Azure Meetup
TORINO

#GlobalAzureTorino

Deep Learning with Azure ML and ML.NET

Clemente Giorio
Gianni Rosa Gallina

deltatre

MVP Microsoft® Most Valuable Professional

#GLOBALAZURE 2022

welol beyond the digital

TechData

7 maggio 2022

#GlobalAzureTorino

Azure Meetup
TORINO

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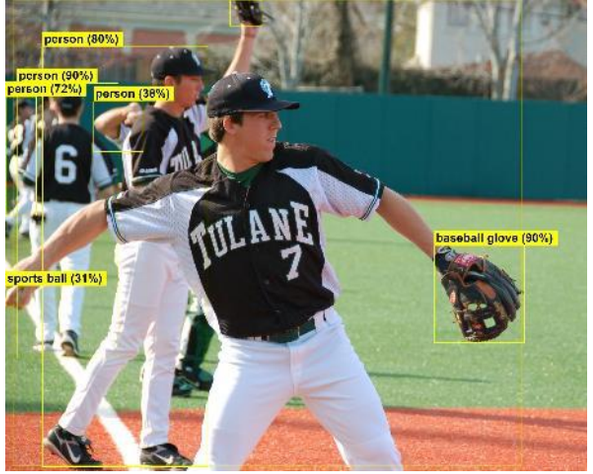
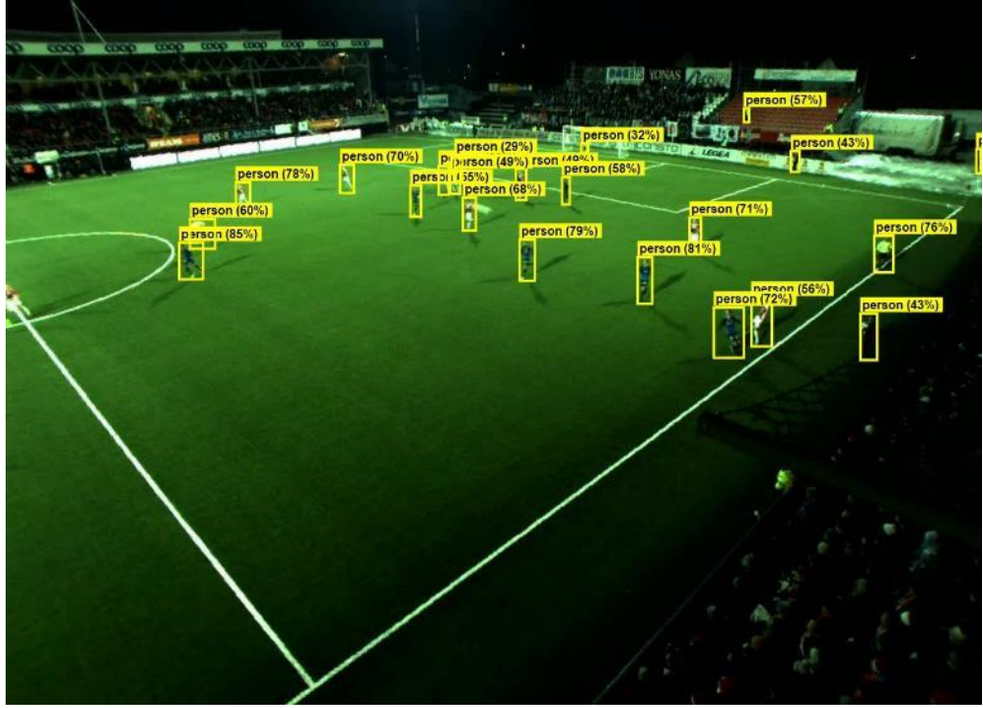
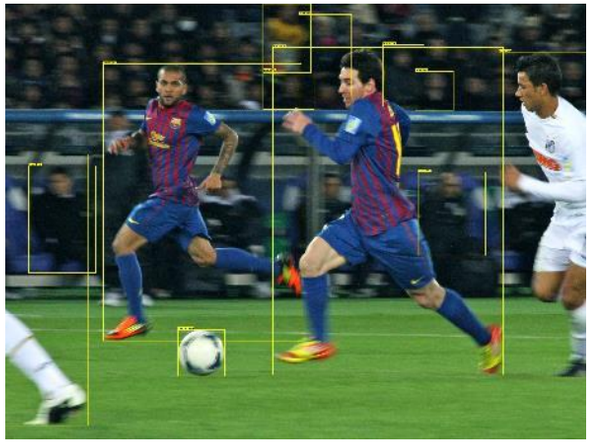
Tech Data

