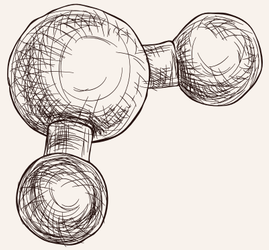
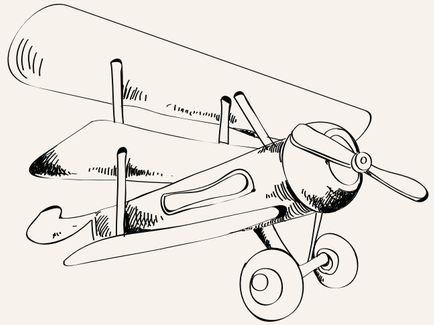


Fakultet elektrotehnike i računarstva

Neuronske mreže

PREPOZNAVANJE POZICIJE I KUTA DLANA

U SVRHU UPRAVLJANJA ZRAKOPLOVOM U SIMULACIJI



Leonarda Pribanić
Jakov Jakovac
Daniel Košmerl

Nikola Perić
Domagoj Marić
Tomislav Matanović

Zagreb, 23.01.2025.

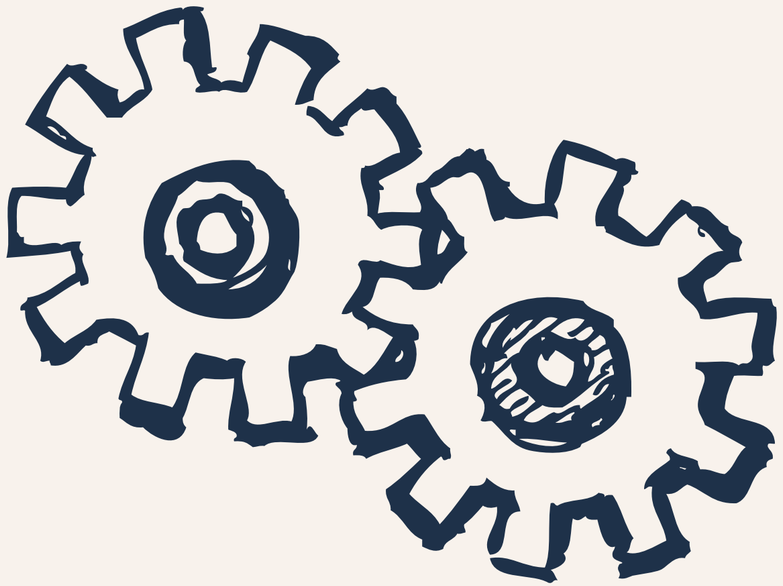
Pregled projekta

CILJEVI:

- Razvoj sustava za prepoznavanje gesta dlana
- Integracija sustava s igricom simulacije zrakoplova
- Naučiti o ovim metodama

USMJERENOST NA:

- Samostalan razvoj rješenja
- Brzina proizvoda
- Generalizacija



Podaci

PRIKUPLJANJE:

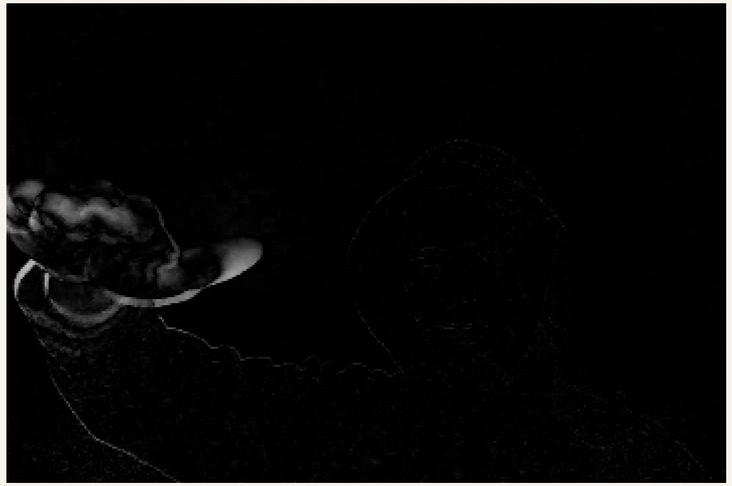
- Prikupljeno oko 720 slika
- Različite osobe i scene
- 4 kategorije
- ["FLY", "PAUSE", "NOPALM", "UNDEFINED"]

PRETPROCESIRANJE:

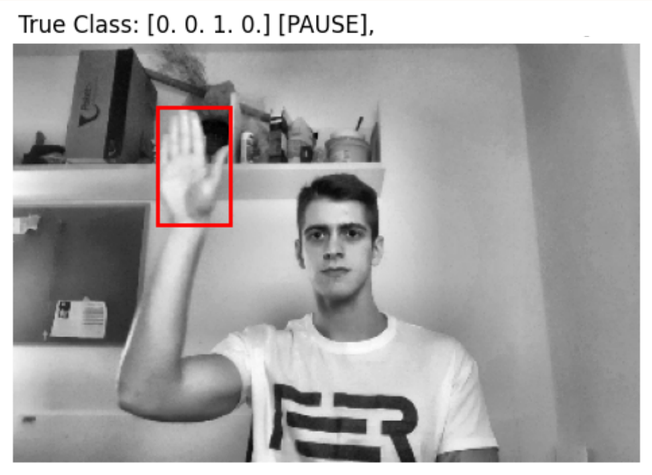
- Slike izvučene iz videa -> Python
- Pretprocesirane u crno-bijele (360, 240)
- Normalizacija intenziteta svijetlja
- Slike razlike

Procesuirana b/w slika (360, 240)

Slika razlike (360, 240)



Podaci – klase



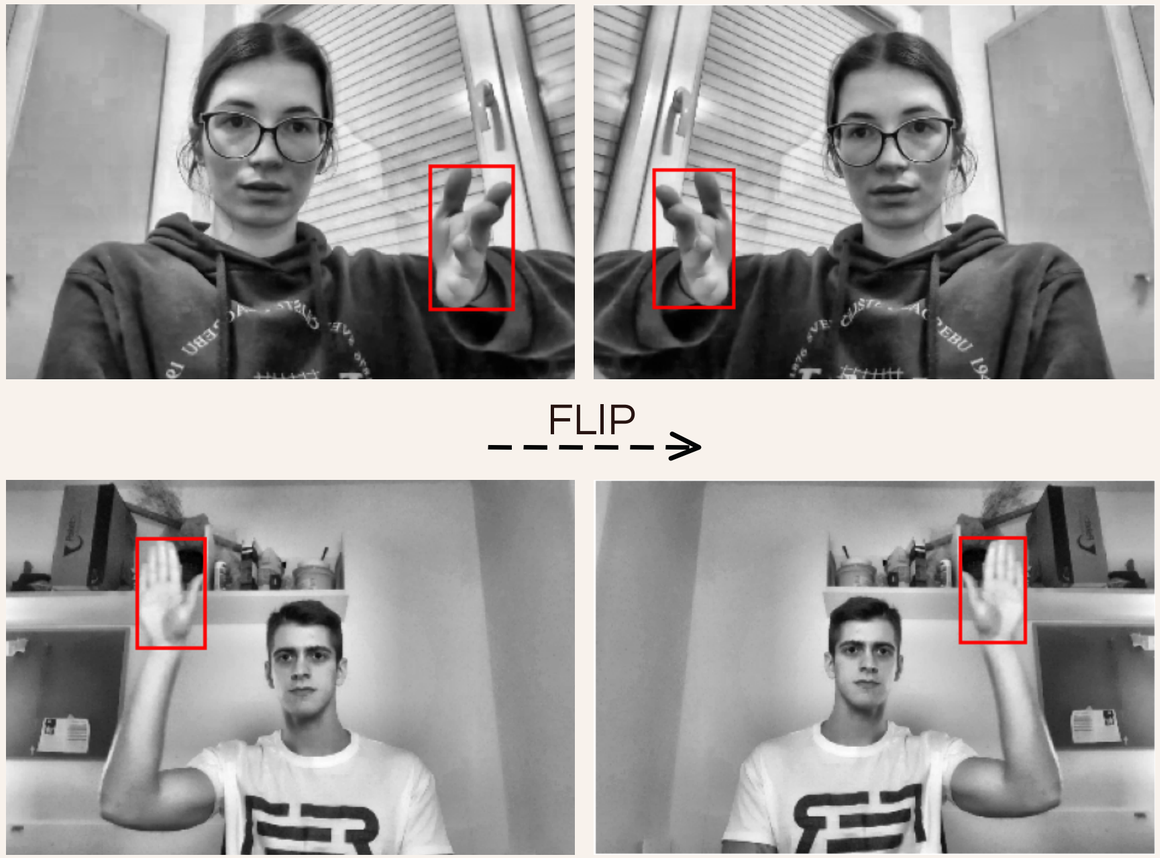
Označavanje

Označavanje podataka:

