CoViD-X
CoViD-CT

COGNEX VisionPro Deep Learning 1.0 identifying images of CoViD-19 in Chest X-Rays & CT-Scans

Dr. Joerg Vandenhirtz | October 2020
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Senior AI Expert
Life Sciences OEM

Scientific Background - Particle Physicist
Former Entrepreneur: Machine Vision on Plants

6 years with COGNEX
Located in Aachen, Germany
Introduction to COGNEX
What is COGNEX Deep Learning?
CoViD-X & CoViD-CT
Comparison with other State of the Art CNNs
Summary
Questions & Answers
INTRODUCTION TO COGNEX

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2019 Revenue By Region

*Includes revenue from a customer in Europe for vision products used in production processes in Asia.
TECHNOLOGY LEADERSHIP

16% OF REVENUE INTO R&D

>1K US & INTERNATIONAL PATENTS ISSUED & PENDING
PRODUCTS ACROSS ALL INDUSTRIES ARE MADE BETTER AND AT LOWER COST WITH COGNEX VISION
COGNEX PRODUCTS

VisionPro
Deep Learning

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WHAT IS COGNEX DEEP LEARNING TECHNOLOGY?

Human performance and flexibility

COGNEX VisionPro Deep Learning

Computer Reliability and consistency
What Is Cognex Deep Learning?

- Different approach to solving vision problems
  - Example-based training modeled on human learning
  - Not rigid rules-based solution
END-TO-END LEARNING & BLACK BOX RESULTS

- Easier to understand and maintain
- Requires fewer images and less computing power than other CNN architectures
What is the COGNEX AI Solution?

PROBLEMS WITH AI FOR IMAGING

- Data sharing outside the hospital firewalls is difficult
- Radiologists/Pathologists are not Data Scientist
- Healthcare organizations lack in-house AI expertise
- “Generic” AI algorithms for “Case Studies” do not apply well to individual patient images and medical conditions
- Accuracy of algorithms might depend on the particular set of images

COGNEX SOLUTIONS

- No need for data sharing – doctors feed images/information within hospital firewalls
- Dramatically simple and easy to use, absolutely no need for Data Science expertise – developed for similar needs in the Industrial Automation markets
- No need at all for in-house AI expertise
- Doctors can customize their solution and then optimize it for their specific needs – continue optimization by themselves, no need for outsiders
- Fewest images needed than any other AI software in the market – doctor can easily customize with limited images
CoViD-X
Background

March 2020


May 2020

Arjun Sarkar (from the FH University of Aachen) started his master thesis internship at COGNEX Aachen being proficient in TensorFlow and Python but novice with COGNEX VisionPro Deep Learning

August 2020


August 2020

Hayden Gunraj and Linda Wang (from the Vision and Image Processing Lab of the University of Waterloo, ON, Canada) published "COVIDNet-CT: A Tailored Deep Convolutional Neural Network Design for Detection of COVID-19 Cases from Chest CT Images"

September 2020

Arjun published his second paper "Identification of images of COVID-19 from Chest Computed Tomography (CT) images using Deep learning: Comparing COGNEX VisionPro Deep Learning 1.0TM Software with Open Source Convolutional Neural Networks"
COVID-X Dataset

Normal

Non CoViD (Pneumonia)

CoViD-19

https://github.com/lindawang/COVIDNet
COVID-X Dataset

https://github.com/lindawang/COVIDNet
CNN Benchmark

- VGG19
- ResNet50 V2
- Densenet121
- Inception V3
- COVID-Net

COGNEX

- VisionPro DL 1.0 - Entire ROI
- VisionPro DL 1.0 - Segmented Lungs
Heatmaps

Highlight regions in the image which were important for the AI Classification
Provide additional Information for the Computer Aided Diagnostic Decision Making Process
Results

F-Scores

<table>
<thead>
<tr>
<th>Model</th>
<th>Normal</th>
<th>Non-COVID-19</th>
<th>COVID-19</th>
</tr>
</thead>
<tbody>
<tr>
<td>VGG19</td>
<td>86</td>
<td>86</td>
<td>81</td>
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<tr>
<td>RESNET50 V2</td>
<td>91</td>
<td>85</td>
<td>85</td>
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<tr>
<td>DENSENET121</td>
<td>88</td>
<td>86</td>
<td>84</td>
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<tr>
<td>INCEPTION V3</td>
<td>93</td>
<td>89</td>
<td>92</td>
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<tr>
<td>COVID-NET</td>
<td>92.6</td>
<td>92.6</td>
<td>94.7</td>
</tr>
<tr>
<td>VISIONPRO DL 1.0 - ENTIRE ROI</td>
<td>93.8</td>
<td>92.2</td>
<td>96</td>
</tr>
<tr>
<td>VISIONPRO DL 1.0 - SEGMENTED LUNGS</td>
<td>95.6</td>
<td>93.3</td>
<td>97</td>
</tr>
</tbody>
</table>
CoViD-CT
COVID-CT Dataset