Object Detection

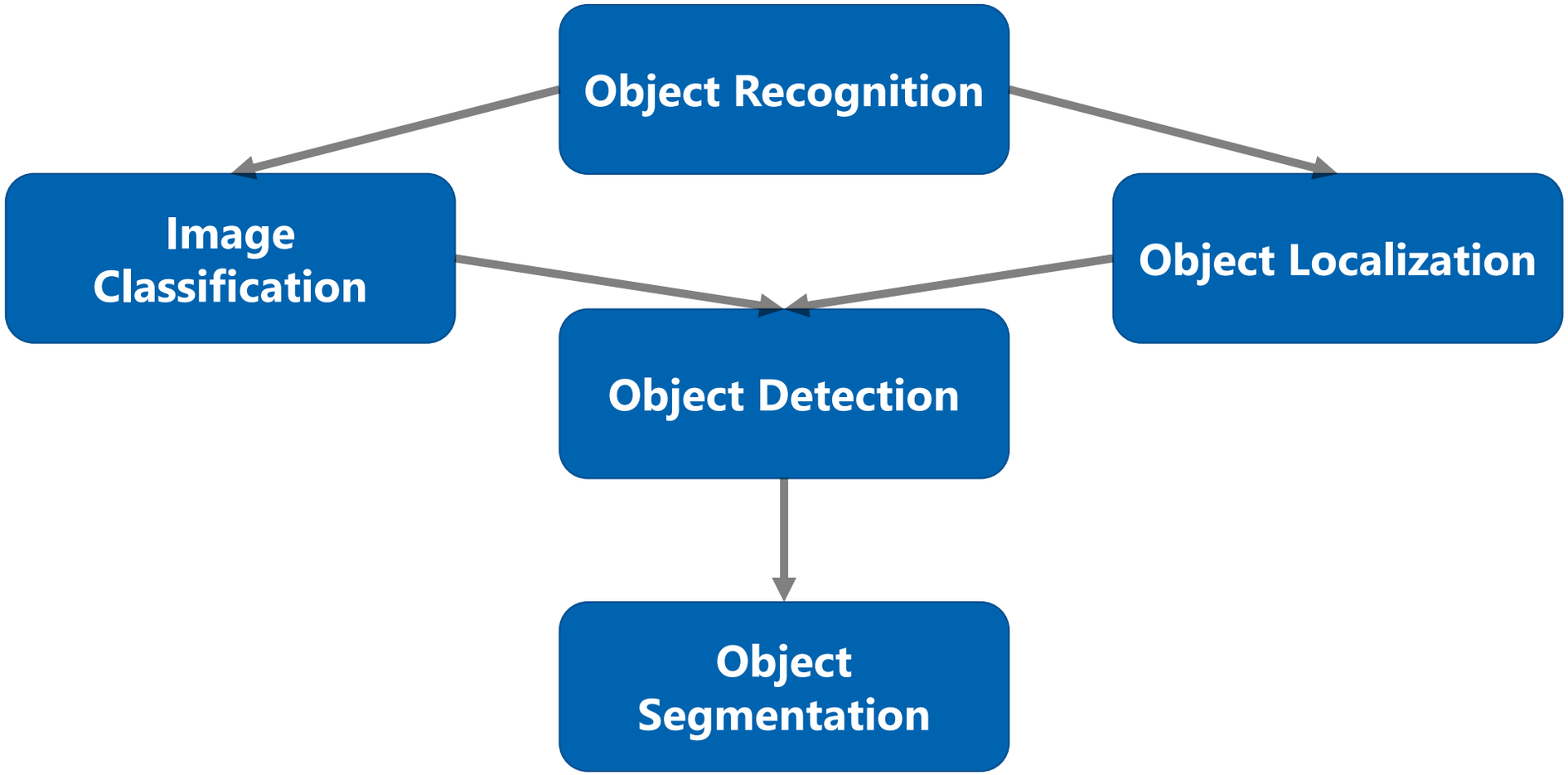






Source: Images from wikimedia

Overview of Object Detection Vision Task

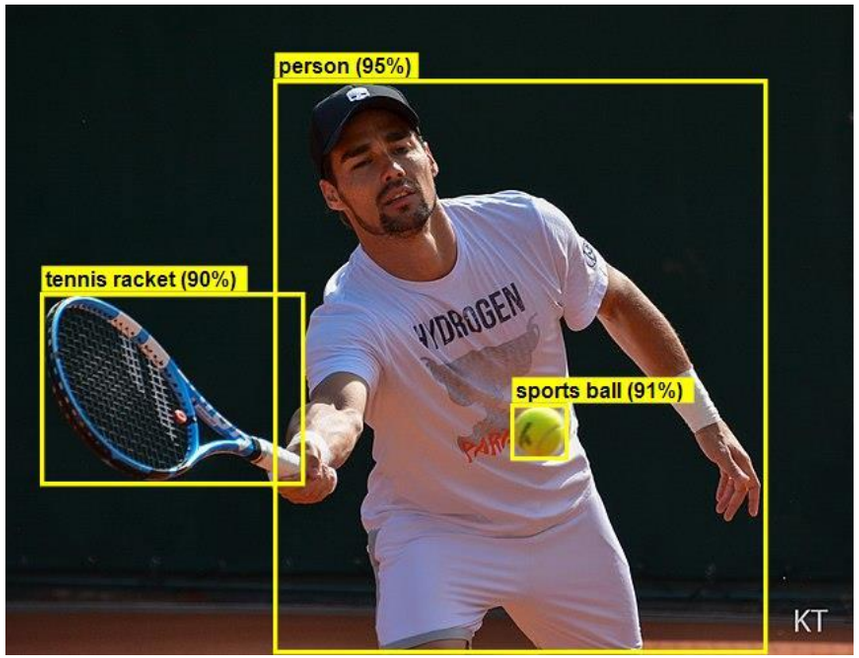


Overview of Object Detection Vision Task

Image Classification

Output:
Class – Person

Object Detection

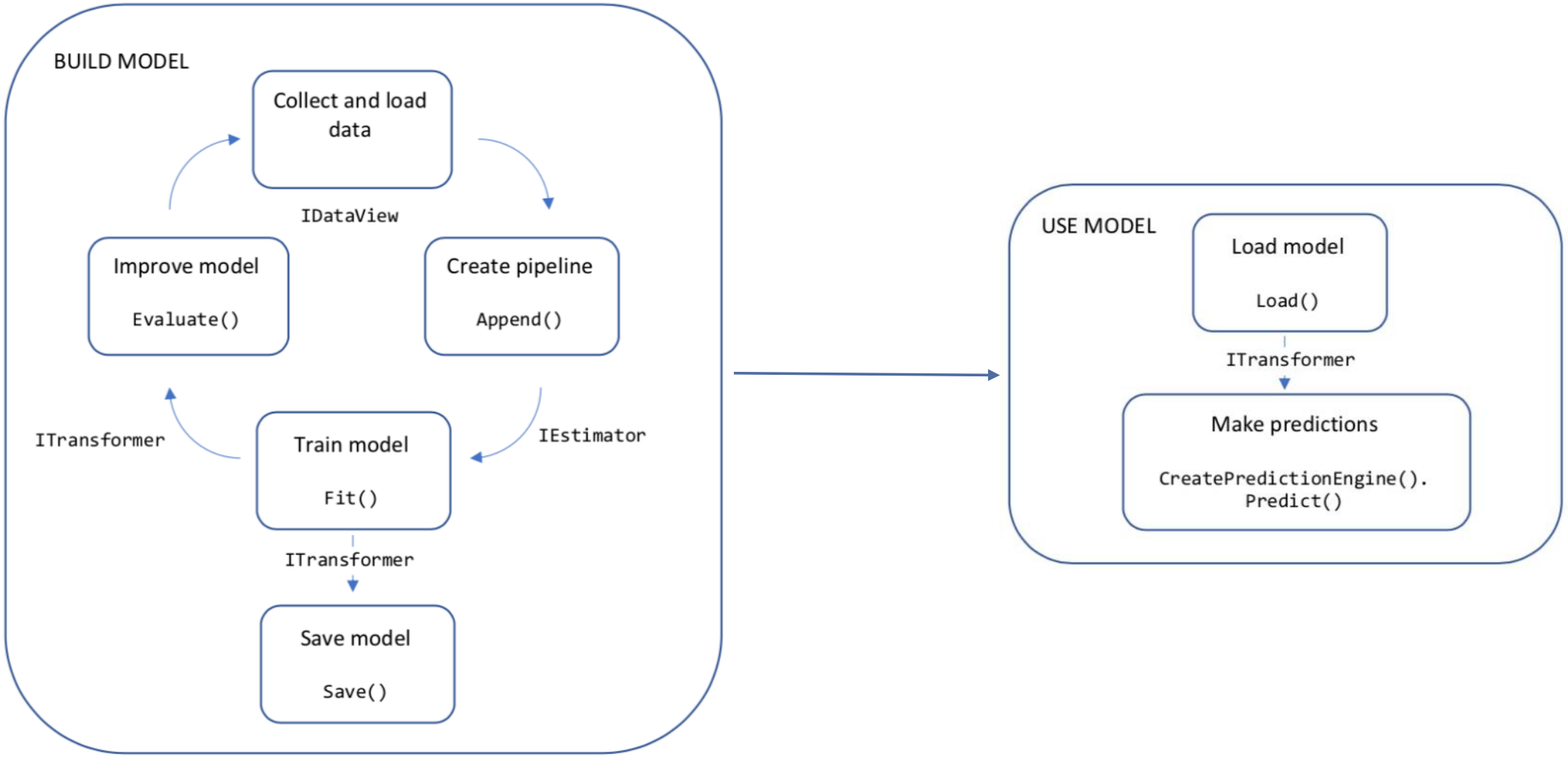


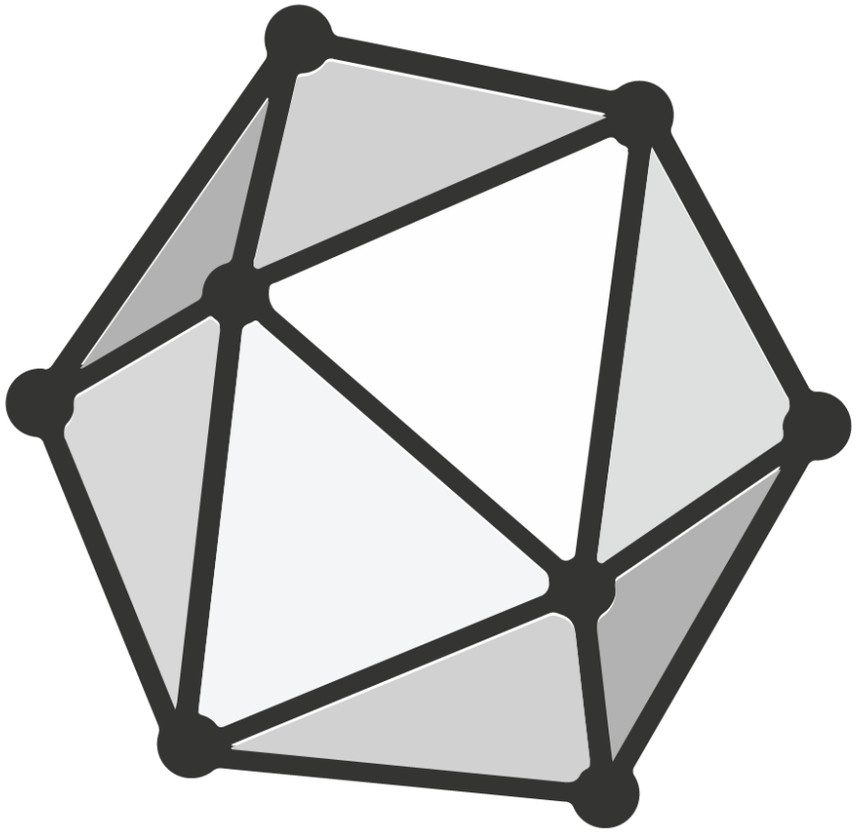
Output:
Bounding box – pc,x,y,w,h
Class – Person, Sports Ball, Tennis Racket
Confidence – 0.95, 0.91, 0.90

Source: Images from wikimedia

What is ML.NET and how does it work?

