End to End Learning for Self-driving Plane in GTA V

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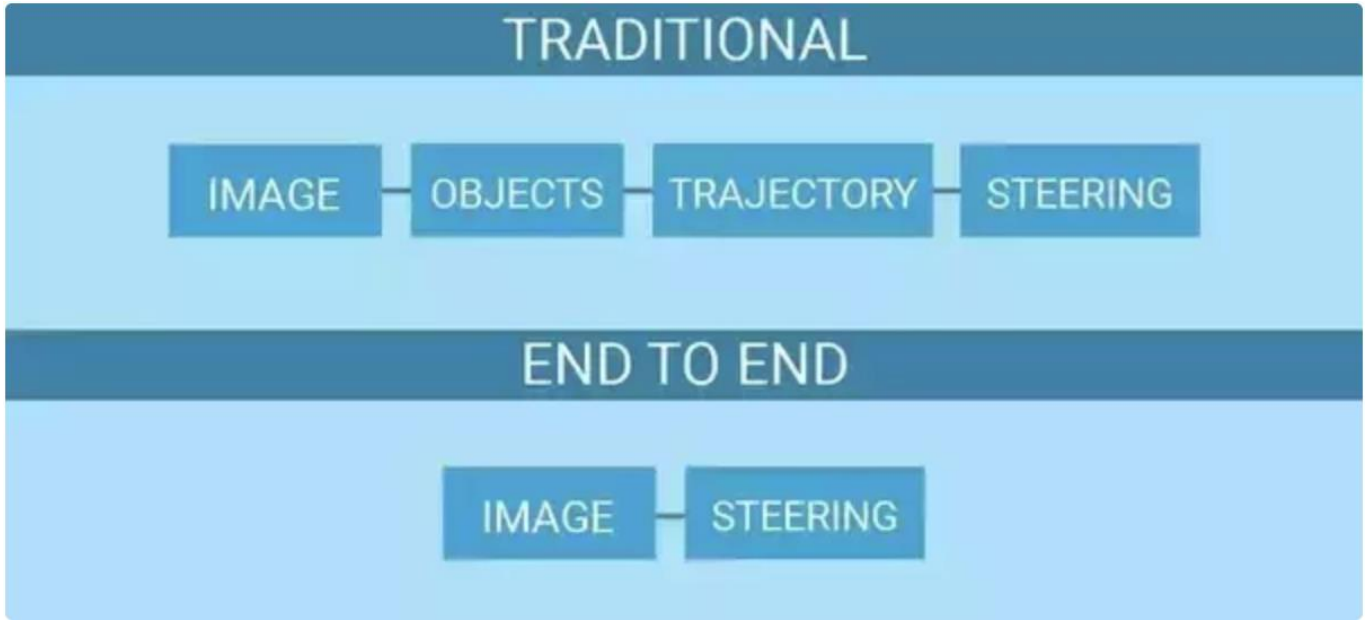
Self-driving car



