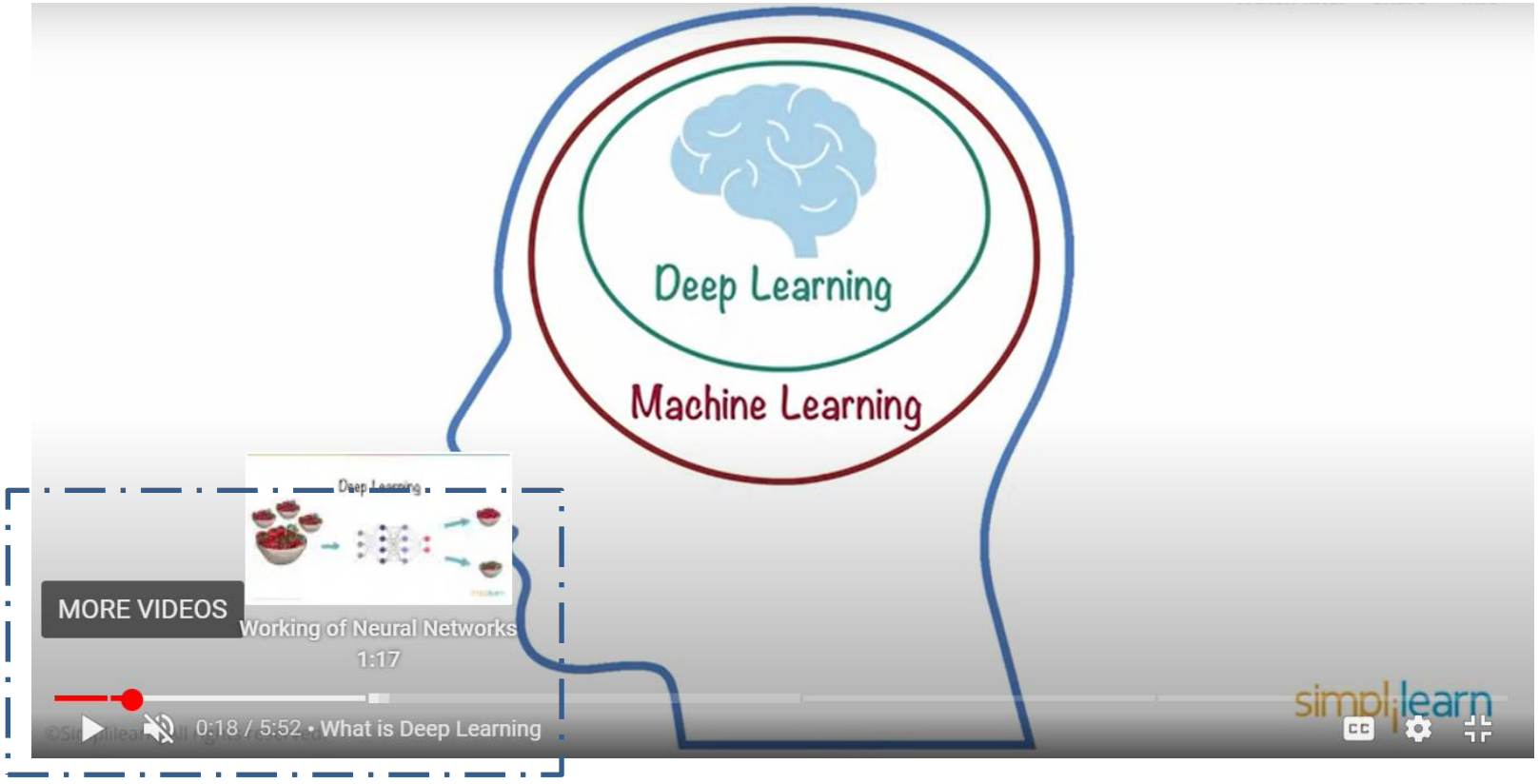
Outline

Introduction

YouTube's "Video Chapter" feature segments a video into sections marked by timestamps so that the user can easily navigate to the part of the video which is of most interest. This can be done by clicking or pressing the chapter marker, or by selecting the timestamp in the video description – (AI-5G Challenge)



