

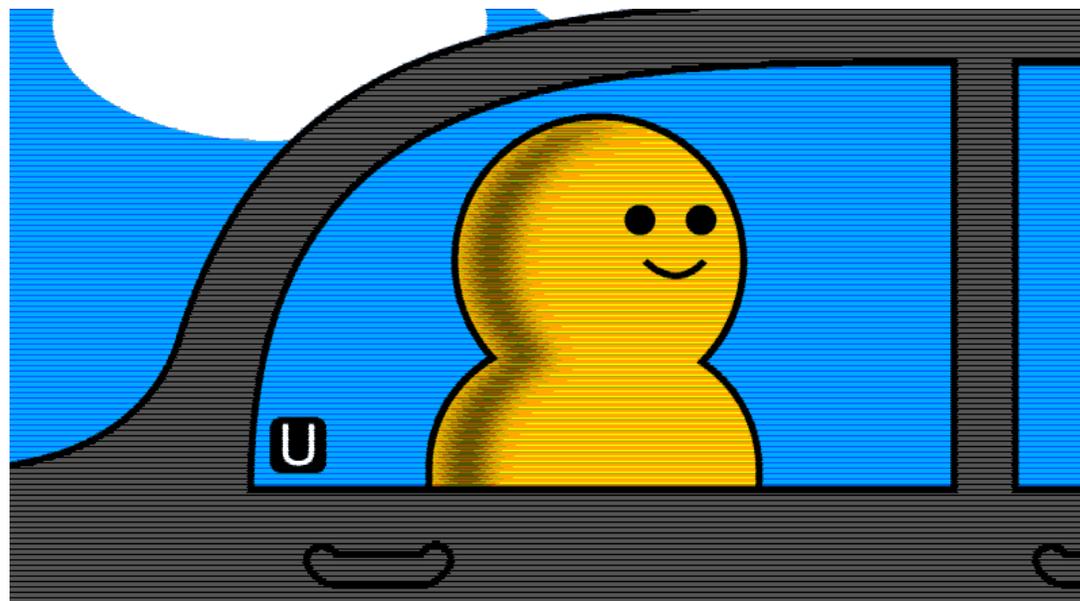
Borse di studio GARR
Orio Carlini

Human-Centered Intelligence For Emotional State Recognition Through Cross-Modal Distillation

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IL PROGETTO

Obiettivo: Implementazione di un algoritmo per l'addestramento di una rete neurale a riconoscere le emozioni umane.