M. Bojarski et al., ”End to end learning for self-driving cars,” arXiv preprint arXiv:1604.07316, 2016.

Low altitude flight

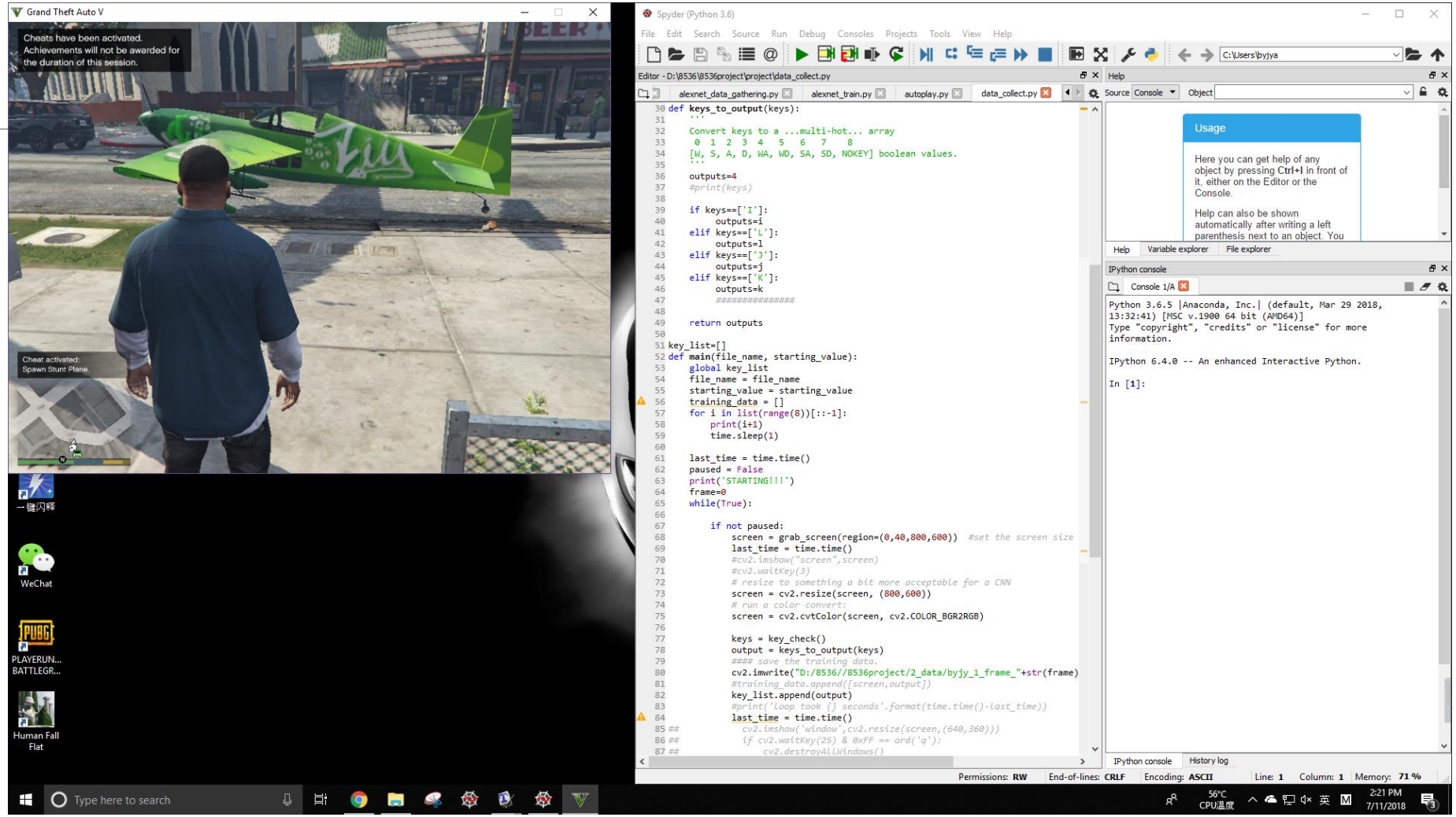
Purchase a plane

GTA V

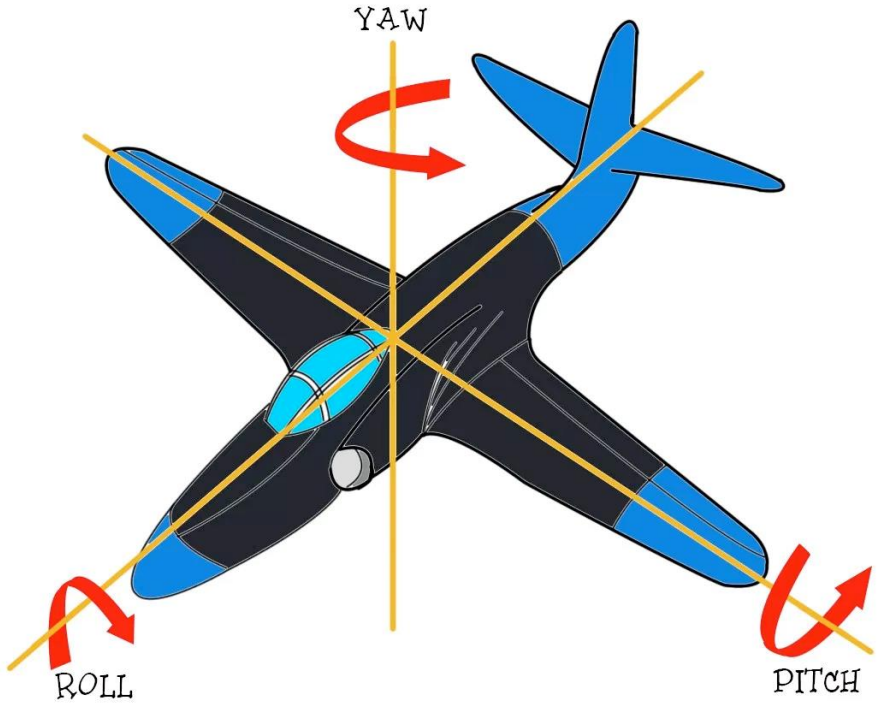