Introduction: Problem Definition

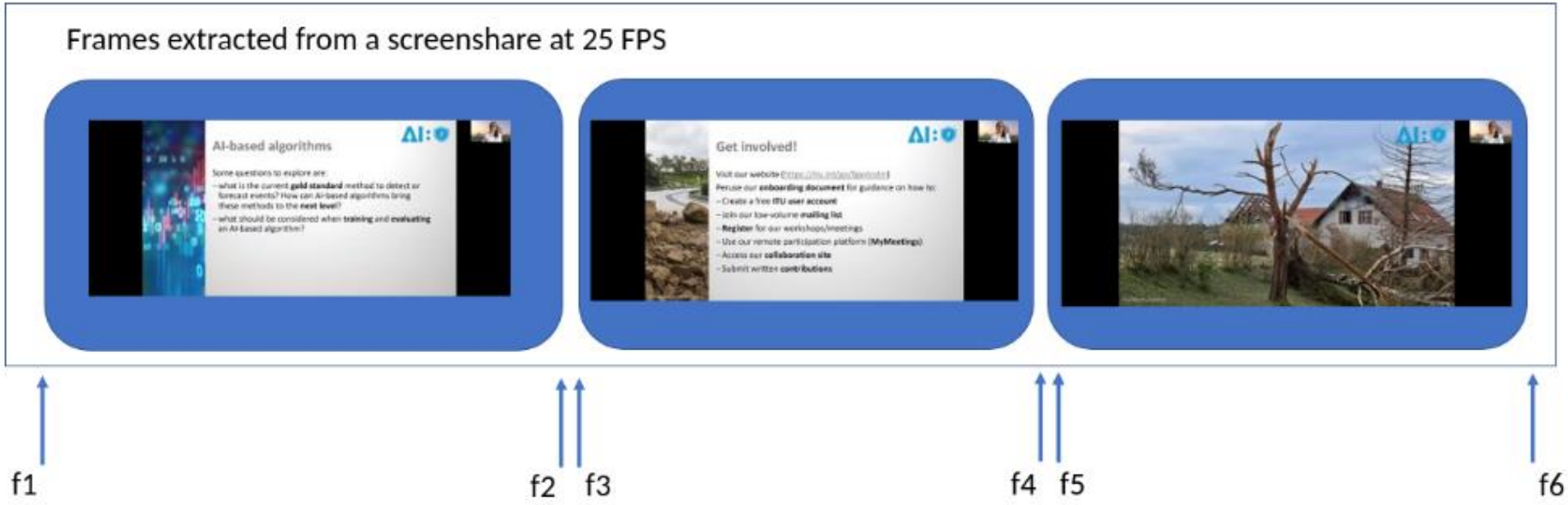
AI model which annotates slide transitions by:

- Identifying starting and ending frames of each slide shown in the video
- Extracting (apparent) titles of each slide
- All videos were recorded at 25FPS

Dataset:

- ❑ Video files covering the presentation from when speaker started screen share right to the moment when it was turned off. Video files vary in duration (from several minutes to several hours) and resolution (from **1600** x **1200** to **3840** x **2160**).
- ❑ A ground truth data set with **2500+** slide transitions showing the starting and ending frame of each slide including (apparent) titles.