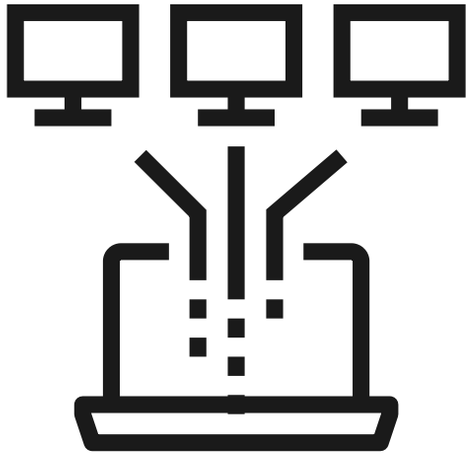
Code workflow



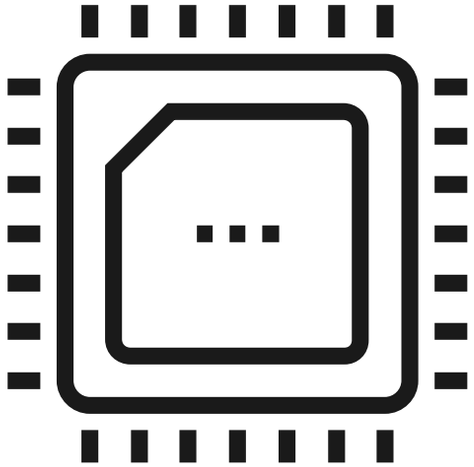


ONNX

ONNX – Key Benefits

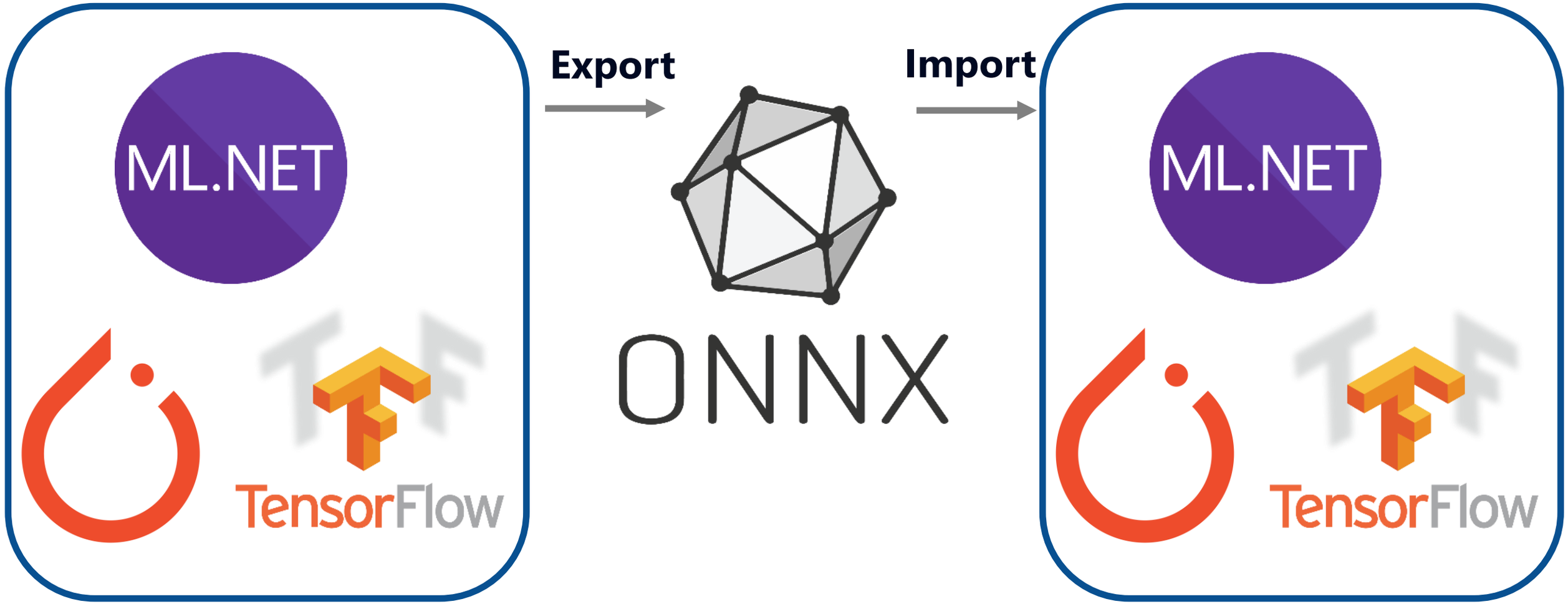


Interoperability

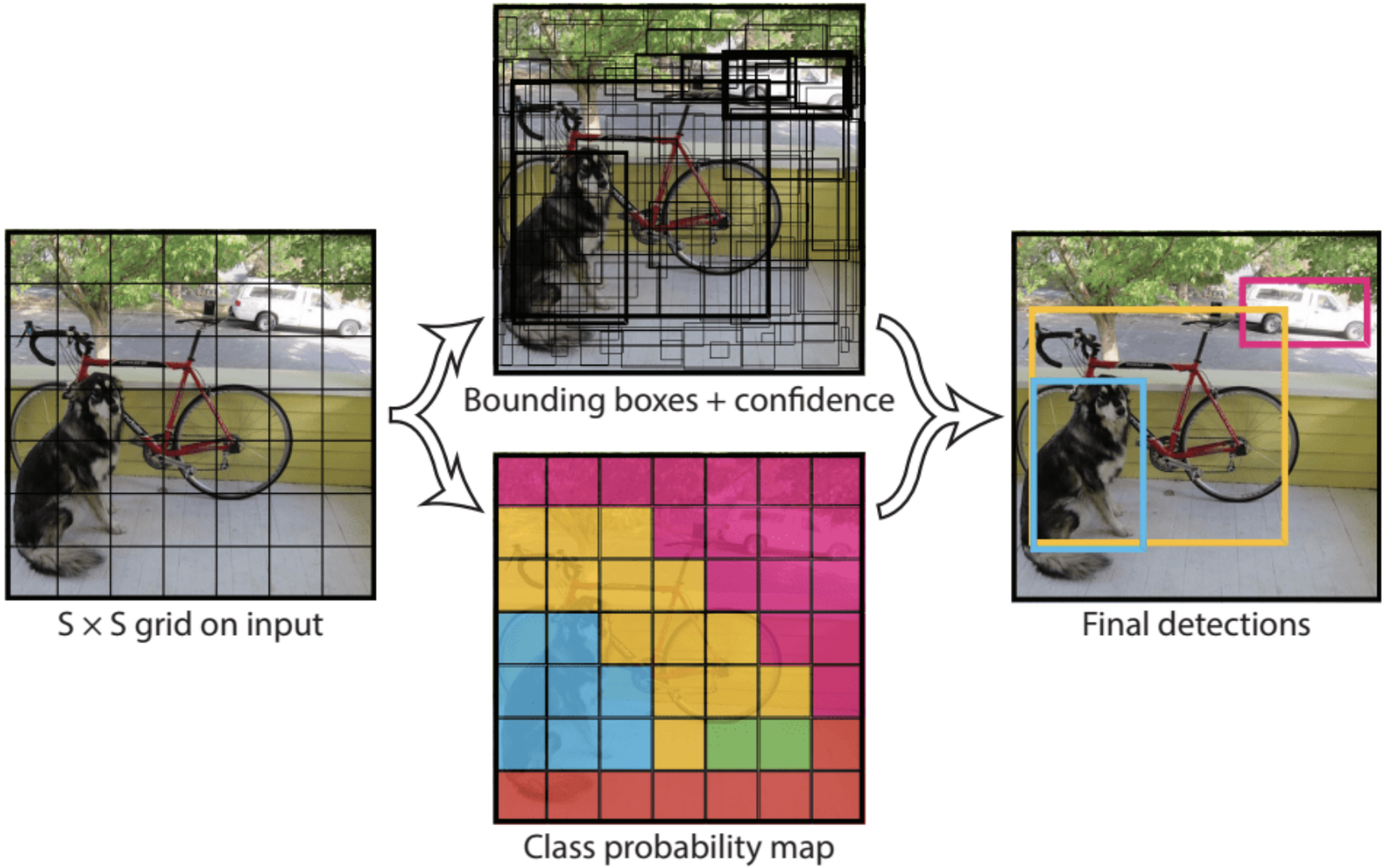


Hardware Access

ONNX

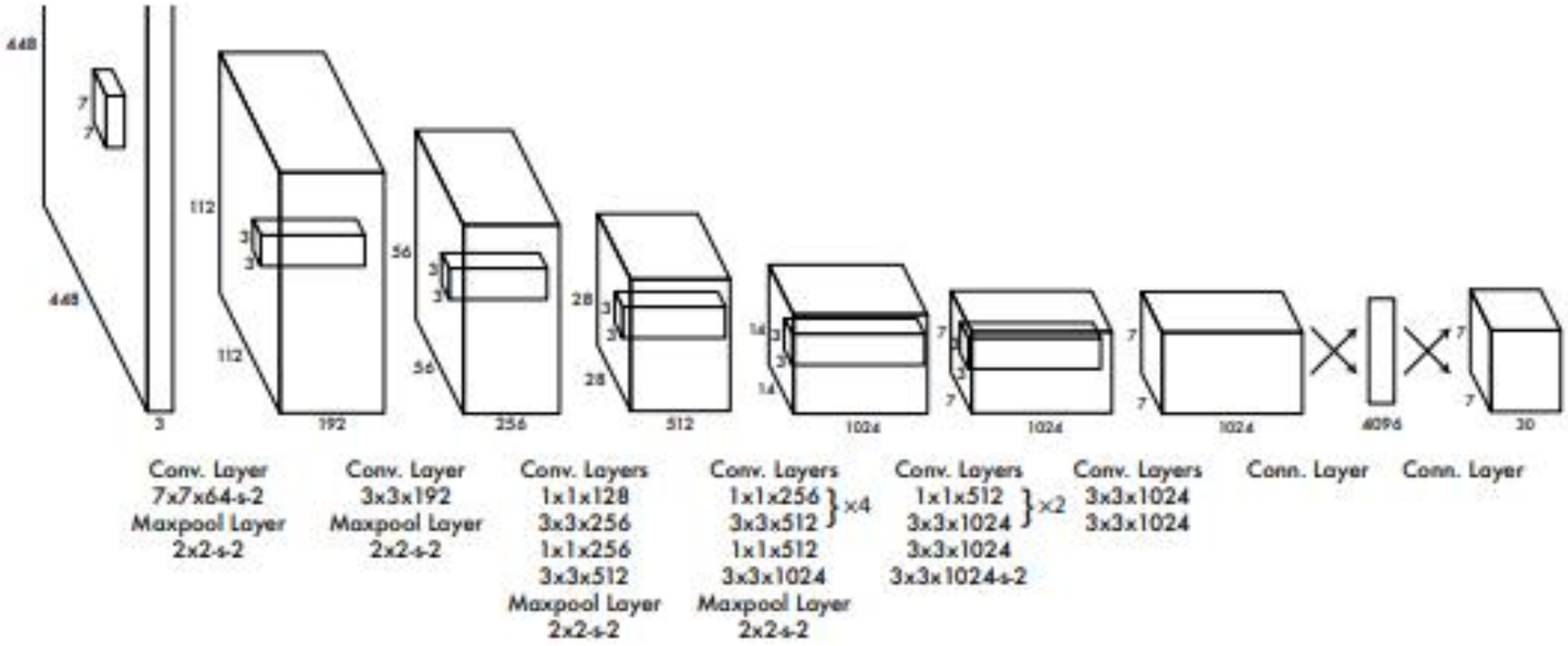


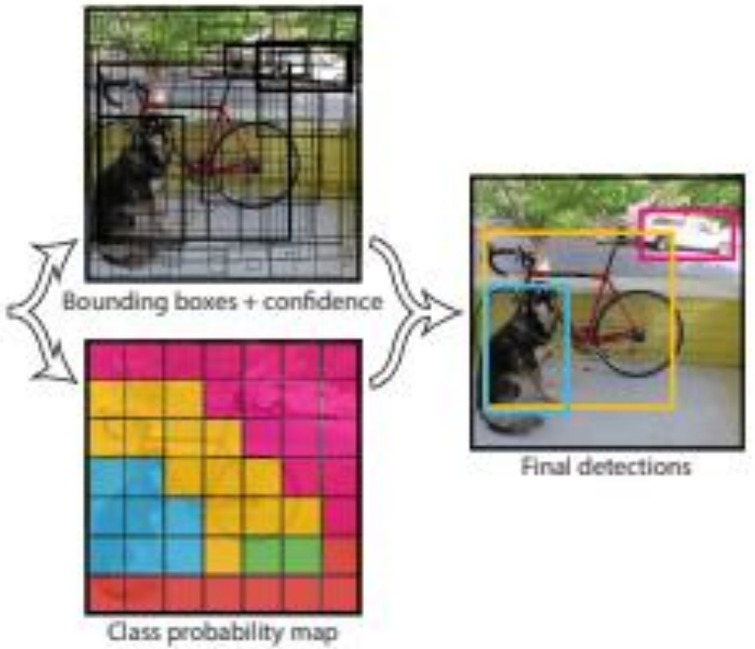
YOLO



Summary of Predictions made by YOLO Model.Taken from: You Only Look Once: Unified, Real-Time Object Detection