- Label Studio
- Bounding box i klasa

Augmentacija podataka:

- Umjetna transformacija postojećih
- Zrcaljenje
- Translacija i skaliranje
- Dodavanje šuma
- Rotacija?
- Duplo veći set označenih slika



Neuronska mreža

- TensorFlow
- 6 konvolucija
- 2 potpuno povezana
- 2 glave:
  - lokalizacijaklasifikacija

Arhitektura:

Conv2D (7x7), 64 filters
-Leaky ReLU
-MaxPool(2x2)

Conv2D (3x3), 128 filters
-Leaky ReLU
-MaxPool(2x2)

Conv2D (1x1), 64 filters
-Leaky ReLU

Conv2D (3x3), 128 filters
-Leaky ReLU

Conv2D (1x1), 128 filters
-Leaky ReLU

Conv2D (3x3), 128 filters
-Leaky ReLU

MaxPool(2x2)
Flatten

Fully-Connected
-128 neurons
-ReLU

Fully-Connected
-64 neurons
-ReLU

BBOX prediction
[73, 125, 60, 44]

CLASS prediction
-softmax
[1, 0, 0 ,0]

Neuronska mreža

Glavna metrika:

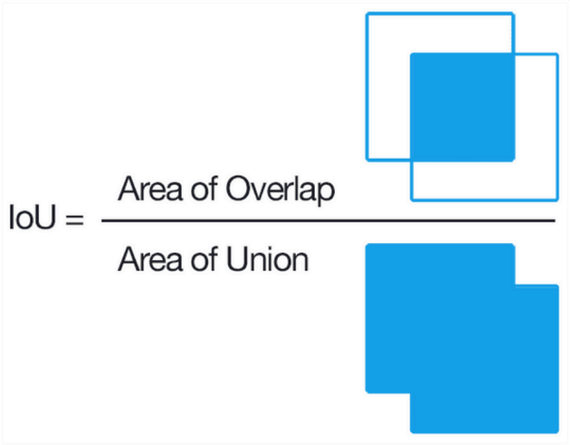
- IoU - Intersection over Union [0 -> 1]
- MSE - Mean Squared Error [+inf -> 0]
- Sparse Categorical Cross-Entropy
- SCCE - za klasifikaciju [+inf -> 0]

Funkcija gubitka:

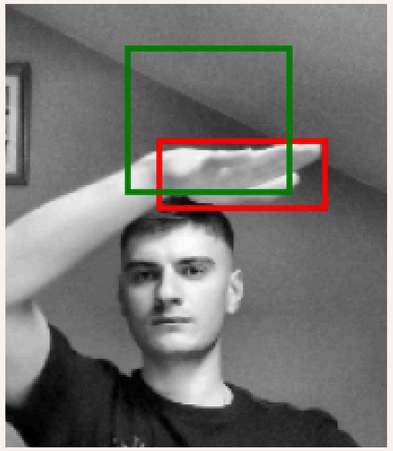
- L = 2*SCCE + ((2-IoU)**2) * MSE

Uvjet zaustavljanja:

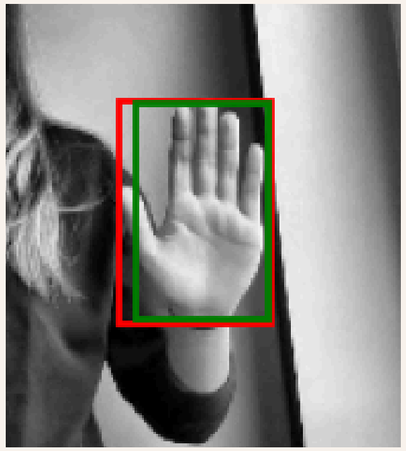
- Unakrsna provjera (70%/30%), nasumično
- learn. rate reduce (val_loss, strpljenje 3, faktor 0.5)
- zaustavljanje (val_loss, strpljenje 10)