Introduction: Problem Detail



frame_start, frame_end, is_slide, title
f1, f2, 1, "AI-based algorithms"
f3, f4, 1, "Get involved!"
f5, f6, 1, "NO_TITLE"

where f1, f2, f3, f4, f5, f6 – are frame numbers,
f2 is adjacent to f3, f4 is adjacent to f5

“groundtruth.csv”

A1 starting_frame1

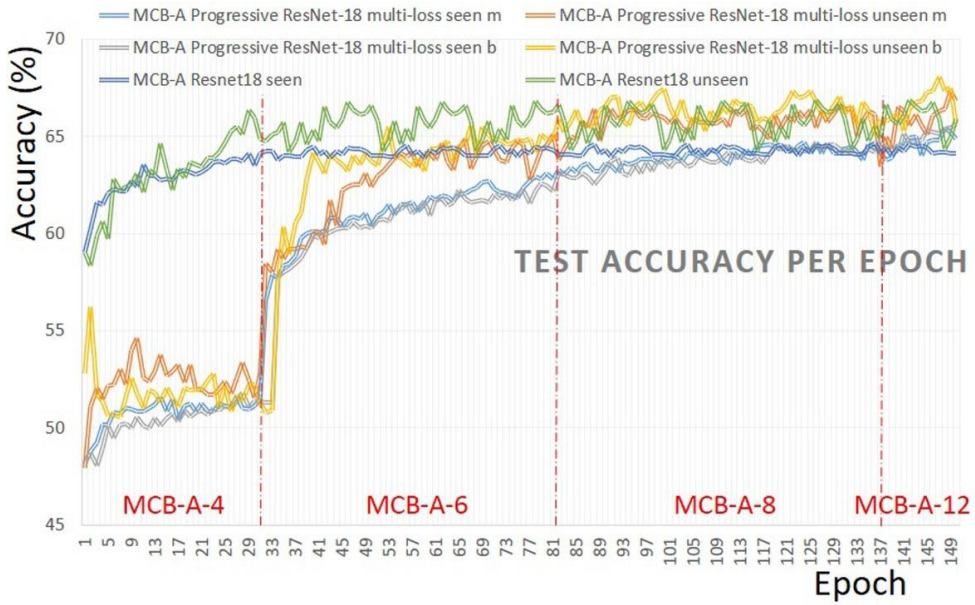
	A	B	C	D	E	F	G	H	I	J	K	L
1	starting_frame1	starting_frame2	ending_frame1	ending_frame2	title1	title2	title3	title4	bonus_title1	bonus_title2	is_hybrid	
2	25	25	97	97	CAN TECHNOLOGY SCALE TO FEED THE WORLD ?						0	
3	98	102	949	977	CAN TECHNOLOGY SCALE TO FEED THE WORLD ?						0	
4	950	978	1332	1345	HPE-STUDENTS-FARMERS						0	
5	1333	1346	1765	1782	HPE-STUDENTS-FARMERS						0	
6	1766	1783	2721	2730	HPE-STUDENTS-FARMERS						0	
7	2722	2731	4268	4279	RESULTS						0	

