Optical Computing using Nonlinear Optical Propagation in Multi-Mode Fibers

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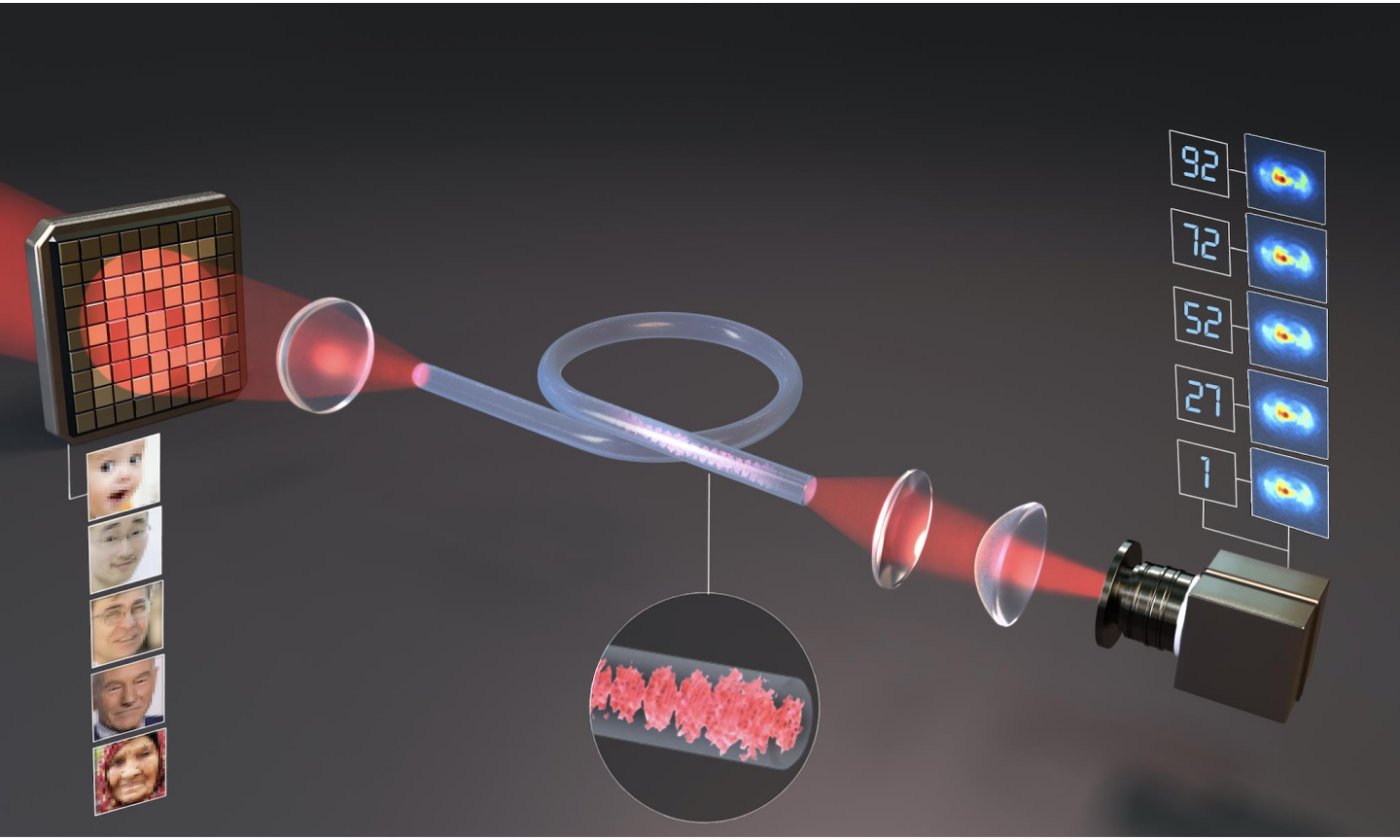
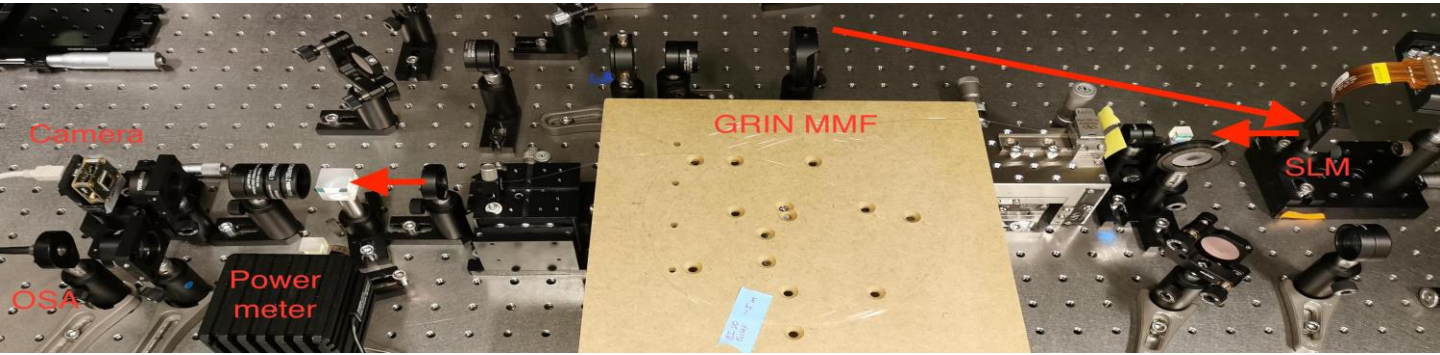
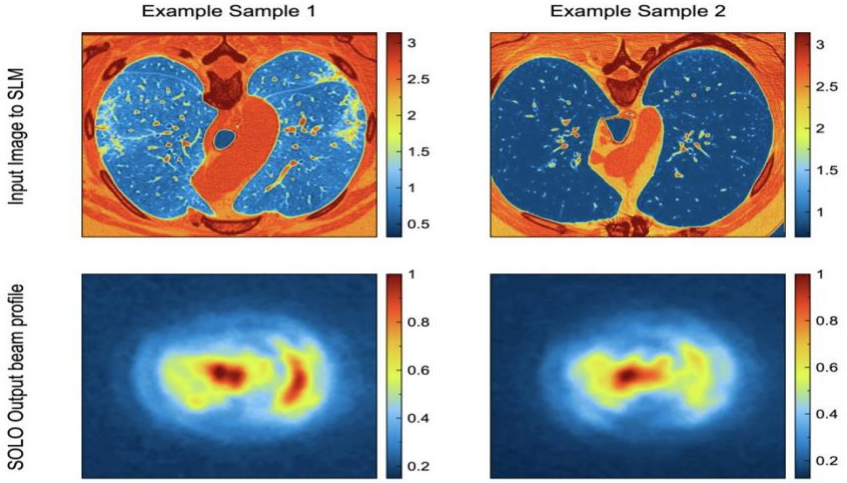