grand
theft
auto
FIVE
V

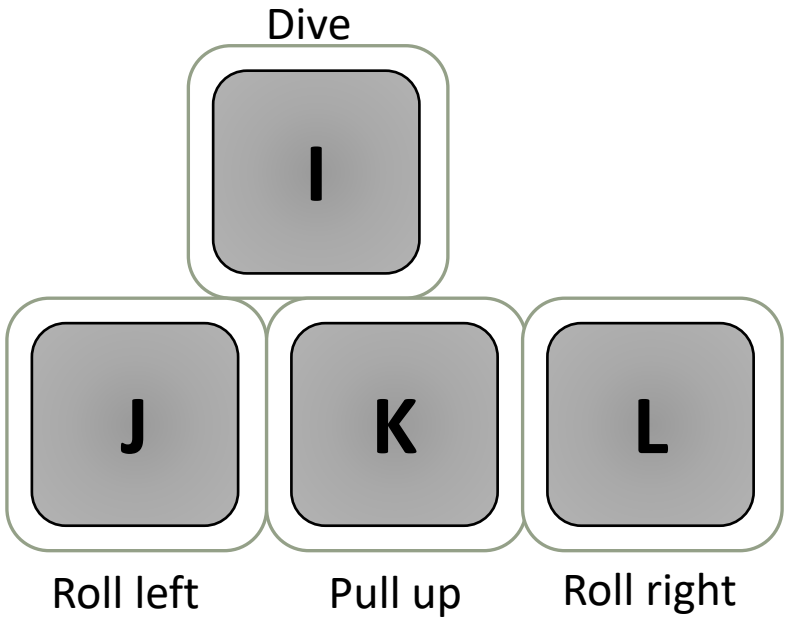

Grand Theft Auto V
Cheats have been activated.
Achievements will not be awarded for
the duration of this session.
Cheat activated:
Spawn Stunt Plane.