Introduction: Motivation

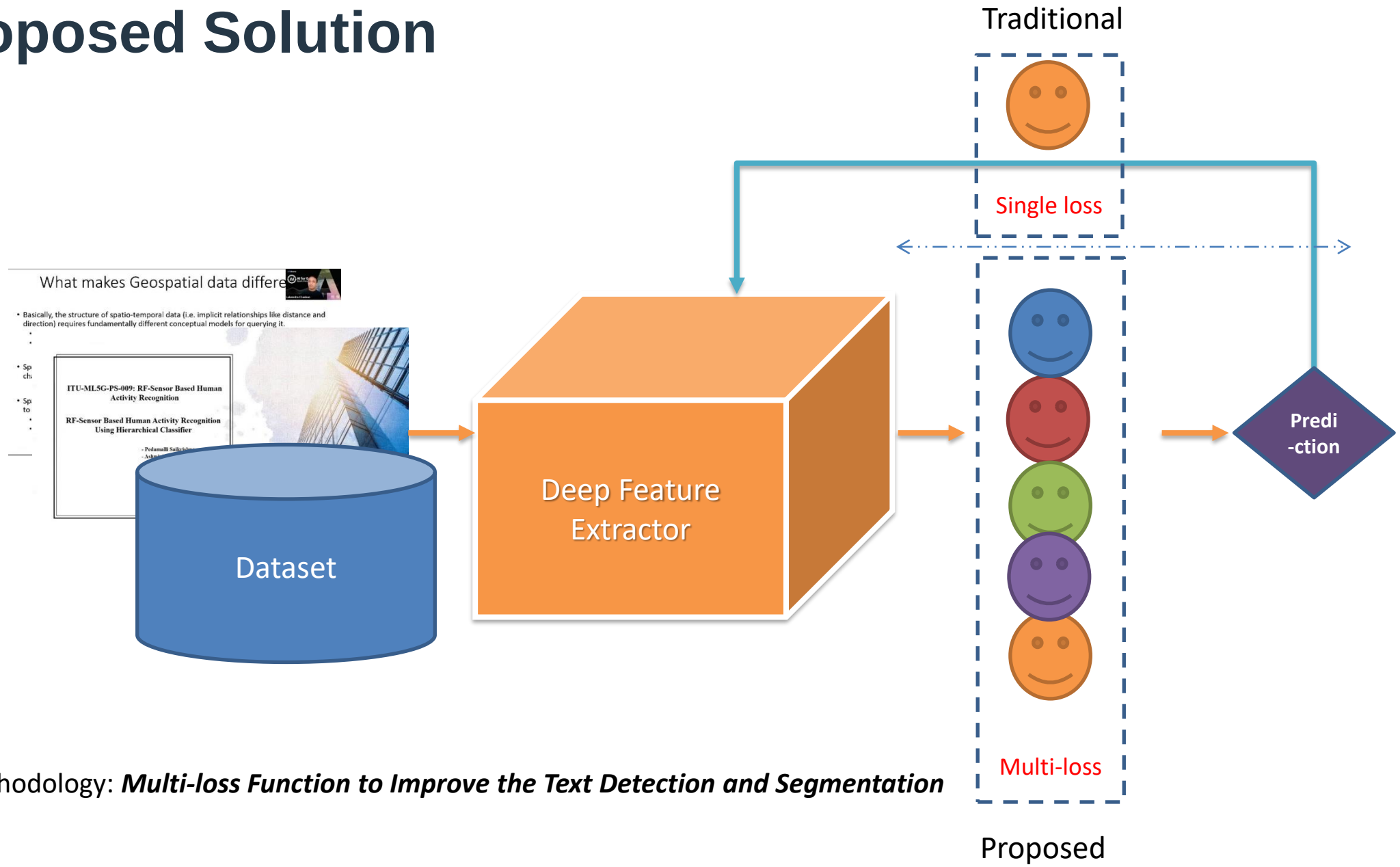
YouTube introduced a multi-loss view invariant stochastic prototype embedding to minimize and improve the recognition accuracy of novel objects at different viewpoints by using a progressive multi-view learning approach.

- Prasad, S., Li, Y., Lin, D., Dong, S. and Nwe, M.T.L., 2021. A Progressive Multi-View Learning Approach for Multi-Loss Optimization in 3D Object Recognition. *IEEE Signal Processing Letters*, 29, pp.707-711.