92
72
52
27
1

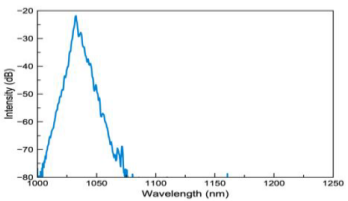
Experimental set-up

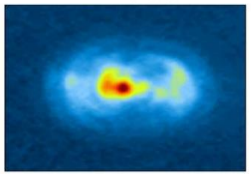


Classification of lung x-ray images

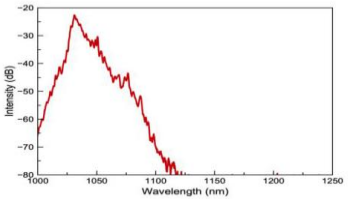


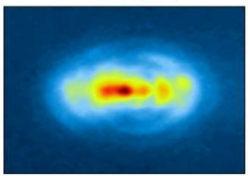
Output spectrum and beam shape at different pulse peak powers



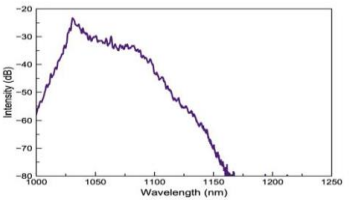


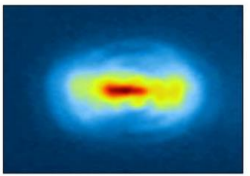
1.76 kW





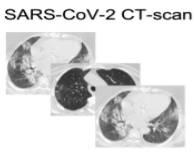
3.36 kW

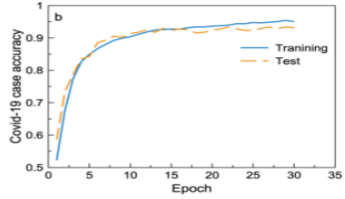


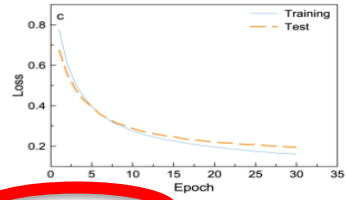


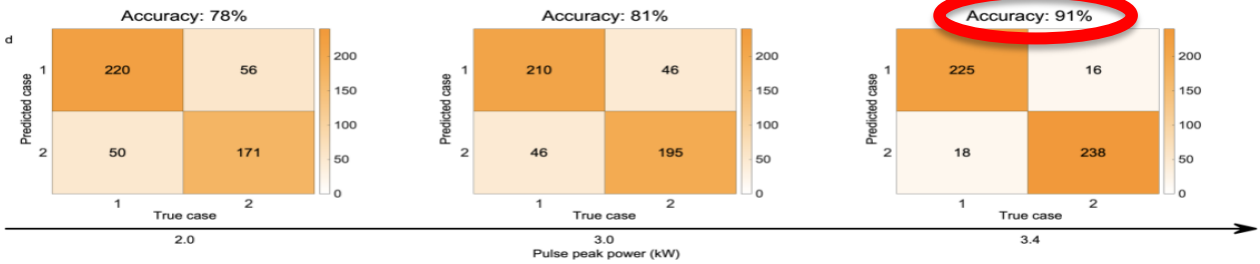
4.96 kW

Results









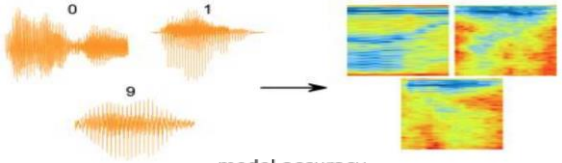
Method \ Metric	Accuracy
xDNN	97.38%
ResNet	94.96%
GoogleNet	91.73%
VGG-16	94.96%
AlexNet	93.75%
Decision Tree	79.44%
AdaBoost	95.16%

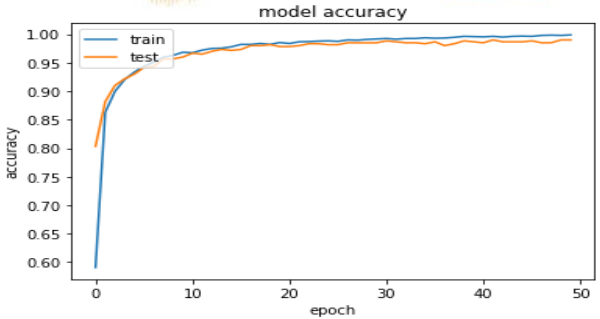
2500 samples
2000 in the training set
500 in the test set

Soares, E., et. Al.
SARS-CoV-2 CT-scan dataset: A large dataset
of real patients CT scans for SARS-CoV-2 identification.
medRxiv (2020)

Digit Recognition from Audio

6 speakers, 3’000 recordings (50 of each digit per speaker)