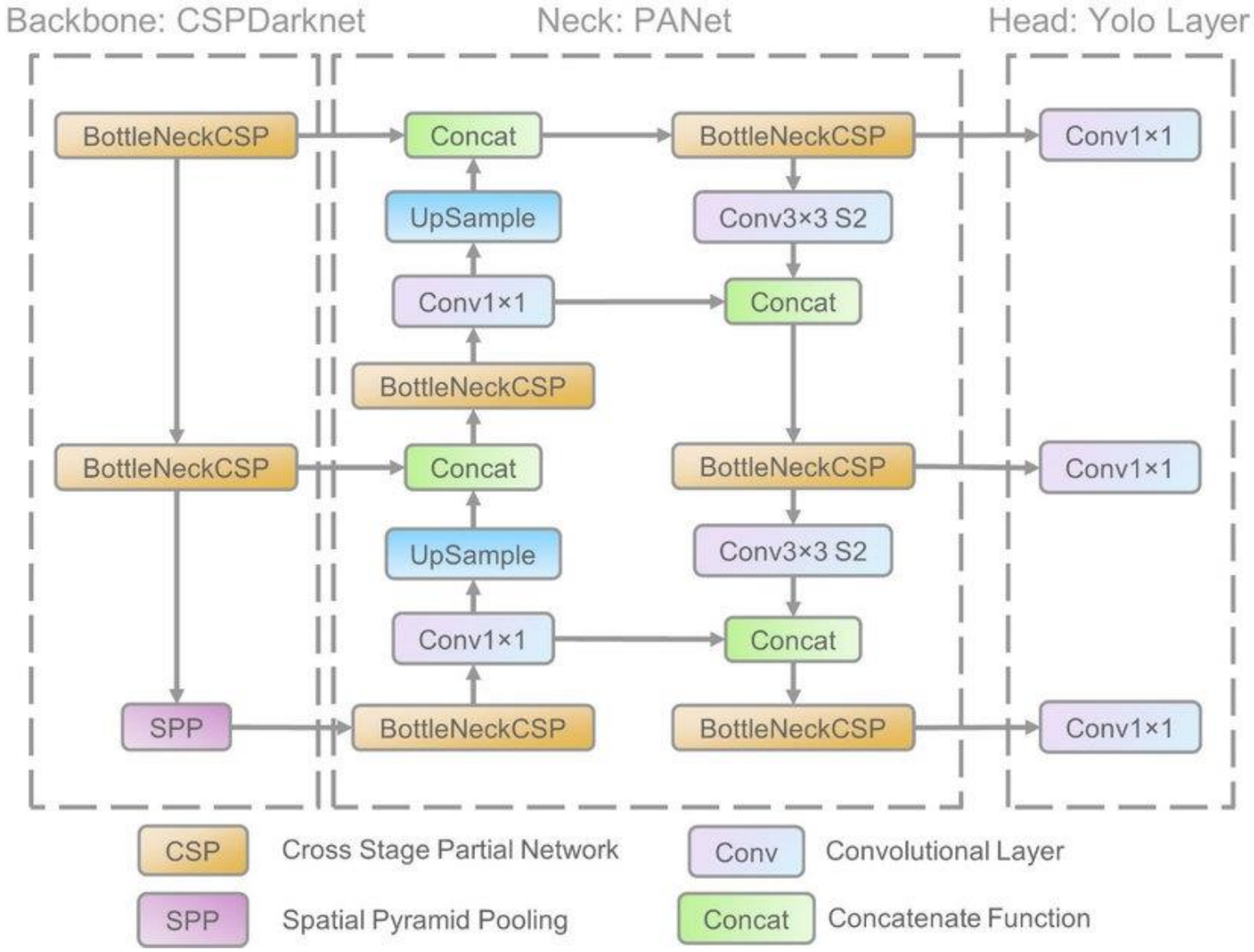
YOLO



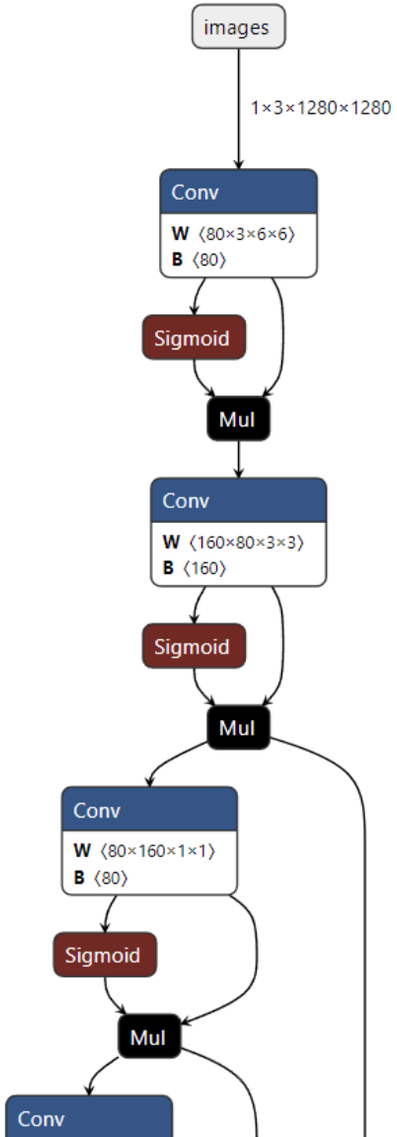


Summary of Predictions made by YOLO Model.Taken from: You Only Look Once: Unified, Real-Time Object Detection

YOLOv5x6

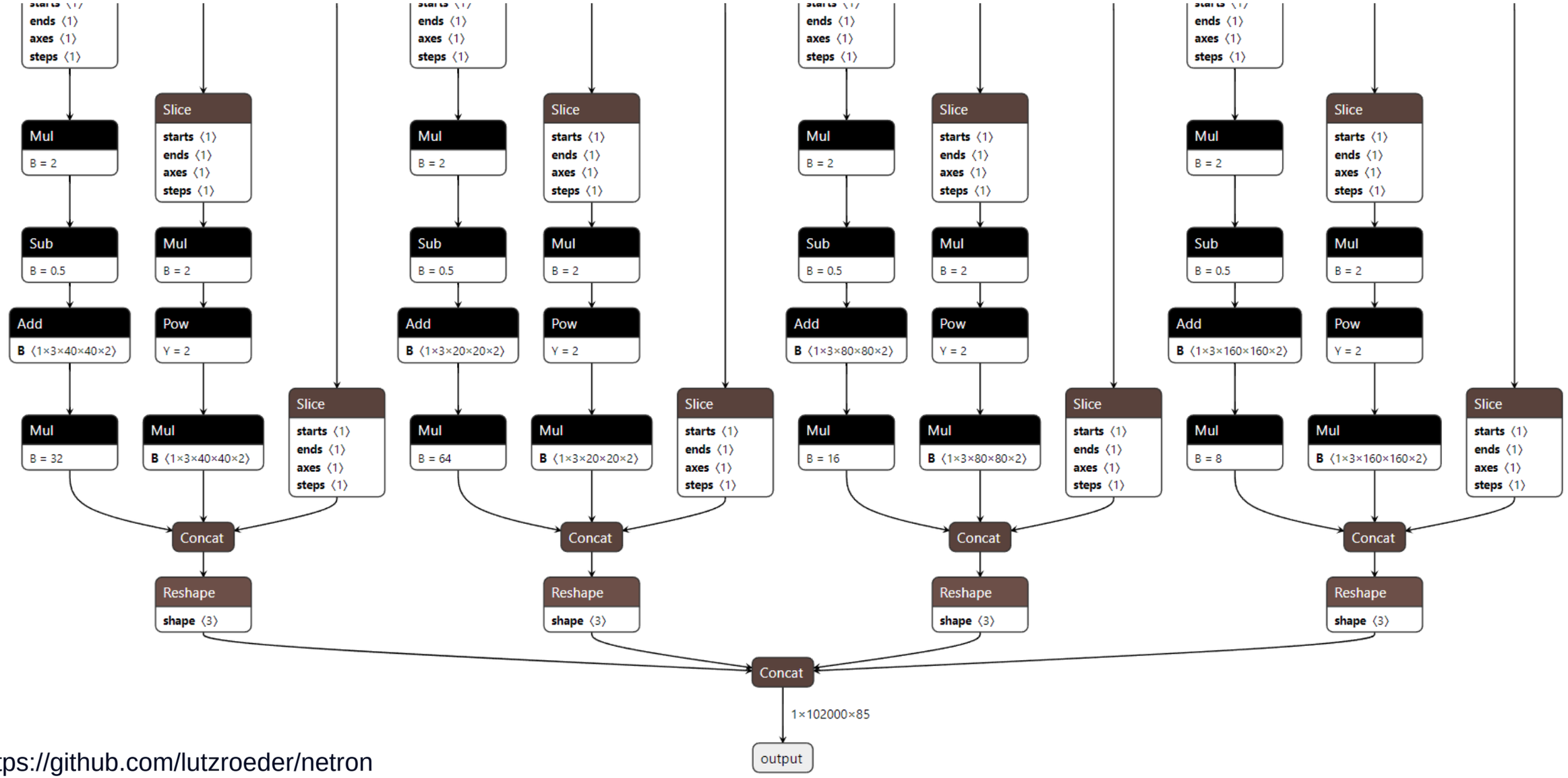

Backbone: CSPDarknet
Neck: PANet
Head: Yolo Layer
BottleNeckCSP
Concat
BottleNeckCSP
Conv1×1
UpSample
Conv3×3 S2
Conv1×1
Concat
BottleNeckCSP
BottleNeckCSP
Concat
BottleNeckCSP
Conv1×1
UpSample
Conv3×3 S2
Conv1×1
Concat
SPP
BottleNeckCSP
BottleNeckCSP
Conv1×1
CSP
Cross Stage Partial Network
Conv
Convolutional Layer
SPP
Spatial Pyramid Pooling
Concat
Concatenate Function