- Multi-loss in Detection and Segmentation



Proposed Solution

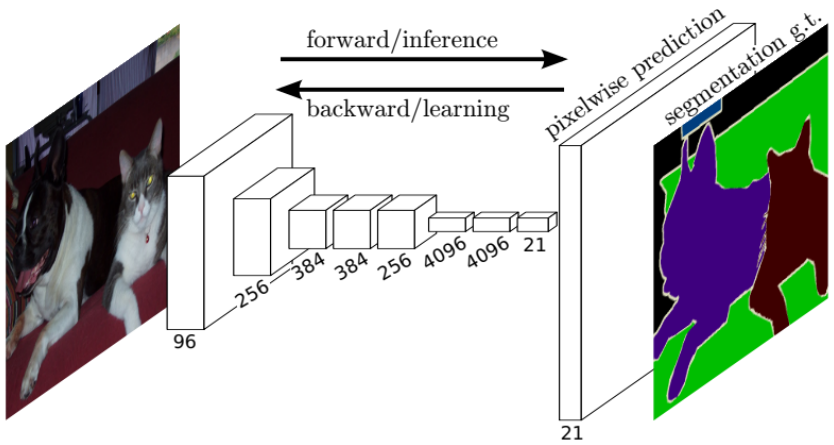


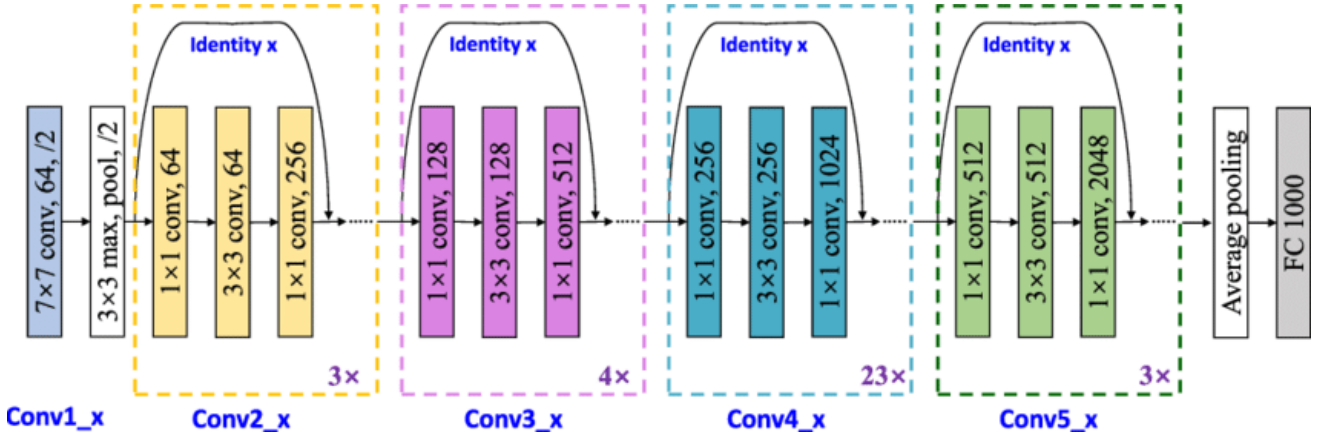
Methodology: ***Multi-loss Function to Improve the Text Detection and Segmentation***

Proposed Solution

Advantages:

- ❑ Model used **ResNet101** (createDeepLabv3)
- ❑ No architectural changes
- ❑ Negligible model computation cost (equivalent to the original)
- ❑ Multi-loss training strategy converges the network much faster
- ❑ Gives a significant boost in the performance by ~5%





https://github.com/msminhas93/DeepLabv3FineTuning/blob/bcdc3dfc79a5b75bc30c52b32315661c0a4da17e/model.py#L6

Results: Comparison

Metrics	Baseline	Proposed Multi-loss (4)
Epochs	10	10
Train Loss	0.00279	0.00192
Train F1	0.853	0.911
Train AUROC	0.993	0.990
Test Loss	0.0241	0.0200
Test F1	0.764	**0.812**
Test AUROC	0.925	**0.949**