IL DATASET

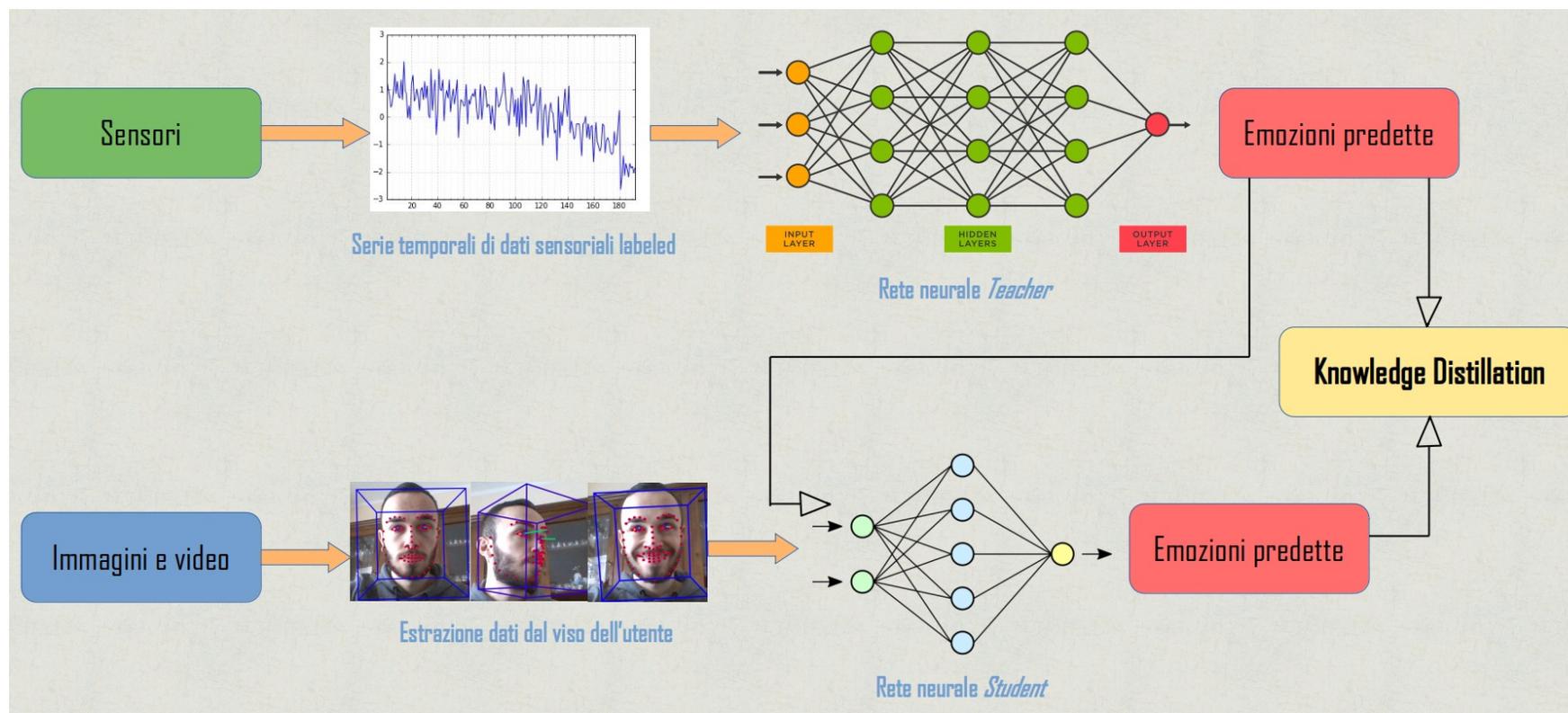
Dataset BioVid Emo contenente 430 file di dati estratti dai sensori e 430 video registrati, uno per ogni tipo di emozione.

scl	ecg	emg_trap	emotion	timestamp
1.2090	-1836.6	16794.0	4	0.000000
1.2090	-1842.5	16797.0	4	0.001953
1.2090	-1820.8	16798.0	4	0.003906
1.2086	-1799.3	16800.0	4	0.005859
1.2080	-1790.2	16795.0	4	0.007812
...
1.0530	1801.0	-6674.9	1	49.990234
1.0530	1790.7	-6751.7	1	49.992188
1.0530	1786.5	-6790.4	1	49.994141
1.0530	1783.0	-6692.8	1	49.996094
1.0530	1785.5	-6634.1	1	49.998047