NETRON

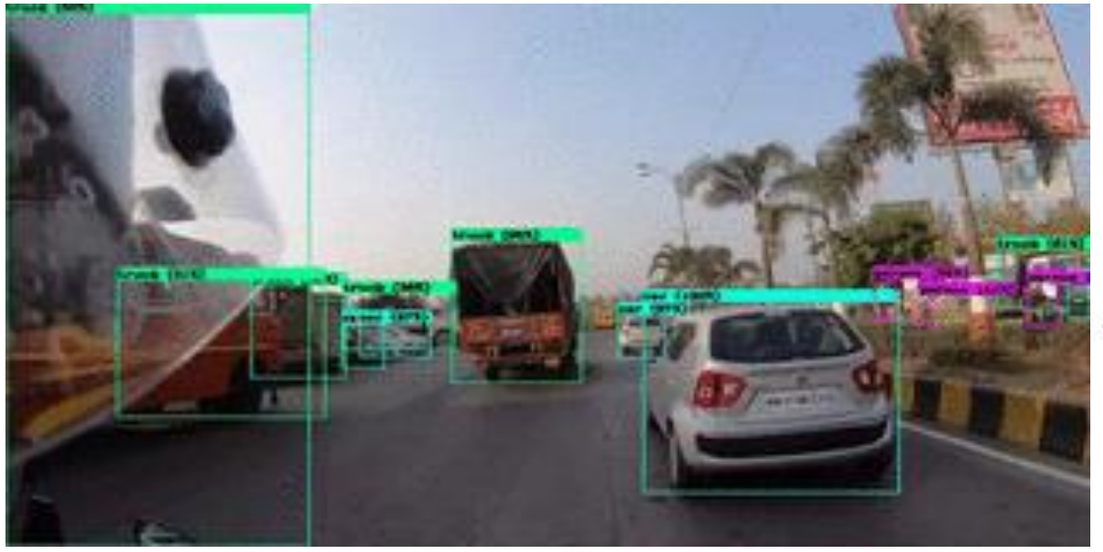


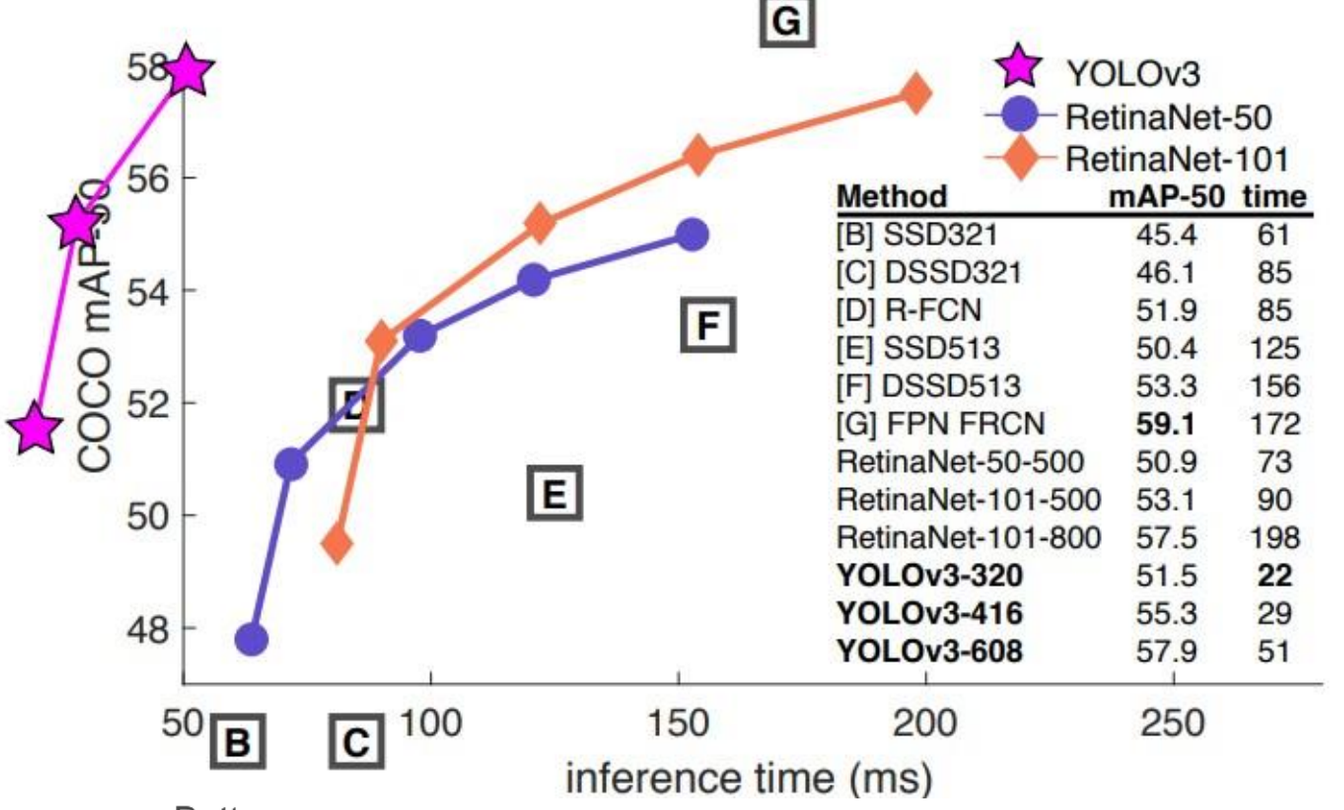
https://github.com/lutzroeder/netron

NETRON

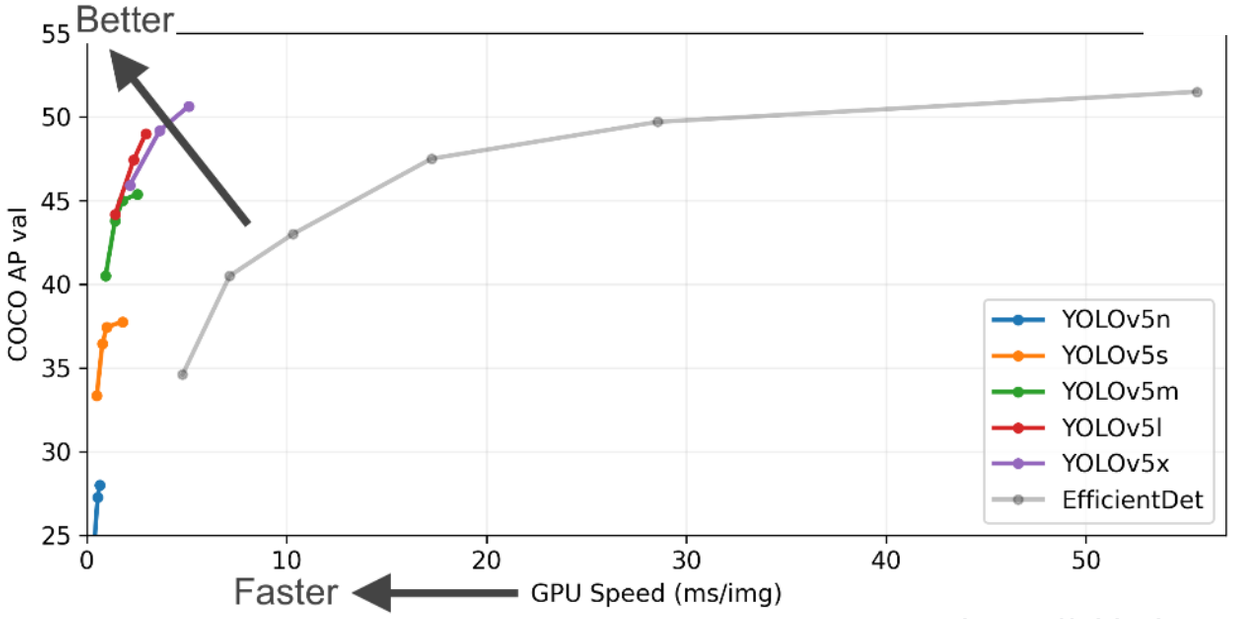


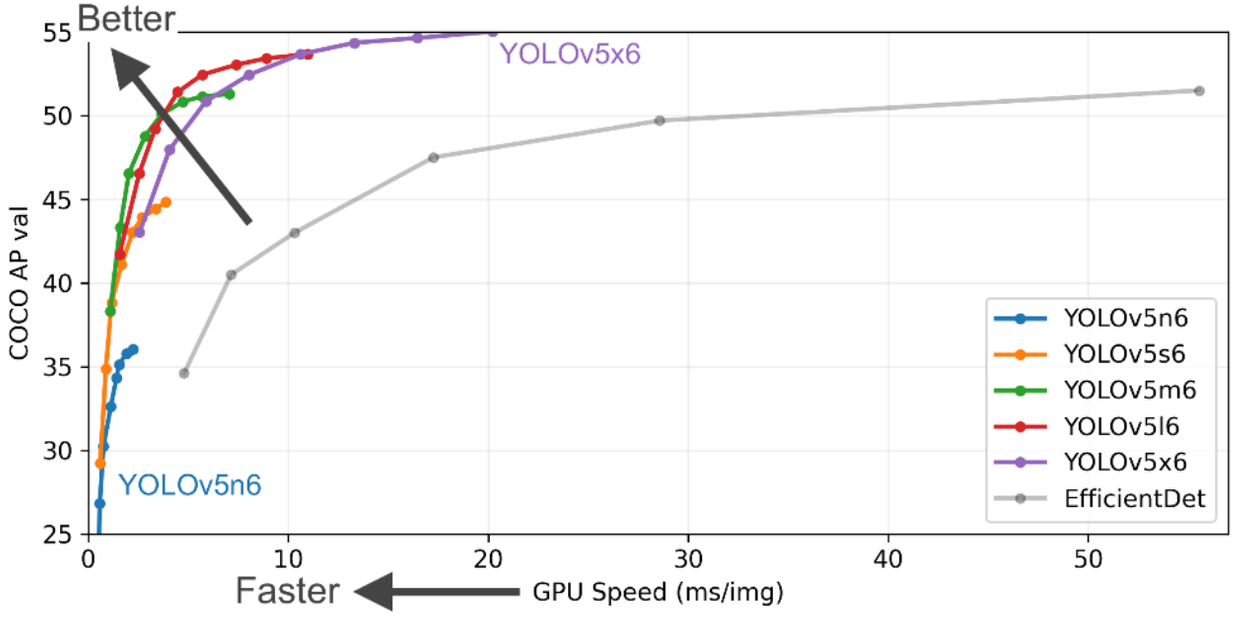
https://github.com/lutzroeder/netron





Method	mAP-50	time
[B] SSD321	45.4	61
[C] DSSD321	46.1	85
[D] R-FCN	51.9	85
[E] SSD513	50.4	125
[F] DSSD513	53.3	156
[G] FPN FRCN	**59.1**	172
RetinaNet-50-500	50.9	73
RetinaNet-101-500	53.1	90
RetinaNet-101-800	57.5	198
YOLOv3-320	51.5	**22**
YOLOv3-416	55.3	29
YOLOv3-608	57.9	51





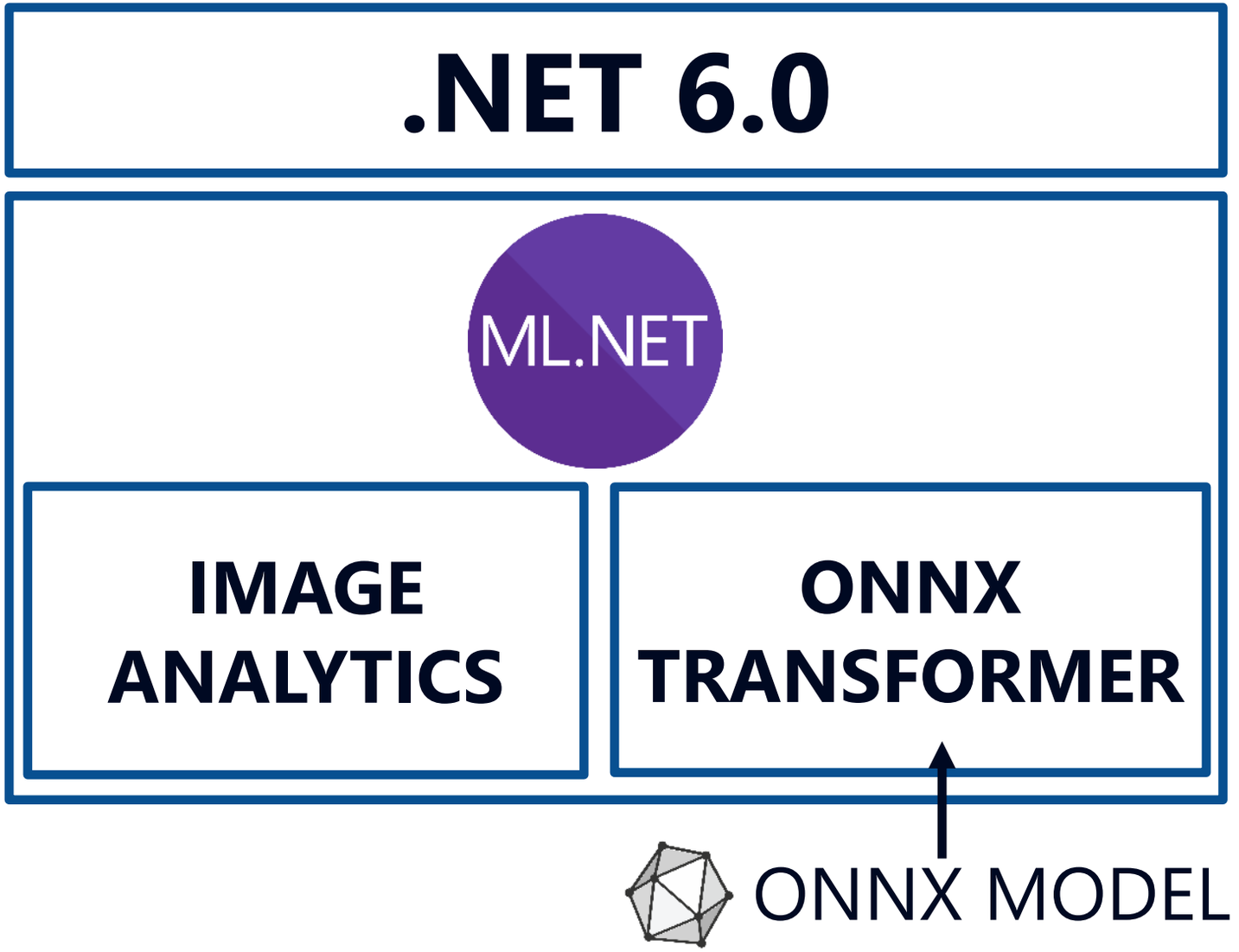
https://github.com

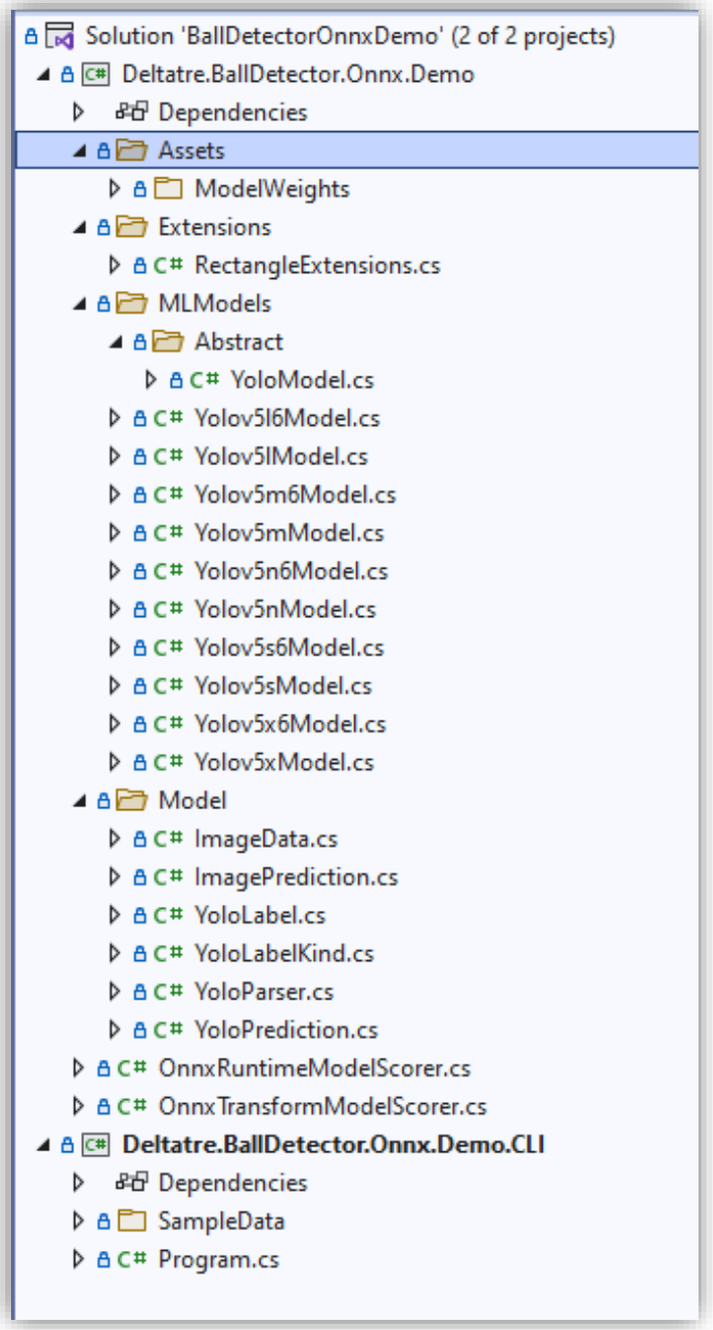