Normal

Non CoViD
(Pneumonia)

CoViD-19

https://github.com/haydengunraj/COVIDNet-CT
COVID-CT Dataset

Number of images in each class of Training Set

<table>
<thead>
<tr>
<th></th>
<th>Normal</th>
<th>Pneumonia</th>
<th>COVID-19</th>
<th>Total</th>
</tr>
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<tbody>
<tr>
<td>Train</td>
<td>27201</td>
<td>22061</td>
<td>12520</td>
<td>61782</td>
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<tr>
<td>Validation</td>
<td>9107</td>
<td>7400</td>
<td>4529</td>
<td>21036</td>
</tr>
<tr>
<td>Test</td>
<td>9450</td>
<td>7395</td>
<td>4346</td>
<td>21191</td>
</tr>
</tbody>
</table>

https://github.com/haydengunraj/COVIDNet-CT
3 Train – Test Settings

Setting 1

- Train: 61782
- Validation: 21036
- Test: 21191

75% Train / 25% Test

Setting 2

- Train: 52081
- Validation: 21036
- Test: 30892

63% Train / 37% Test

Setting 3

- Train: 26338
- Validation: 21036
- Test: 56635

32% Train / 68% Test
CNN Benchmark

- ResNet50 V2
- Densenet121
- Inception V3
- Xception
- COVID-Net CT A
- COVID-Net CT B

COGNEX

- VisionPro DL 1.0 - Entire ROI
Heatmaps

Highlight regions in the image which were important for the AI Classification
Provide additional Information for the Computer Aided Diagnostic Decision Making Process
### Results – Setting 1 (75% train / 25% test)

#### F-score comparison - Setting 1

<table>
<thead>
<tr>
<th>Model</th>
<th>Normal F-score %</th>
<th>Pneumonia F-score %</th>
<th>COVID-19 F-score %</th>
</tr>
</thead>
<tbody>
<tr>
<td>ResNet50_v2</td>
<td>99.1</td>
<td>96.6</td>
<td>99.5</td>
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<tr>
<td>DenseNet121</td>
<td>99.4</td>
<td>98.3</td>
<td>98.4</td>
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<tr>
<td>Inception_v3</td>
<td>99.6</td>
<td>97.6</td>
<td>98.1</td>
</tr>
<tr>
<td>Xception</td>
<td>99.4</td>
<td>97.9</td>
<td>97.1</td>
</tr>
<tr>
<td>COVID-Net CT A</td>
<td>99.6</td>
<td>95.9</td>
<td></td>
</tr>
<tr>
<td>COVID-Net CT B</td>
<td>97.9</td>
<td>98.1</td>
<td></td>
</tr>
<tr>
<td>COGNEX VisionPro Deep Learning 1.0</td>
<td>97.6</td>
<td>98.2</td>
<td></td>
</tr>
</tbody>
</table>
Results – Setting 2 (60% train / 40% test)

F-score comparison - Setting 2

<table>
<thead>
<tr>
<th>Class Labels</th>
<th>F-score %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>98.9</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>98.4</td>
</tr>
<tr>
<td>COVID-19</td>
<td>99.6</td>
</tr>
</tbody>
</table>

- ResNet50_v2: 96.3, 96.3, 96.7
- DenseNet121: 97.3, 97.3, 96.9
- Inception_v3: 98.4, 98.4, 98.8
- Xception: 99.8, 99.8, 99.8
- COGNEX VisionPro Deep Learning 1.0: 99.2, 99.2, 99.8
Results – Setting 3 (33% train / 67% test)

F-score comparison - Setting 3

Class Labels

- Normal
- Pneumonia
- COVID-19

F-score %

- ResNet50_v2
- DenseNet121
- Inception_v3
- Xception
- COGNEX VisionPro Deep Learning 1.0
SUMMARY

- COGNEX VisionPro Deep Learning is very easy to use
- Unlike other architectures it does not require data curation or coding
- Chaining of tools (e.g. segmentation and classification) is easy
- Heatmaps also help to understand the AI decisions
- Development time reduces dramatically
- Accuracies are better than all other state-of-the-art architectures in this study
- Much fewer training images are required than for the other CNNs

-> Democratization of AI in Radiology
THANK YOU VERY MUCH!

For further information:
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