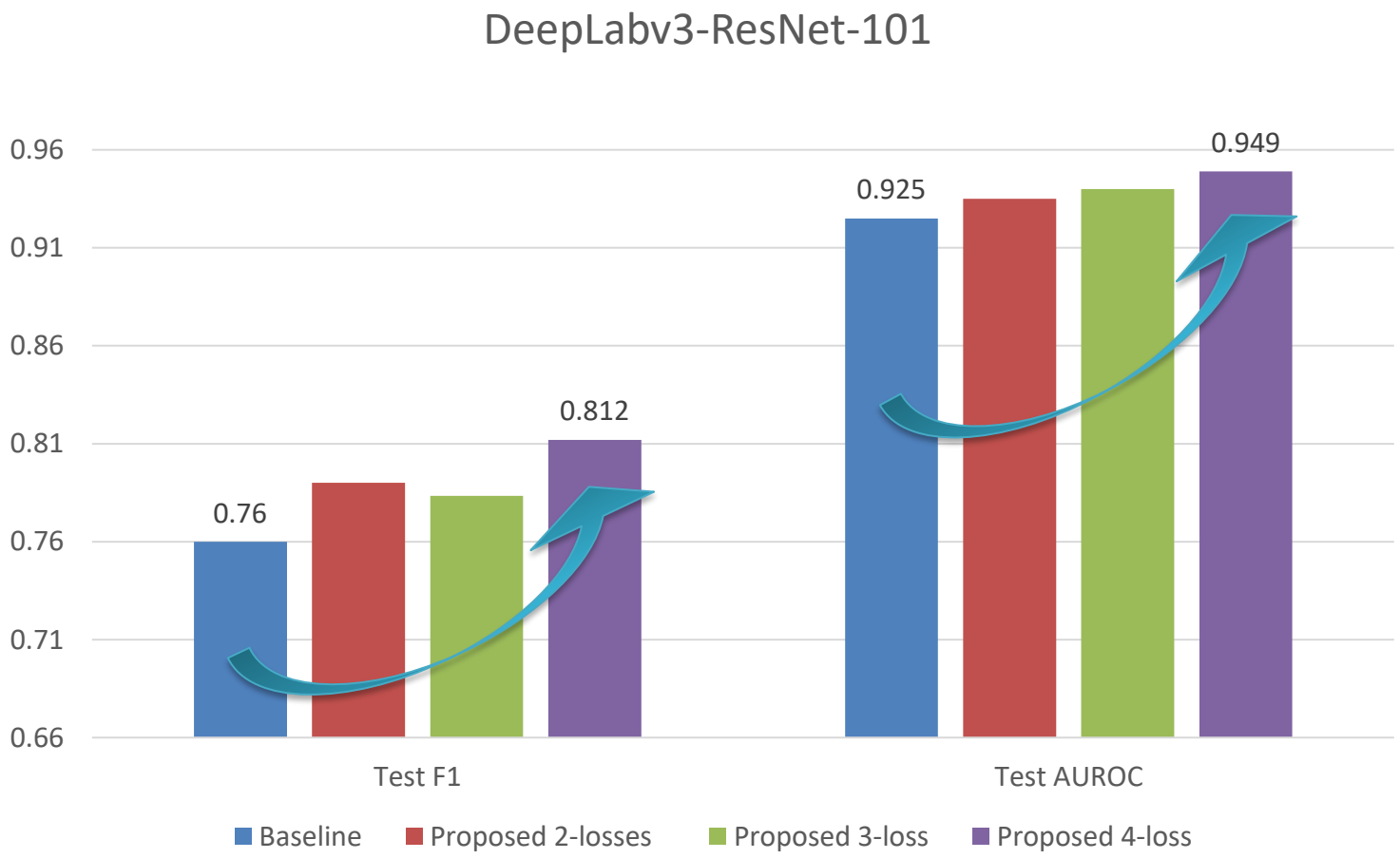
Average of three runs

- We used MAE, MSE, MSLE and variations of Huber loss functions for our experiments