Collect Data

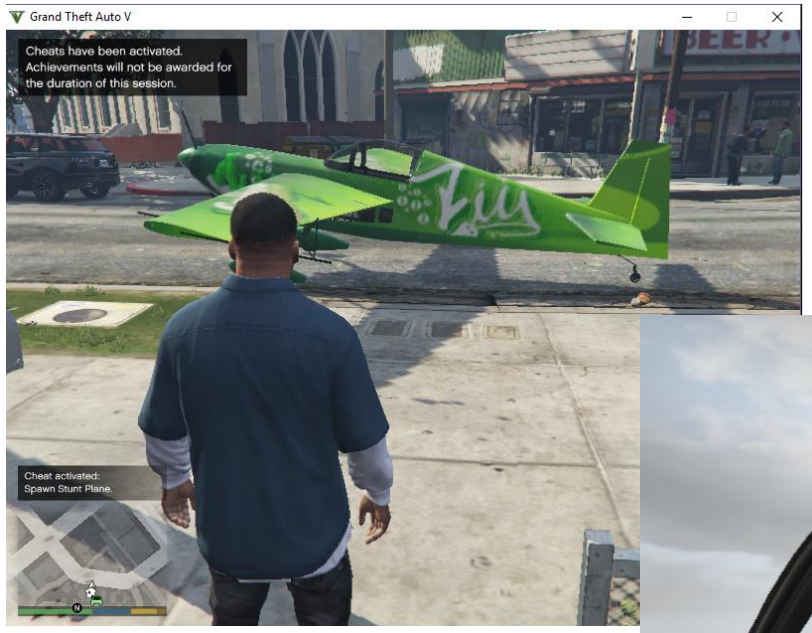


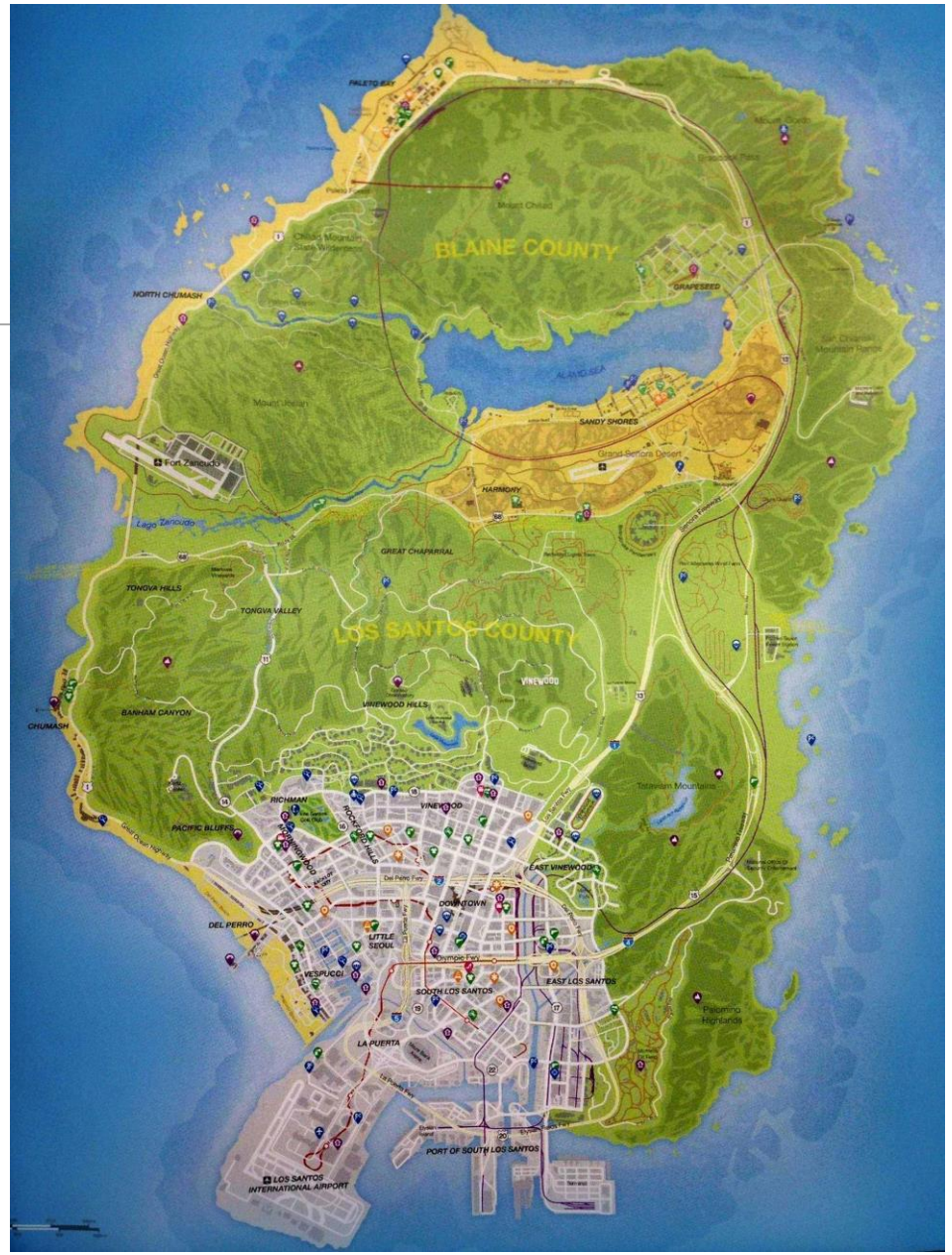
Labels



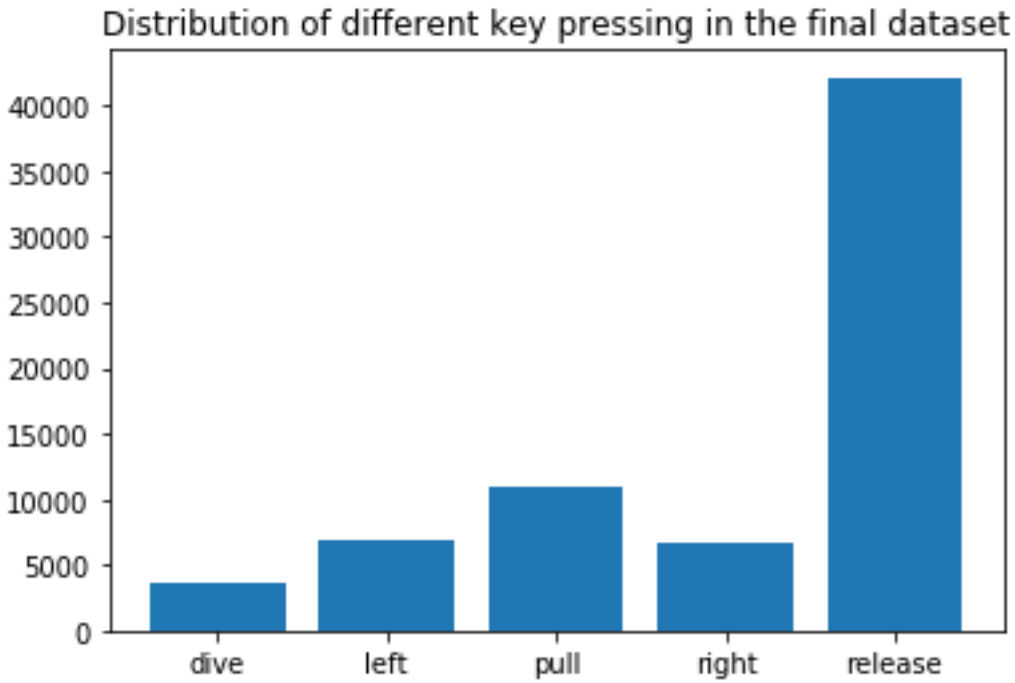


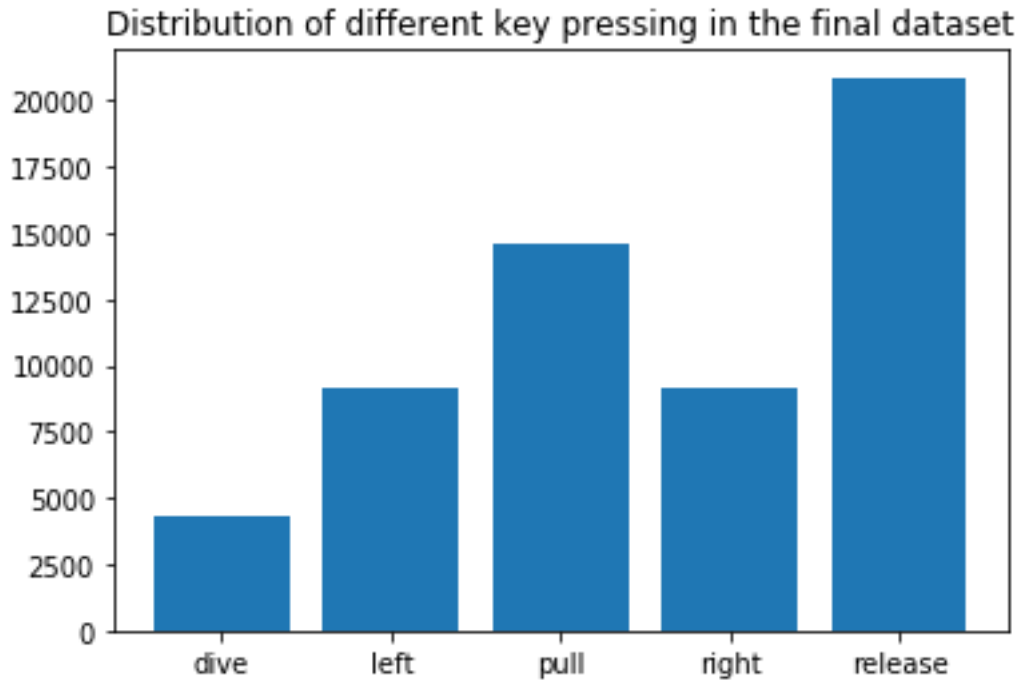
Dataset specifications