DISTILLAZIONE DELLA CONOSCENZA

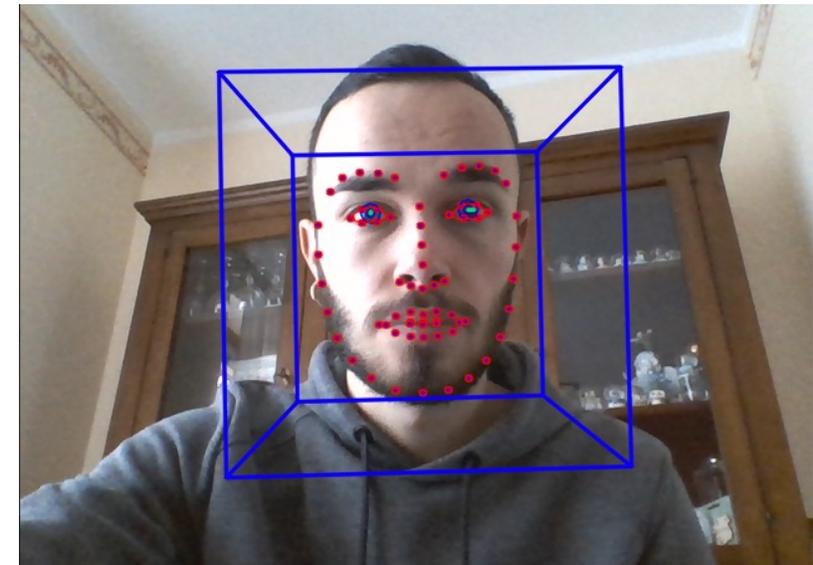
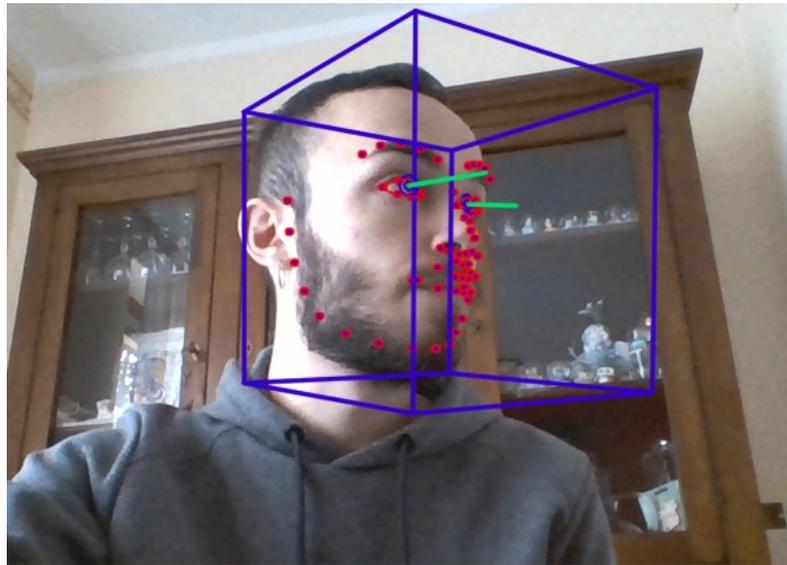
Una rete neurale, *teacher*, sarà allenata utilizzando dati sensoriali "**labeled**", e una seconda rete neurale, *student*, sfrutterà invece i dati estratti dalle immagini e dai video del volto degli utenti.



OPENFACE

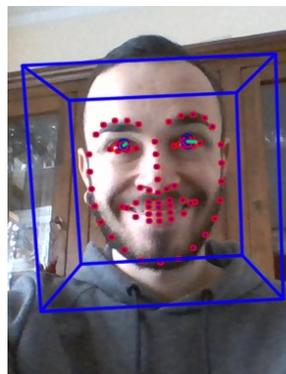
OpenFace è un software open-source destinato ai ricercatori di visione artificiale, apprendimento automatico e in generale alle persone interessate alla creazione di applicazioni interattive basate sull'analisi del **comportamento facciale**.

- Facial Landmarks
- Posa della testa
- Direzione dello sguardo
- Espressioni facciali

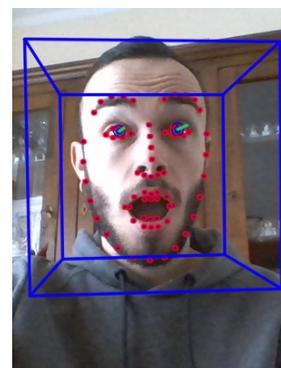


LE FEATURES DI OPENFACE

Emozione	Action Units
Felicità	6+12
Tristezza	1+4+15
Sorpresa	1+2+5+26
Paura	1+2+4+5+7+20+26
Rabbia	4+5+7+23
Disgusto	9+15+16
Disprezzo	12+14



AU01 Inner Brow Raiser	0.00
AU02 Outer Brow Raiser	0.00
AU04 Brow Lowerer	0.00
AU05 Upper Lid Raiser	0.00
AU06 Cheek Raiser	2.55
AU07 Lid Tightener	0.00
AU09 Nose Wrinkler	0.00
AU10 Upper Lip Raiser	1.64
AU12 Lip Corner Puller	3.12
AU14 Dimpler	0.97
AU15 Lip Corner Depressor	0.00
AU17 Chin Raiser	0.00
AU20 Lip stretcher	0.00
AU23 Lip Tightener	0.00
AU25 Lips part	2.78
AU26 Jaw Drop	0.00
AU28 Lip Suck	0.00
AU45 Blink	0.00