YOLOv5 – Pretrained Checkpoints

Model	size (pixels)	mAP^{val} 0.5:0.95	mAP^{val} 0.5	Speed CPU b1 (ms)	Speed V100 b1 (ms)	Speed V100 b32 (ms)	params (M)	FLOPs @640 (B)
YOLOv5n	640	28.0	45.7	**45**	**6.3**	**0.6**	**1.9**	**4.5**
YOLOv5s	640	37.4	56.8	98	6.4	0.9	7.2	16.5
YOLOv5m	640	45.4	64.1	224	8.2	1.7	21.2	49.0
YOLOv5l	640	49.0	67.3	430	10.1	2.7	46.5	109.1
YOLOv5x	640	50.7	68.9	766	12.1	4.8	86.7	205.7
YOLOv5n6	1280	36.0	54.4	153	8.1	2.1	3.2	4.6
YOLOv5s6	1280	44.8	63.7	385	8.2	3.6	12.6	16.8
YOLOv5m6	1280	51.3	69.3	887	11.1	6.8	35.7	50.0
YOLOv5l6	1280	53.7	71.3	1784	15.8	10.5	76.8	111.4
YOLOv5x6 + TTA	1280 1536	55.0 **55.8**	72.7 **72.7**	3136 -	26.2 -	19.4 -	140.7 -	209.8 -