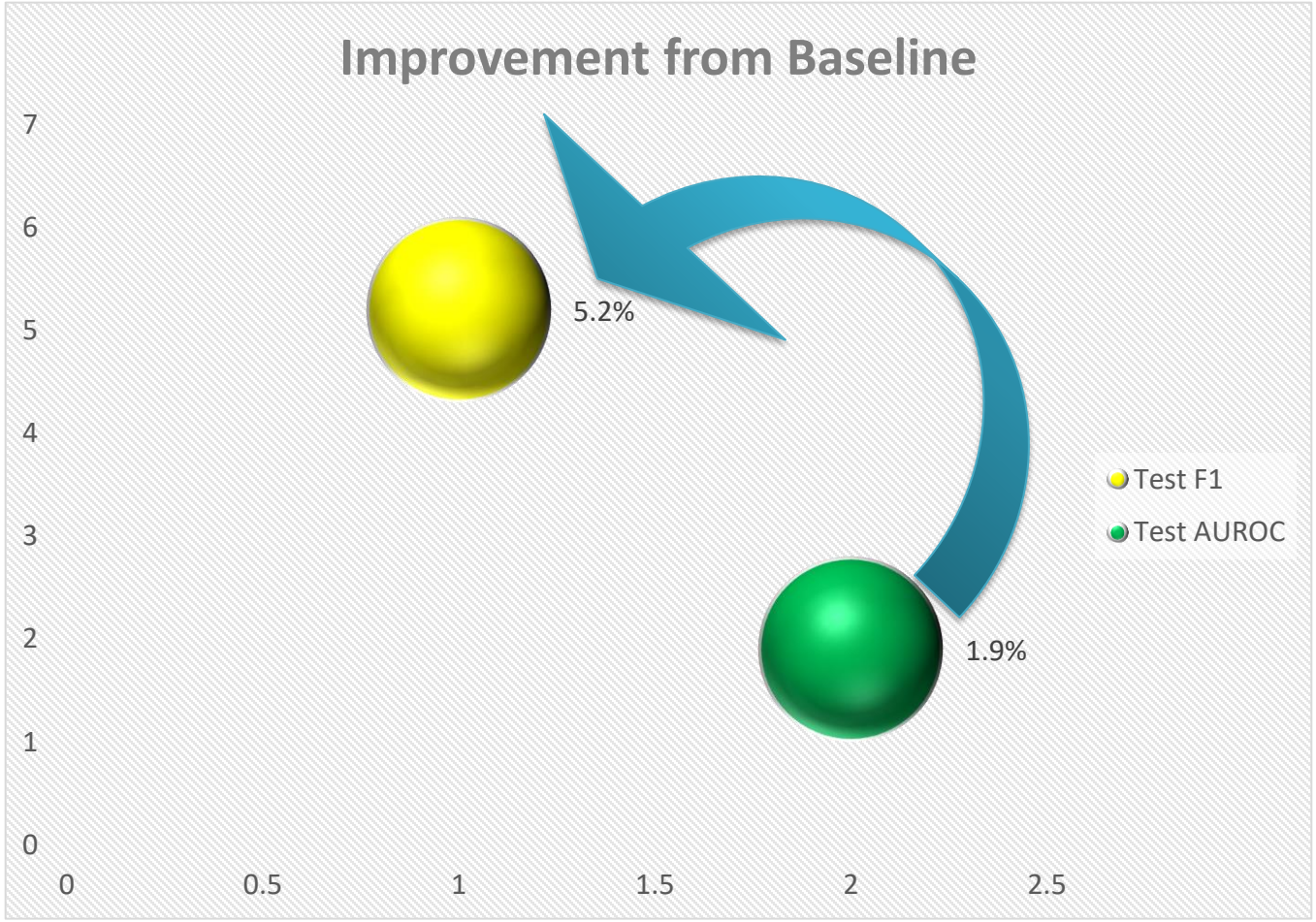
Evaluations: $F_1 = 2 * \frac{precision * recall}{precision + recall} = \frac{\mathrm{TP}}{\mathrm{TP} + \frac{1}{2}(\mathrm{FP} + \mathrm{FN})}$