AU01 Inner Brow Raiser	4.46
AU02 Outer Brow Raiser	3.17
AU04 Brow Lowerer	0.00
AU05 Upper Lid Raiser	3.07
AU06 Cheek Raiser	0.00
AU07 Lid Tightener	0.00
AU09 Nose Wrinkler	0.00
AU10 Upper Lip Raiser	0.00
AU12 Lip Corner Puller	0.00
AU14 Dimpler	0.00
AU15 Lip Corner Depressor	0.00
AU17 Chin Raiser	0.00
AU20 Lip stretcher	0.00
AU23 Lip Tightener	0.00
AU25 Lips part	2.80
AU26 Jaw Drop	1.84
AU28 Lip Suck	0.00
AU45 Blink	0.78

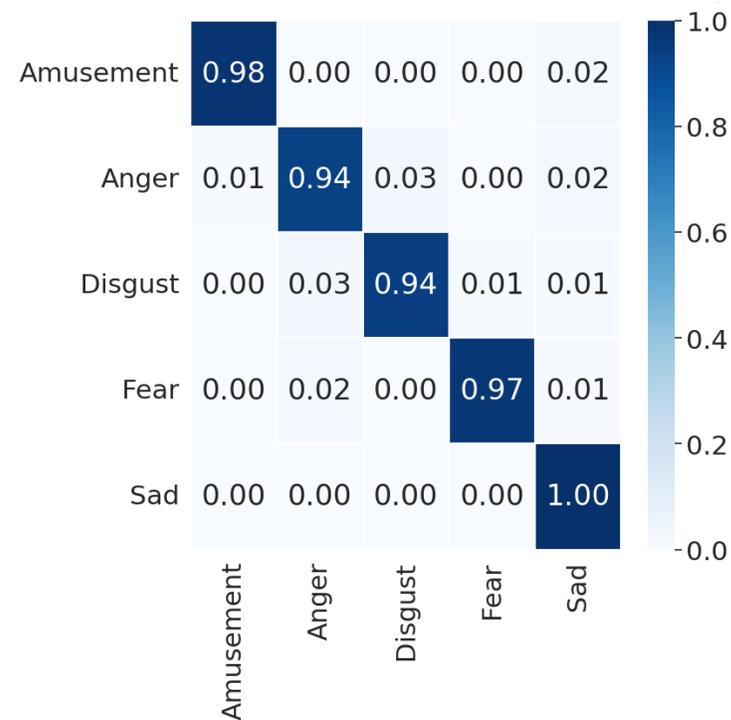
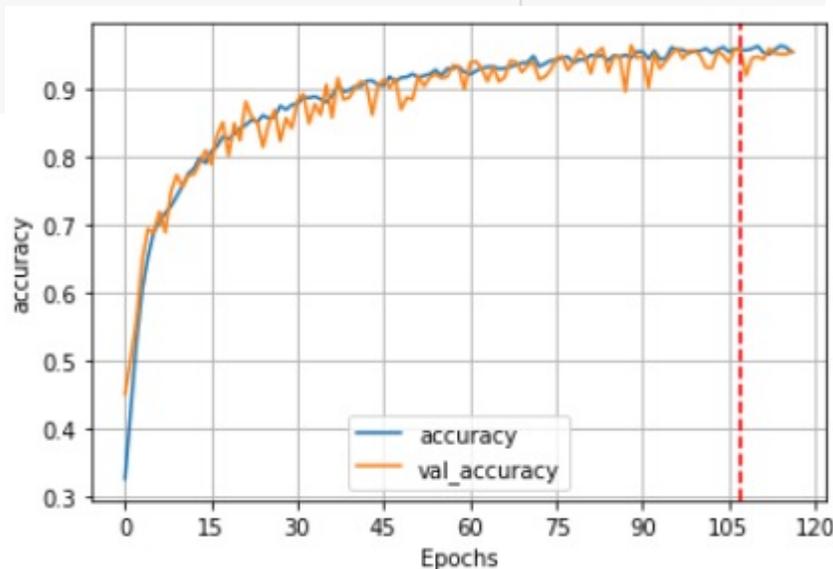
	gaze_0_x	gaze_0_y	gaze_0_z	gaze_1_x	gaze_1_z	gaze_angle_x	gaze_angle_y	eye_lmk_x_0	eye_lmk_y_0	eye_lmk_z_0	...	AU14_c	AU15_c	AU17_c	AU20_c	AU23_c	AU25_c	AU26_c	AU28_c	AU45_c	emotion	
379676	0.017686	0.055992	-0.998275	-0.215621	-0.976273	-0.100	0.018	658.9	446.2	374.9	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4	
379677	0.005334	0.071095	-0.997455	-0.235085	-0.971956	-0.116	0.039	659.6	447.6	396.2	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4	
379678	-0.004033	0.085392	-0.996339	-0.232154	-0.972555	-0.119	0.051	658.3	448.2	385.3	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4	
379679	0.006743	0.081370	-0.996661	-0.219907	-0.975494	-0.108	0.045	658.9	448.1	386.1	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4	
379680	0.001409	0.082566	-0.996585	-0.220305	-0.975398	-0.111	0.046	658.7	448.1	387.9	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4	
...
121996	0.010300	0.106215	-0.994290	-0.080538	-0.992373	-0.035	0.100	621.3	563.6	413.3	...	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	1	
121997	0.007436	0.105960	-0.994343	-0.082072	-0.992940	-0.038	0.096	621.3	563.5	417.9	...	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	1	
121998	0.000694	0.108067	-0.994143	-0.083315	-0.992453	-0.042	0.099	621.4	563.6	421.8	...	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	1	
121999	0.000686	0.109724	-0.993962	-0.084202	-0.992597	-0.042	0.099	621.4	563.5	421.7	...	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	1	
122000	-0.002153	0.108837	-0.994057	-0.082270	-0.992700	-0.042	0.099	621.4	563.5	423.8	...	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	1	