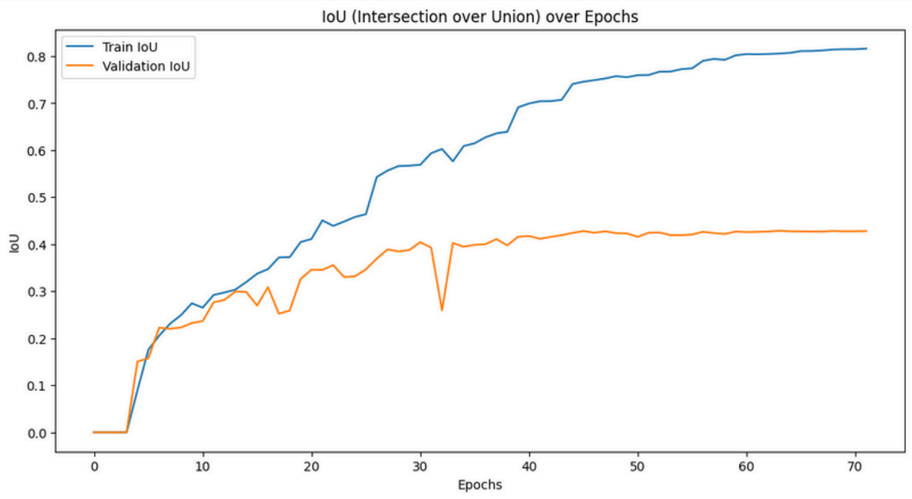
IoU = 0.23

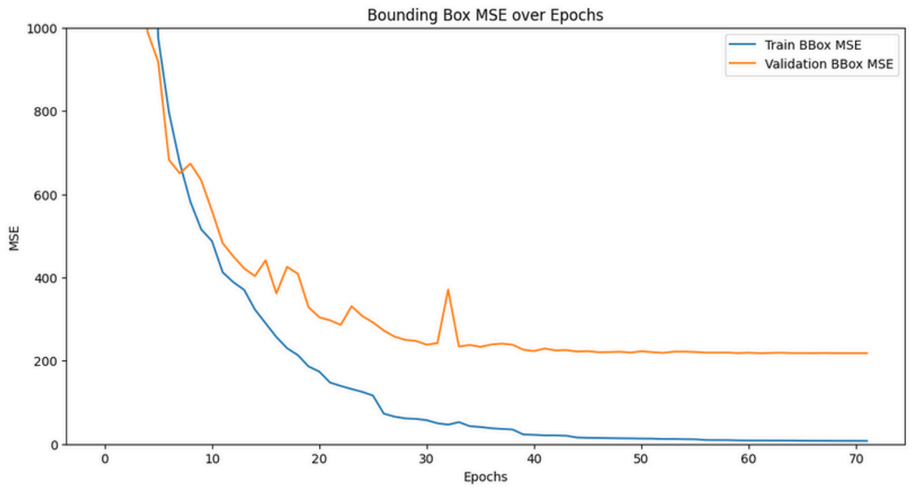


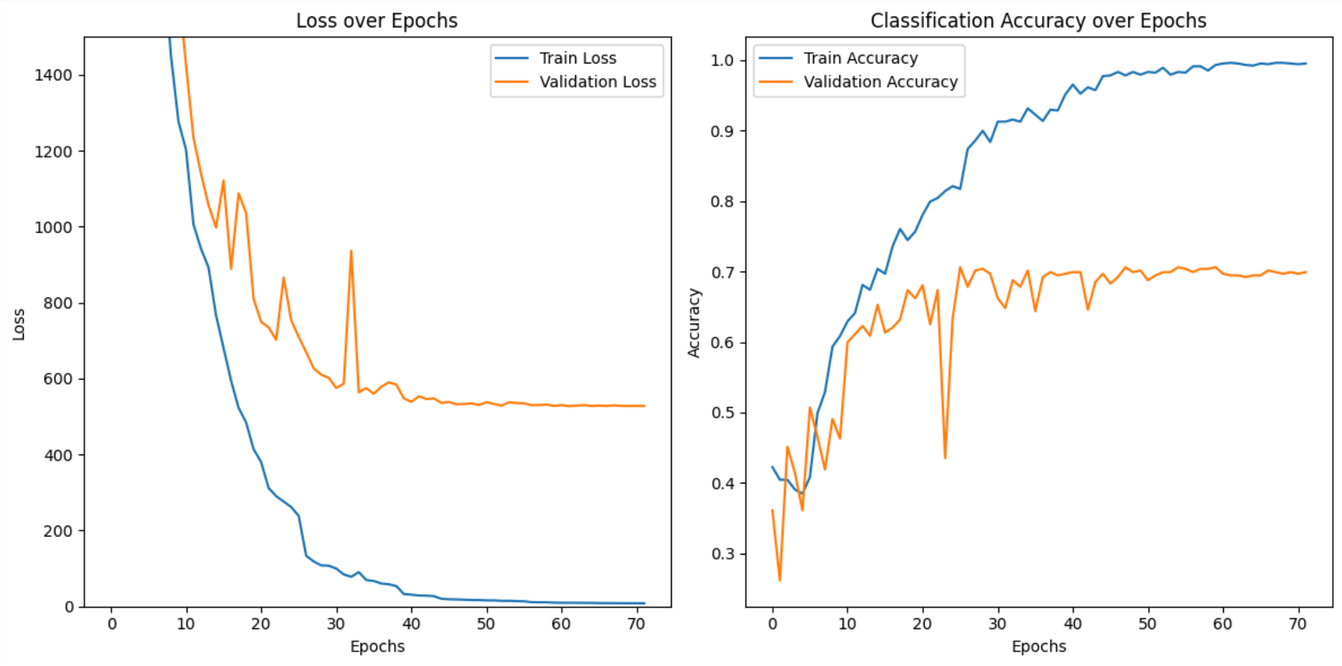
IoU = 0.85



Treniranje



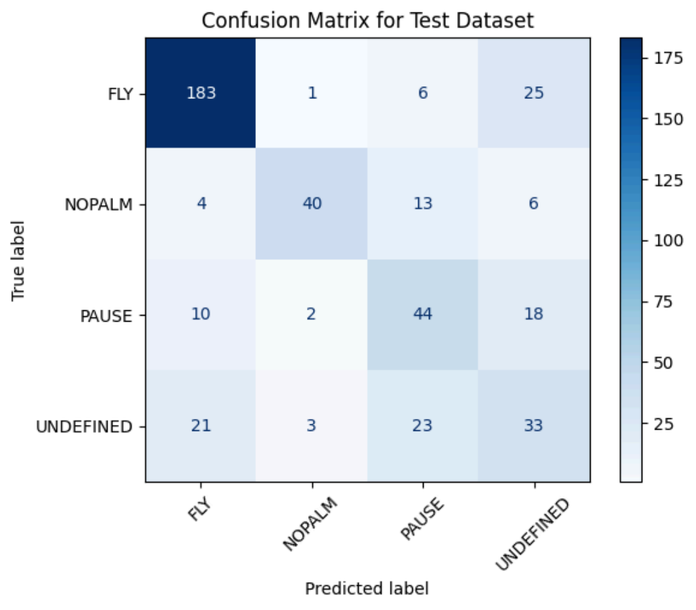


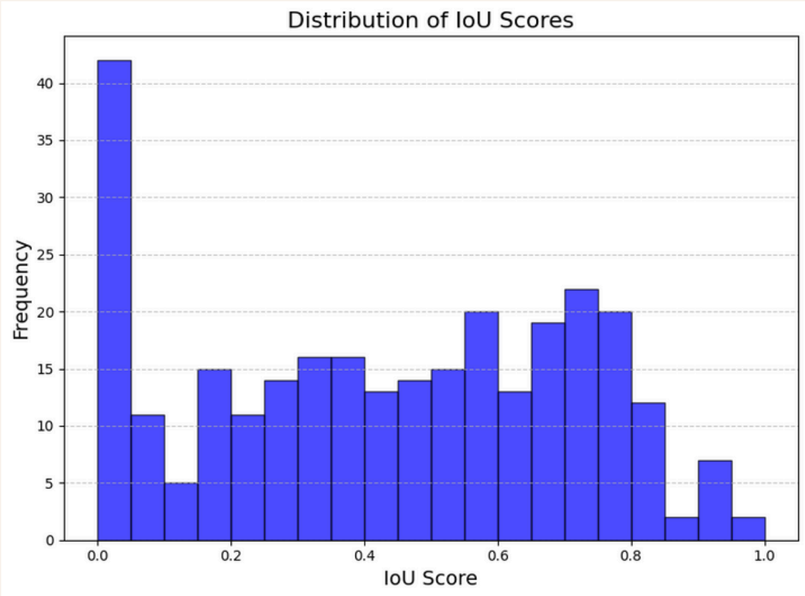


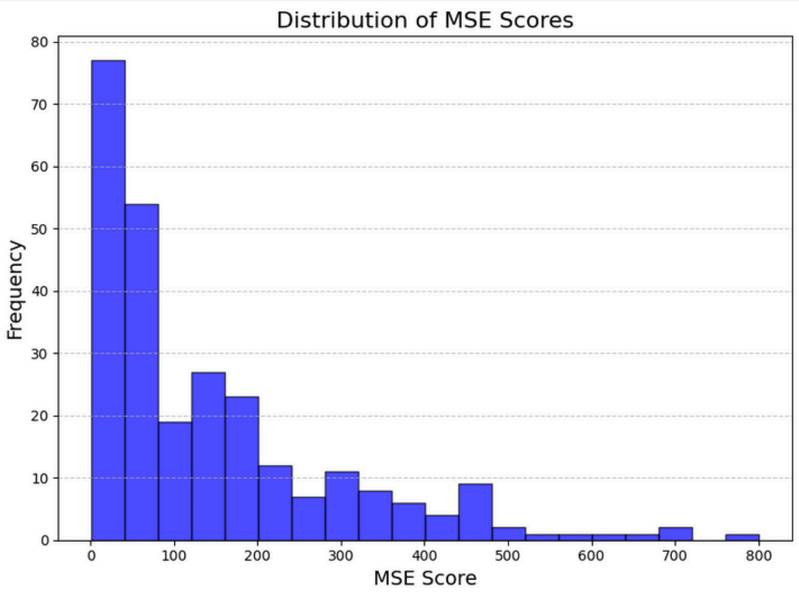
- Rješenje pronađeno u 62. epohi