Balance Dataset

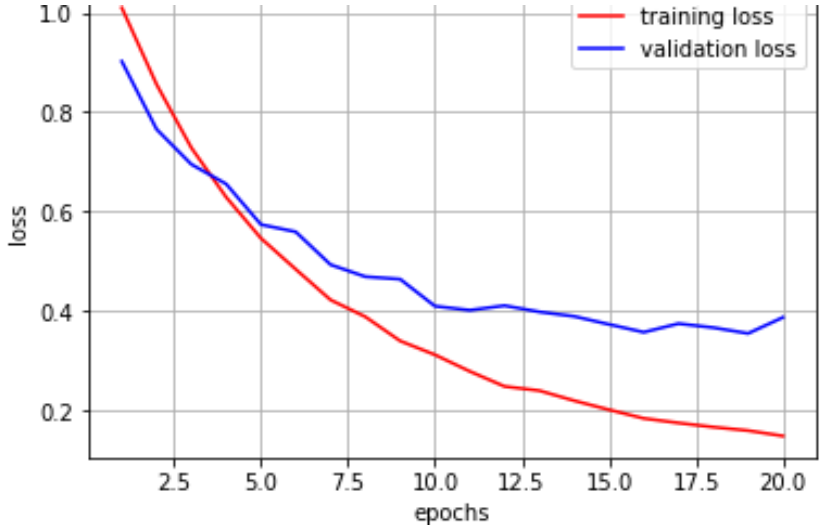




GTA Network architecture

conv in=3, 32 × 5 × 5,stride=1,padding=2 ReLu BN
conv 64 × 5 × 5 stride=1,padding=2 ReLu BN maxpooling 2 × 2, stride=2
conv 128 × 3 × 3 stride=1,padding=1 ReLu BN maxpooling 2 × 2, stride=2
conv 256 × 3 × 3 stride=1,padding=1 ReLu BN maxpooling 2 × 2, stride=1
conv 256 × 3 × 3 stride=1,padding=1 ReLu BN maxpooling 2 × 2, stride=1