https://www.analyticsvidhya.com/blog/2020/06/auc-roc-curve-machine-learning/

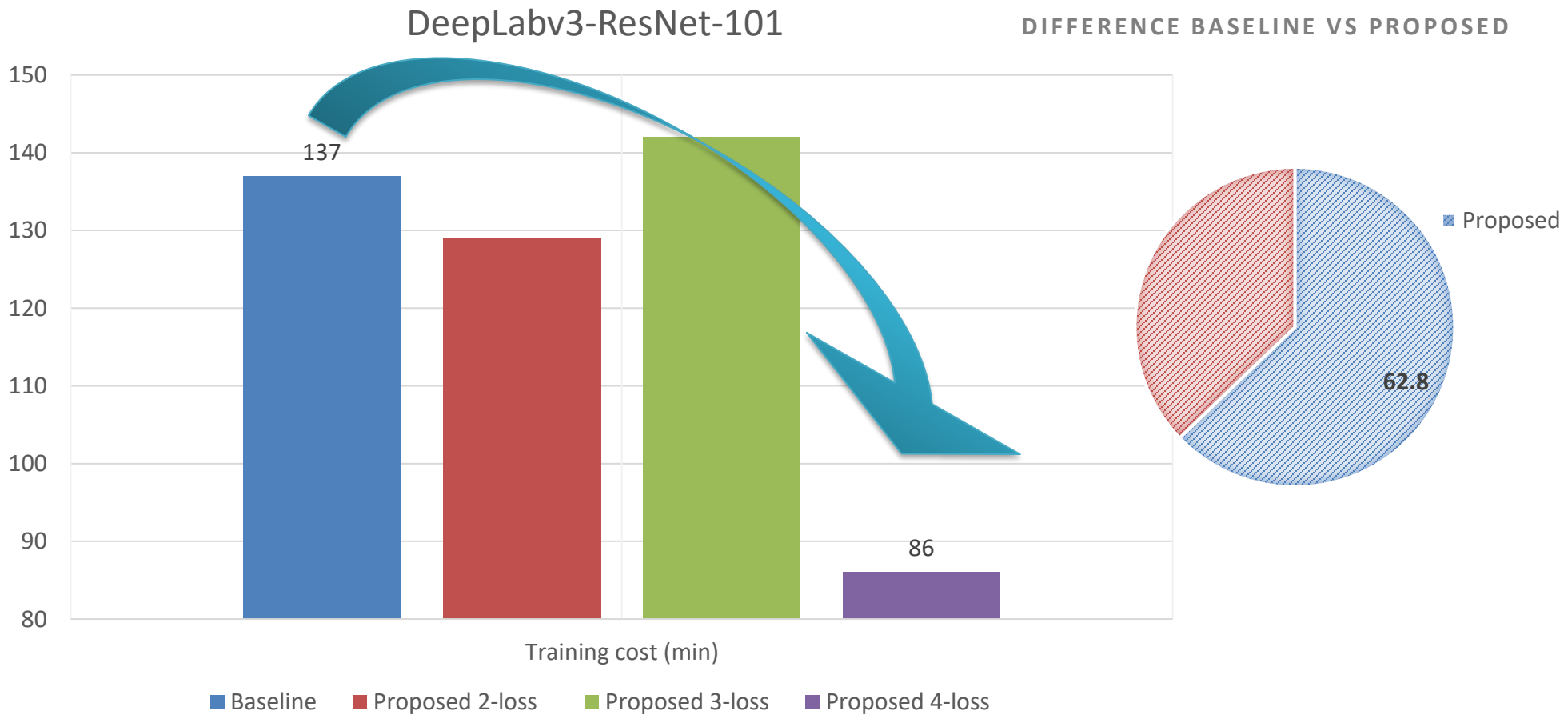
Results: Ablations Study



Results: Ablations Study



Results: Ablations Study (Computations)



Conclusion

In deep digital world,

- Not very important to improve the network architectural to improve the model performance
- Training strategy is important to optimize the learning
- Multi-loss training strategy converges the network
- Significant boost in the performance by simply involving several loss functions for same task
- Gradient calculation is optimized for detection and segmentation

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Thank you for attention