- Bez smanjivanja l.r. i prijevremenog zaustavljanja, trebalo bi preko 120 epoha, a rješenje bi bilo manje optimalno

Rezultati

Točnost Kalsifikacije (TRENING)	MSE (TRENING)	IOU (TRENING)	Točnost Kalsifikacije (TEST)	MSE (TEST)	IOU (TEST)
93.6%	**16.4**	**0.75**	**69.4%**	**240.1**	**0.43**







Određivanje kuta

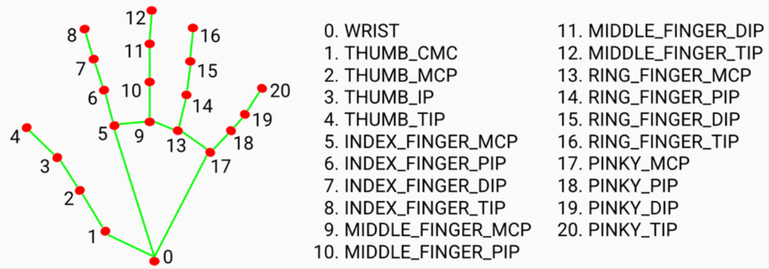
Google Hand Landmarks:

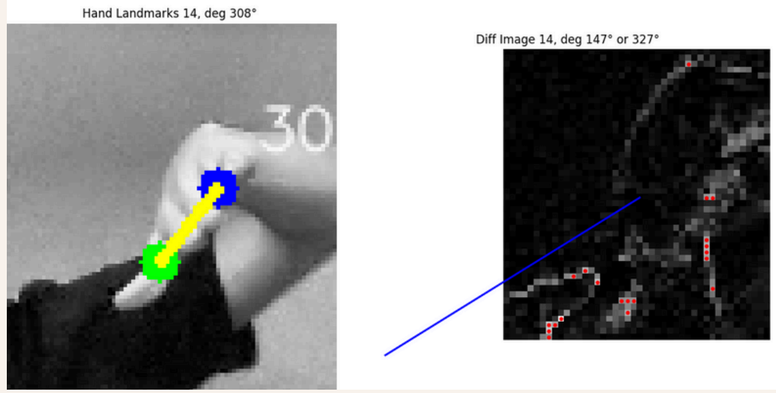
- Preuzeta gotova implementacija
- Služi za procjenu kuta
- Rijetko kad prepozna dlan (25%)

Slika razlike:

- U slučaju da Google Hand ne prepozna
- Iz slike razlike izvlači 20 najintenzivnijih točaka
- Linearna regresija za aproksimaciju
- Ima potencijala za daljnje optimiranje