https://github.com/ultralytics/yolov5

Demo


.NET 6.0
ML.NET
IMAGE ANALYTICS
ONNX TRANSFORMER
ONNX MODEL

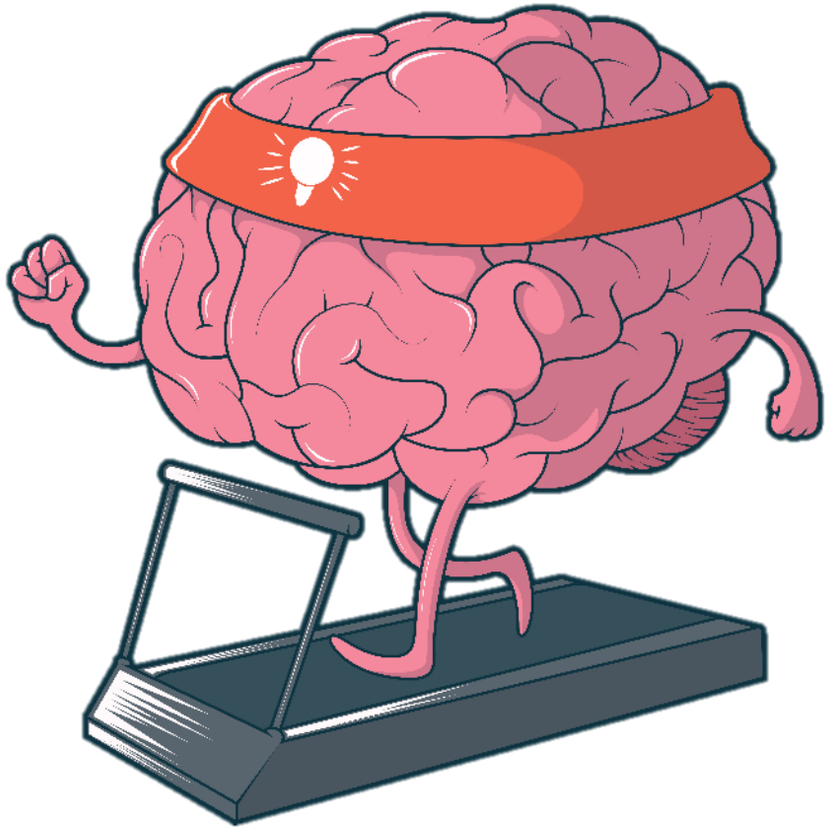

Solution 'BallDetectorOnnxDemo' (2 of 2 projects)
Deltatre.BallDetector.Onnx.Demo
Dependencies
Assets
ModelWeights
Extensions
RectangleExtensions.cs
MLModels
Abstract
YoloModel.cs
Yolov5l6Model.cs
Yolov5lModel.cs
Yolov5m6Model.cs
Yolov5mModel.cs
Yolov5n6Model.cs
Yolov5nModel.cs
Yolov5s6Model.cs
Yolov5sModel.cs
Yolov5x6Model.cs
Yolov5xModel.cs
Model
ImageData.cs
ImagePrediction.cs
YoloLabel.cs
YoloLabelKind.cs
YoloParser.cs
YoloPrediction.cs
OnnxRuntimeModelScorer.cs
OnnxTransformModelScorer.cs
Deltatre.BallDetector.Onnx.Demo.CLI
Dependencies
SampleData
Program.cs

Other Frameworks

TorchSharp: https://github.com/dotnet/TorchSharp

TensorFlow.NET: https://github.com/SciSharp/TensorFlow.NET

Training/Fine Tuning



Dataset

60%

20%

20%

soccer

```yaml
path: "./soccer" # Path relative to the `train.py` script.
train: images/train
val: images/val

# Classes
nc: 3
names: [
    "Unknown", "Ball", "Person"
]
```