FC Layer
Flatten
ReLu
512
ReLu
256
ReLu
5



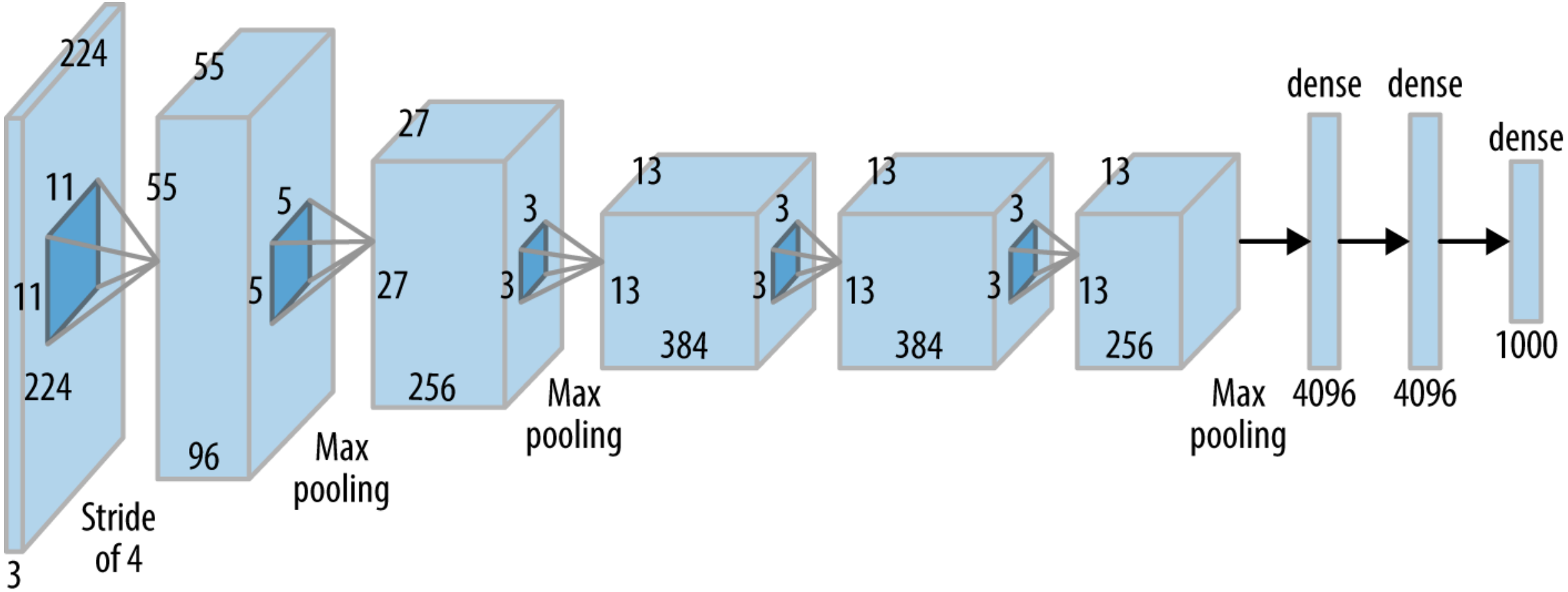
GTA Network

Data: 100x100

Epoch: 20

GTX 1070: 13 hours

AlexNet


224
11
11
224
3
Stride
of 4
55
55
96
5
5
Max
pooling
27
27
256
3
3
Max
pooling
13
13
384
3
3
13
13
384
3
3
13
13
256
Max
pooling
dense
4096
dense
4096
dense
1000

Test metric

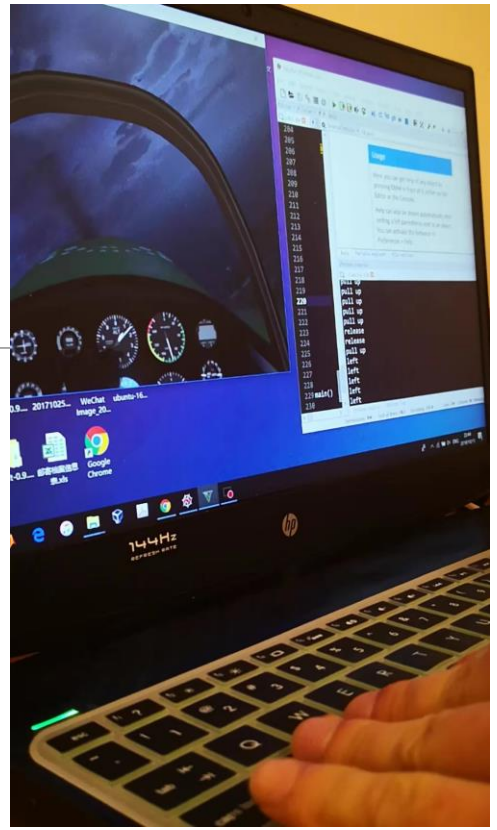
Autonomy[1], "How autonomous the CNN can be "

$1 - \frac{N_{int}}{N_{total}}$ (flight time is fixed)

$N_{int} = Number\ of\ human\ interventions$

$N_{total} = N_{int} + N_{auto}$

$N_{auto} = Number\ of\ autonomous\ manipulations$



It is technically and ethically infeasible to deliberately involve any "crash" to test the model.

[1] Bojarski, Mariusz, et al. "End to end learning for self-driving cars." *arXiv preprint arXiv:1604.07316* (2016).