Google Hand Landmarks





Završni sustav

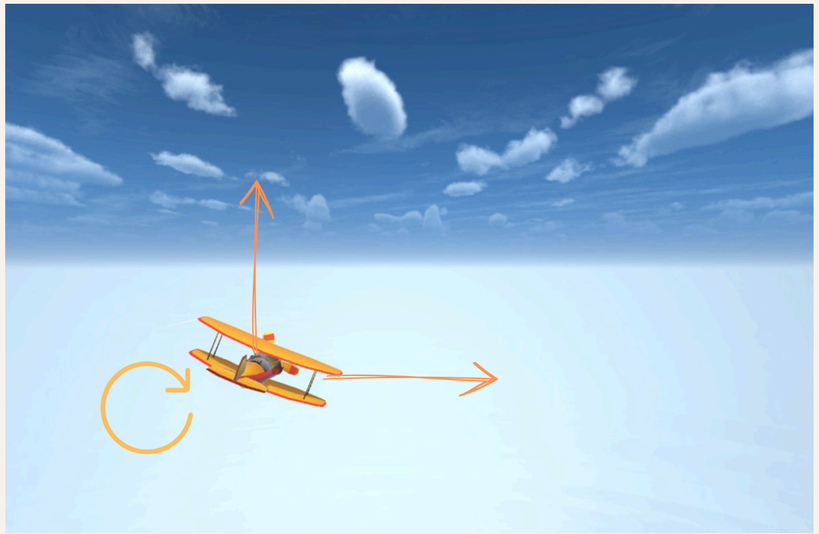
Igrica:

- Preuzeta gotova igica sa ugrađenom fizikom i gotovim 3D modelima
- Unity engine za pokretanje
- Prilagodbe
- Komunikacija modela i igrice

Završni sustav:

- Python skripta koja spaja:
- Učitavanje slika iz web kamere u realnom vemenu
- Pokretanje modela NN nad tom slikom
- Kalkulaciju kuta
- Komunikaciju s igricom

Isječak iz igrice



Trajanje 1 očitanja	Max FPS
0.16s	**5-6**

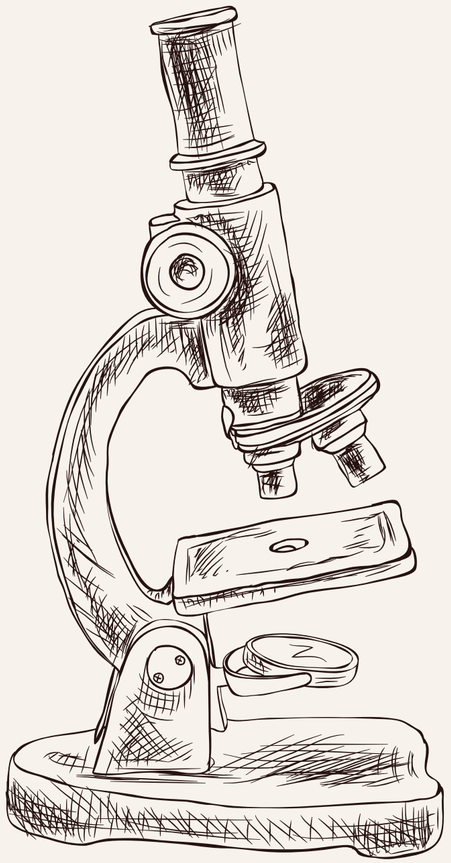
Komentari

Komentari:

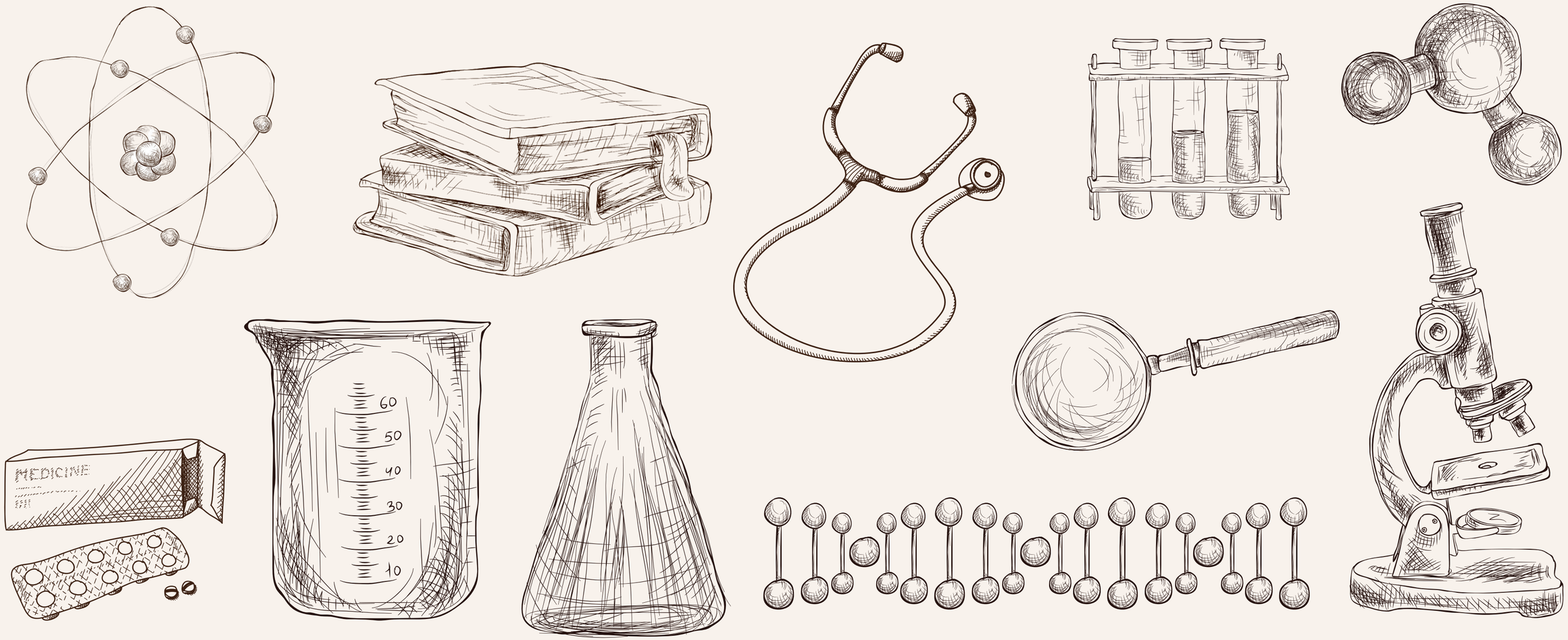
- U stvarnom igranju performanse lošije nego na validacijskom setu -> Prenaučenost
- Slični podaci u test/train podsetovima
- Nebalansirane klase
- Nesavršena interpretaciju kuta

Kako unaprijediti:

- Snimiti više podataka, na sličan način
- Više slika za NOPALM i PAUSE
- Više augmentacije -> računarna složenost
- Usavršiti računanje kuta iz slike razlike



Resource Page



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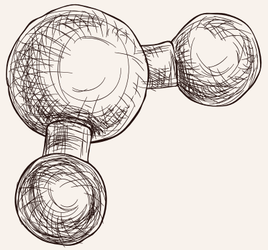
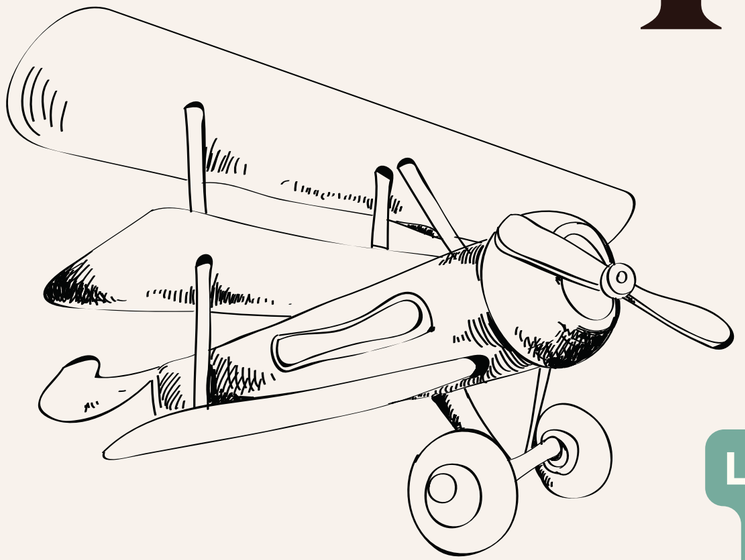
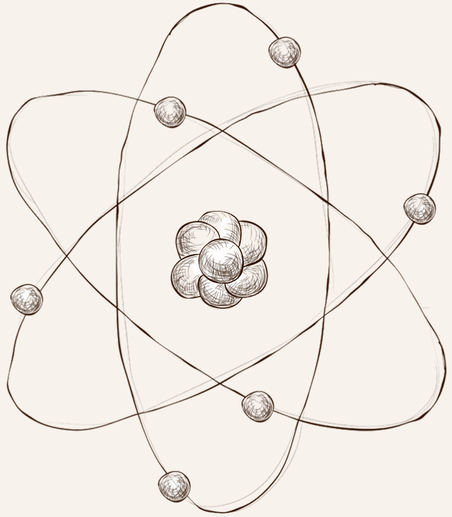




Hvala na pažnji!



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