soccer.yaml

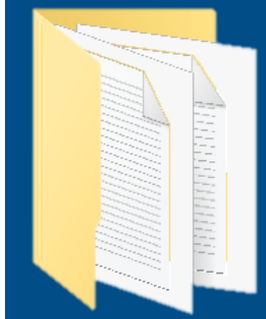
images

test

train

val

labels



test

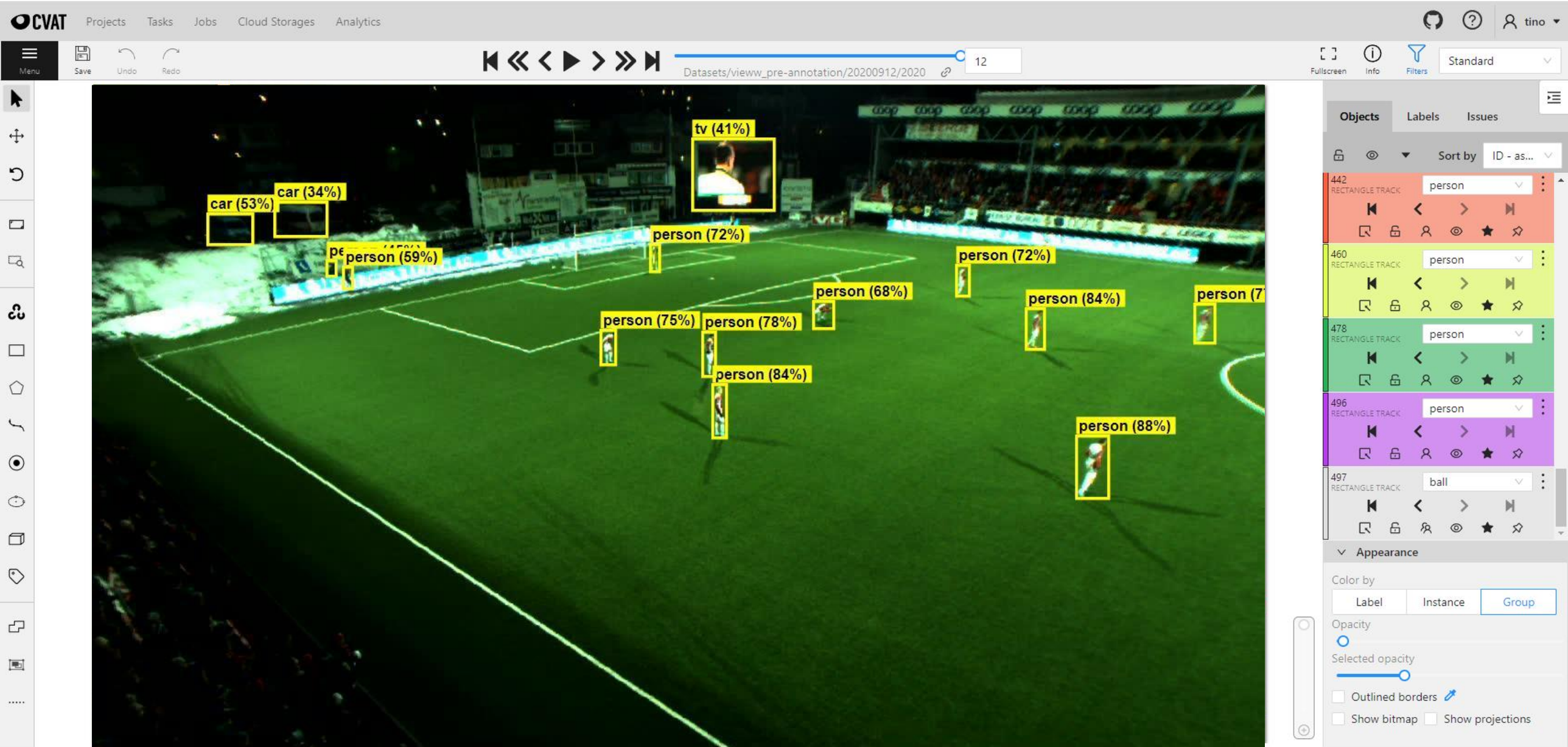
train

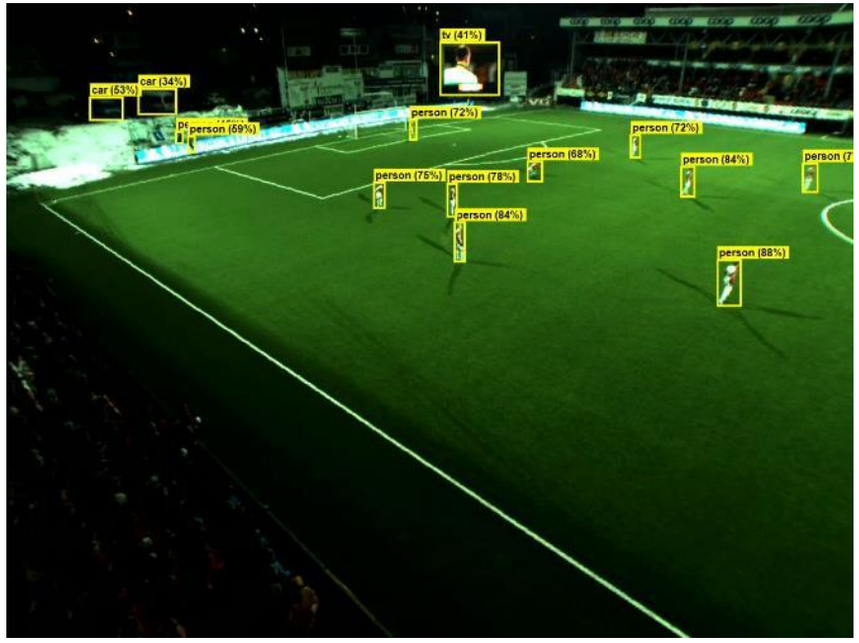
val

Annotation/Labeling

CVAT

Annotation


CVAT
Projects
Tasks
Jobs
Cloud Storages
Analytics
tino
Menu
Save
Undo
Redo
12
Datasets/vieww_pre-annotation/20200912/2020
Fullscreen
Info
Filters
Standard
car (53%)
car (34%)
person (59%)
tv (41%)
person (72%)
person (72%)
person (68%)
person (84%)
person (75%)
person (78%)
person (84%)
person (88%)
Objects
Labels
Issues
Sort by
ID - as...
442
RECTANGLE TRACK
person
460
RECTANGLE TRACK
person
478
RECTANGLE TRACK
person
496
RECTANGLE TRACK
person
497
RECTANGLE TRACK
ball
Appearance
Color by
Label
Instance
Group
Opacity
Selected opacity
Outlined borders
Show bitmap
Show projections




```
2 0.8370949074074073 0.9351851851851852 0.02372685185185185 0.07407407407407408
1 0.8007436342592592 0.3405658436213992 0.006047453703703729 0.010308641975308624
2 0.20578703703703705 0.9281378600823046 0.026157407407407 0.07026748971193411
2 0.8151331018518517 0.38971193415637867 0.017303240740740793 0.05596707818930039
2 0.7034722222222222 0.19444444444444445 0.020138888888888862 0.05349794238683128
2 0.5539351851851851 0.580761316872428 0.015277777777777763 0.0668724279835391
2 0.11574074074074073 0.6481481481481483 0.020833333333333332 0.0617283950617284
2 0.9890624999999998 0.7520576131687243 0.015162037037037062 0.0617283950617284
2 0.21493055555555554 0.1536522633744856 0.009722222222222228 0.051543209876543226
2 0.281886574074074 0.13549382716049382 0.010648148148148134 0.045267489711934145
2 0.5388570601851852 0.36029320987654323 0.016140046296296288 0.05966049382716051
2 0.6171875 0.14969135802469138 0.012152777777777776 0.05246913580246914
2 0.32132523148148145 0.4746399176954733 0.015335648148148147 0.06244855967078189
2 0.66796875 0.4174382716049383 0.01417824074074074 0.06018518518518519
2 0.1720486111111111 0.2559670781893004 0.013078703703703716 0.057201646090535005
2 0.8214699074074073 0.3669753086419753 0.012152777777777776 0.05617283950617287
2 0.8574652777777776 0.34969135802469137 0.035416666666666693 0.02880658436213992
2 0.004918981481481481 0.38991769547325106 0.009837962962962962 0.05349794238683128
2 0.8006944444444444 0.3476851851851852 0.016550925925925872 0.059567901234567885
2 0.12861689814814814 0.2835905349794239 0.011863425925925925 0.054835390946502076
2 0.7350405092592592 0.31790123456790126 0.015335648148148147 0.05555555555555556
2 0.11168981481481481 0.014300411522633744 0.009259259259259259 0.027777777777777778
2 0.9811053240740739 0.6527777777777778 0.013136574074074099 0.06069958847736626
2 0.9525752314814814 0.2431069958847737 0.011631944444444391 0.054115226337448585
2 0.746412037037037 0.36342592592592593 0.016203703703703703 0.05709876543209877
2 0.5156828703703703 0.1868312757201646 0.011458333333333307 0.052263374485596724
2 0.4256655092592592 0.3338477366255144 0.012210648148148161 0.0565843621399177
2 0.8054890046296296 0.25669238683127577 0.01865162037037038 0.051018518518518526
2 0.8894386574074074 0.3833847736625515 0.022048611111111057 0.05771604938271608
```

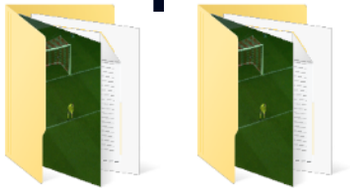
Demo – Fine Tuning with Azure ML

Python

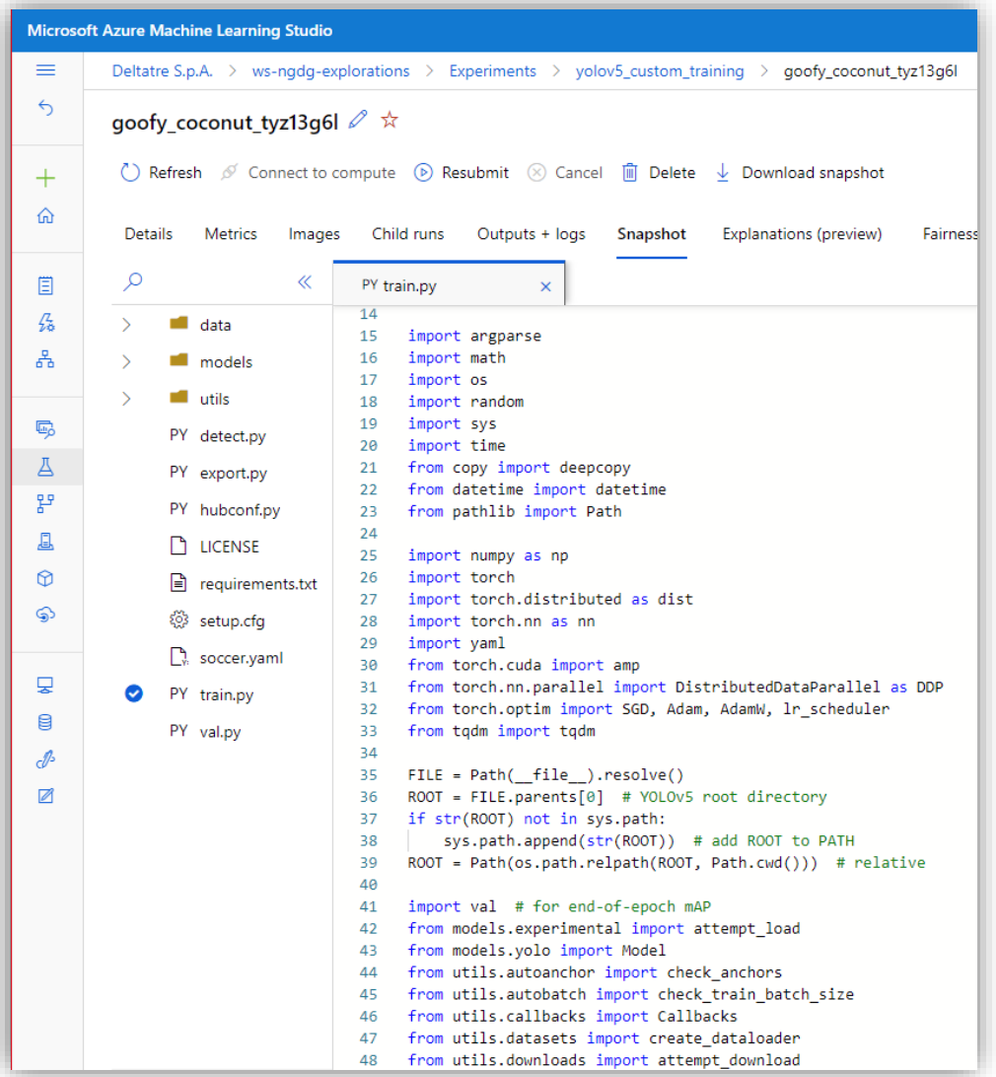
Azure Machine Learning

Dataset

PyTorch



ONNX MODEL



Azure Machine Learning

Support for the end-to-end Machine Learning lifecycle

Prepare Data

Build and train models

Validate and deploy

Manage and monitor

https://azure.microsoft.com/en-us/services/machine-learning/

Thank You!

ευχαριστώ Salamat Po متشكرم شكراً Grazie

благодаря ありがとうございます Kiitos Teşekkürler 谢谢

ขอบคุณครับ Obrigado شكريه Terima Kasih Dziękuję

Hvala Köszönöm Tak Dank u wel дякую Tack

Mulţumesc спасибо Danke Cám ơn Gracias

多謝晒 Ďakujem תודה நன்றி Děkuji 감사합니다

Slides/Demo repository

Deltatre Innovation Lab

https://github.com/deltatrelabs/deltatre-global-azure-torino-2022

Useful links (1/2)

- https://github.com/deltatrelabs/deltatre-net-conf-2022-mlnet
- https://github.com/ultralytics/yolov5/releases
- https://github.com/lutzroeder/netron
- https://github.com/daquexian/onnx-simplifier
- https://docs.microsoft.com/en-us/dotnet/machine-learning/tutorials/image-classification
- https://docs.microsoft.com/en-us/dotnet/machine-learning/tutorials/object-detection-onnx
- https://pytorch.org/
- https://www.tensorflow.org/
- https://github.com/dotnet/TorchSharp
- https://github.com/SciSharp/TensorFlow.NET
- https://docs.microsoft.com/en-us/dotnet/machine-learning/

Useful links (2/2)

- https://azure.microsoft.com/en-us/services/machine-learning/
- https://cvat.org
- https://makesense.ai
- https://labelbox.com
- https://roboflow.com

About us

Clemente Giorio

R&D Senior Software Engineer @ deltatre

@tinux80

- Augmented/Mixed/Virtual Reality
- Artificial Intelligence, Machine Learning, Deep Learning
- Internet of Things
- Hybrid Clusters
- Multimodal Tracking

dotNET{podcast}

MVP Microsoft Most Valuable Professional

intel Software INNOVATOR

[PACKT] PUBLISHING Author

FAB LAB NAPOLI

About us

Ing. Gianni ROSA GALLINA

R&D Technical Lead @ deltatre

@giannirg

- AI, Machine Learning, Deep Learning on multimedia content
- Virtual/Augmented/Mixed Reality
- Immersive video streaming & 3D graphics for sport events
- Cloud solutions, web backends, serverless, video workflows
- Mobile apps dev (Windows / Android / Xamarin)
- End-to-end solutions with Microsoft Azure

MVP Microsoft Most Valuable Professional

Microsoft Specialist
Programming in C#
Programming in HTML5 with JavaScript & CSS3

Microsoft CERTIFIED Solutions Developer
Windows Store Apps Using C#
Web Applications

Microsoft CERTIFIED AZURE AI ENGINEER ASSOCIATE

Microsoft CERTIFIED AZURE DATA SCIENTIST ASSOCIATE

unity Certified Programmer

PLURALSIGHT Author

https://gianni.rosagallina.com/en/

7 maggio 2022

#GlobalAzureTorino

Azure Meetup
TORINO

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Tech Data