169250 rows x 64 columns

LA RETE NEURALE TEACHER

Addestramento della rete neurale con i dati sensoriali.

```
def get_teacher():  
    teacher = Sequential()  
    teacher.add(Conv2D(32,(4,4),activation='relu',input_shape=sens_x_train[0].shape,padding="same"))  
    teacher.add(MaxPooling2D(pool_size=(2,2)))  
    teacher.add(Conv2D(80,(4,4),activation='relu',padding="same"))  
    teacher.add(Dropout(0.01))  
    teacher.add(Conv2D(80,(4,4),activation='relu',padding="same"))  
    teacher.add(Dropout(0.01))  
    teacher.add(Conv2D(32,(1,1),activation='relu',padding="same"))  
    teacher.add(Flatten())  
    teacher.add(Dense(208,activation='relu'))  
    teacher.add(Dropout(0.01))  
    teacher.add(Dense(5))  
    return teacher
```



LA RETE NEURALE STUDENT

Addestramento della rete neurale con i dati di OpenFace.

```
def get_student():  
    student = Sequential()  
    student.add(Conv2D(32, (3,3), activation='relu', input_shape=op_x_train[0].shape, padding="same"))  
    student.add(Dropout(0.5))  
    student.add(Conv2D(32, (3,3), activation='relu', padding="same"))  
    student.add(Dropout(0.1))  
    student.add(Flatten())  
    student.add(Dense(5))  
    return student
```

Abbiamo ottenuto una rete neurale di dimensioni ridotte con accuratezza del 97,5% nella determinazione delle emozioni umane.

CARLA SOFTWARE

Il software **CARLA** è un simulatore di guida open source sviluppato allo scopo di favorire l'implementazione, la formazione e la validazione di sistemi di guida autonoma.



CLIENT-SERVER CARLA

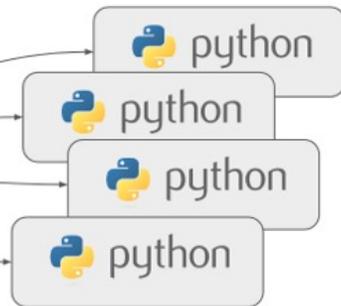
Il simulatore è costituito da un'architettura client-server scalabile.

Il **server** si occupa di gestire l'ambiente di simulazione.