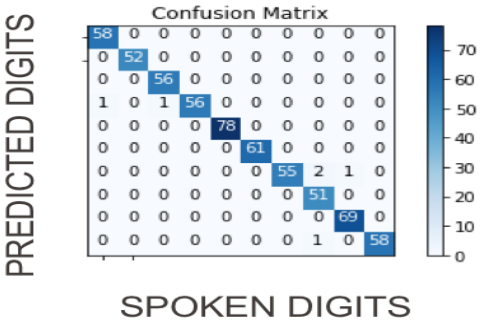




99.0% accuracy on test set

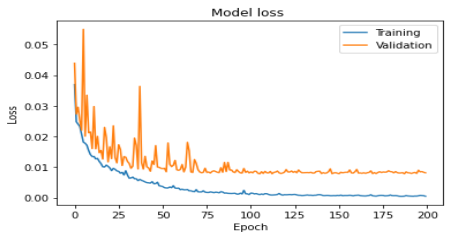
Vs

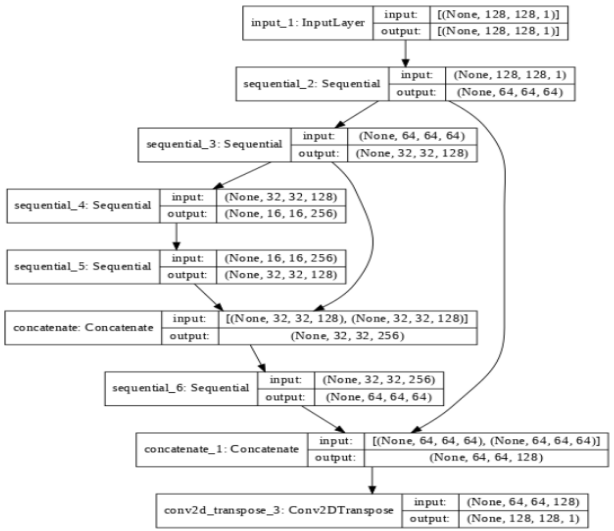
98% for State of the Art



U-Net replication of SOLO results from COVID dataset

- Trainable parameters: 23,088,257
- 7 layers of convolutional layers with 16x16 kernels
- Additional examples, parameters/lay will likely improve generalization

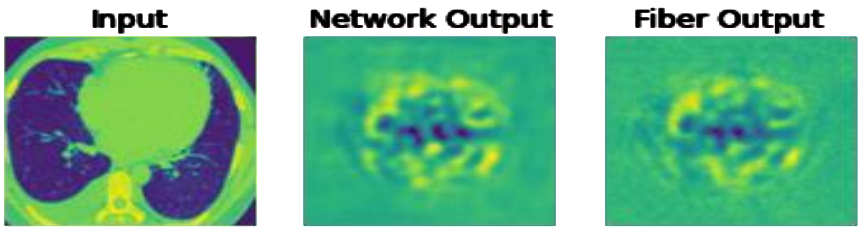




1.5×10^{12} operations

U-Net replication of SOLO results from COVID dataset

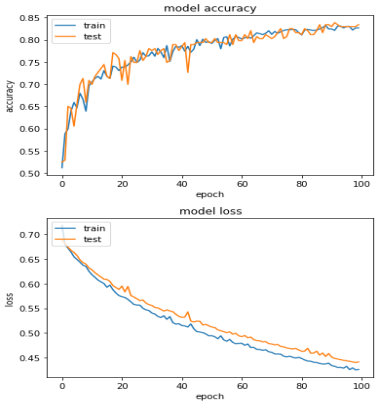
	Mean Absolute Error
Training	0.0179
Validation	0.0682
Test	0.0624



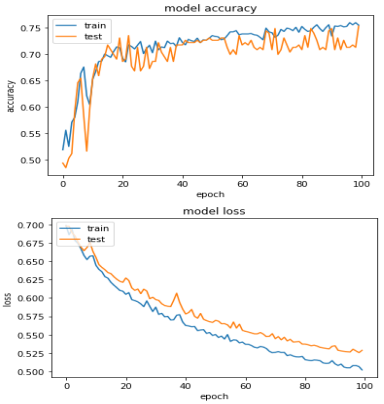
Training takes 100 epochs x 22 seconds/epoch = 0.6 hours on Nvidia Tesla T4 (8 TFLOPS, 70W maximum consumption). Total energy consumption is 42Wh.

U-Net versus SOLO results from COVID dataset - Classification

Measured Data – 83.4%



NN Generated Data – 75.3%



2500 samples in Covid lungs database
1000 (500-500) samples to train the U-net
1500 for classification on Unet and SOLO

Conclusion and Outlook

- Multi-mode fibers as computing elements
  - Power efficiency due to light confinement and long interaction length
- Nonlinear fiber computation is proving to be useful for machine learning
- Scale-up and programmability are the goals for the future

Christophe Moser

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Tegin

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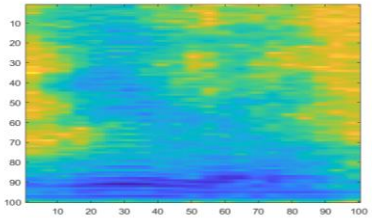
Oguz

Mustafa
Yildrim

Ulas
Dinc

Stability Test



Same input sent in an infinite loop

SOLO