Deploy the CNN

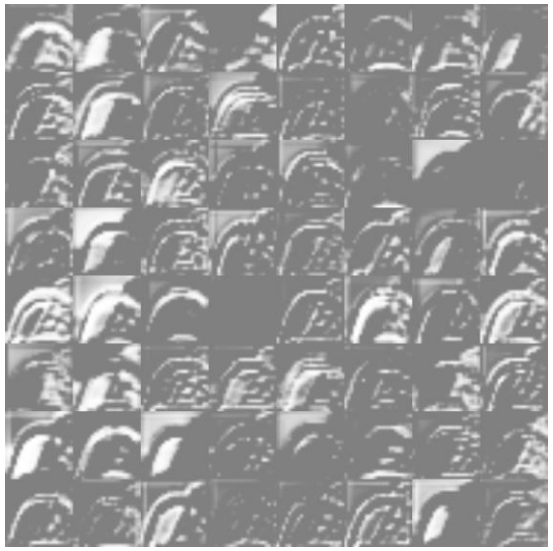
Duration of each flight is 120s, every scene tests for 5 times(start from different random location)

Autonomy(%)

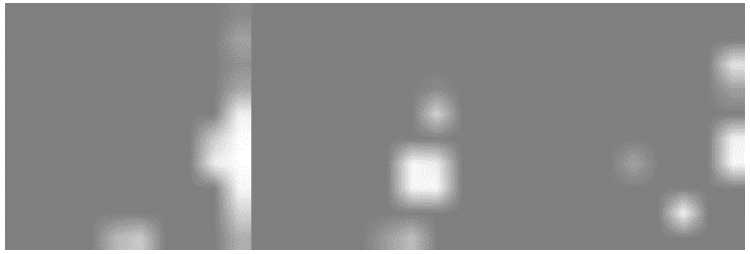
Conditions	GTA-Net	AlexNet
City sunny	99.96	97.43
City clear night	99.04	93.46
City rainy	98.43	75.23
City foggy and cloudy	98.86	82.36
Mountain sunny	94.98	97.06
City thunder storm	Crash	Crash

A little bit visualization

CNN output: left row



CONV 3



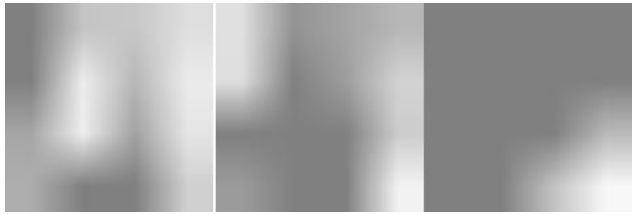
CONV 5

A little bit visualization

CONV3

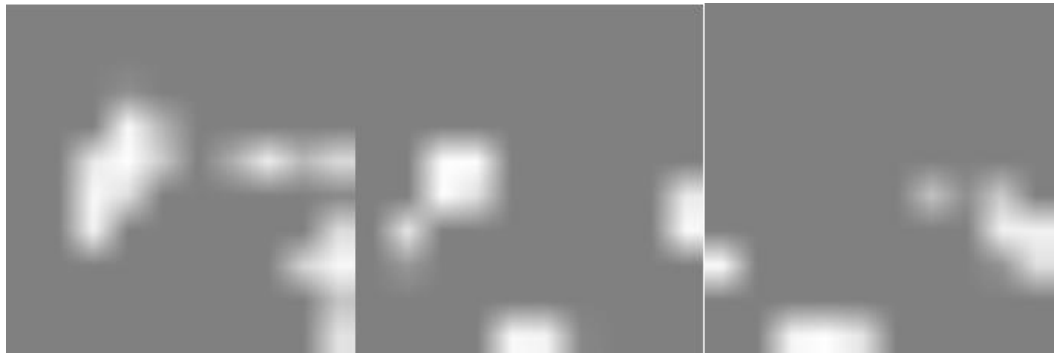
CNN output:
Pull up

A little bit visualization



Alexnet 😔

CONV 3



CONV 5

CNN output:
Pull up

Video DEMO