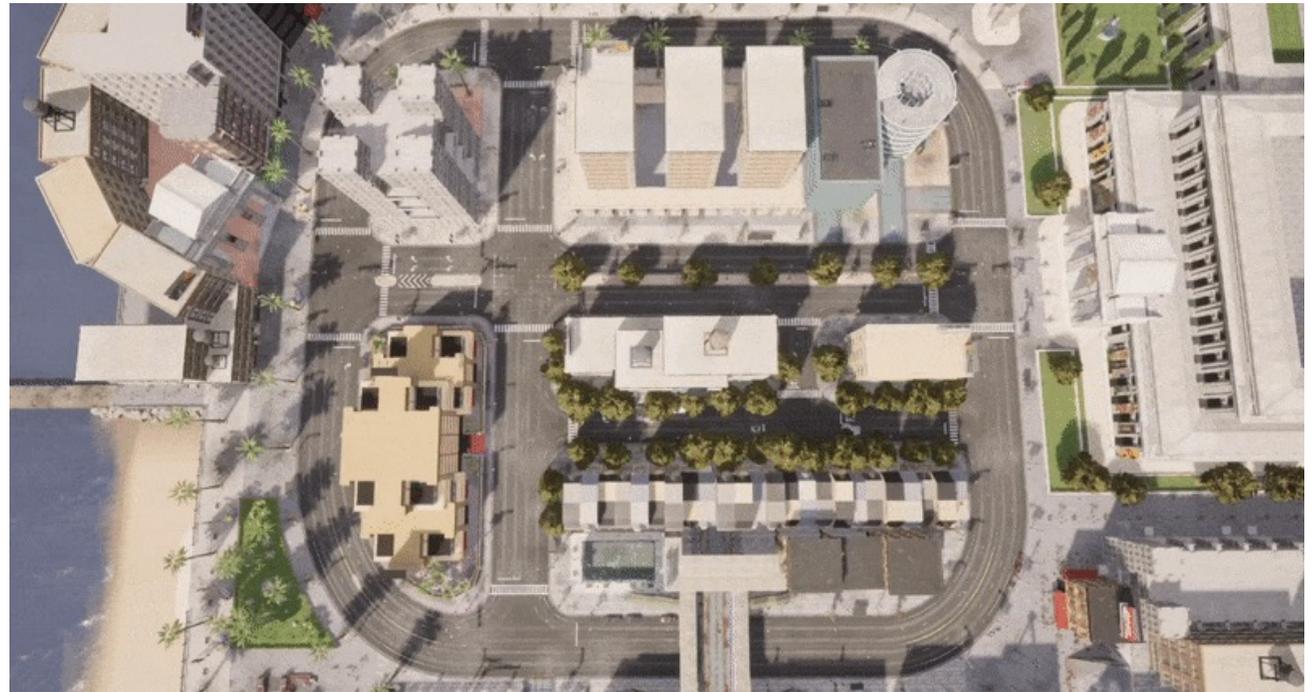
I **clients** sono scripts che controllano la logica degli attori e impostano le condizioni del mondo.



Simulator



User scripts

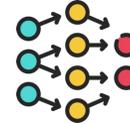


CREAZIONE TESTBED CON DATA AUGMENTATION

-> Creazione del nostro dataset.



-> Validazione reti neurali.

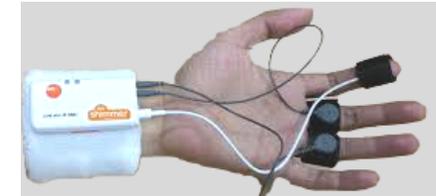
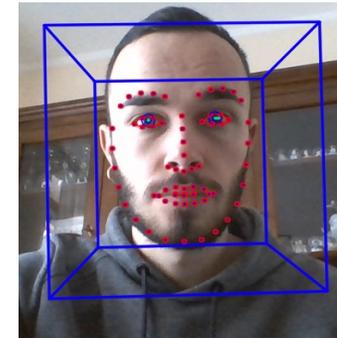


-> Data augmentation.



CREAZIONE DEL DATASET

Primo step del nuovo progetto. Finalizzazione della costruzione del nostro dataset personale.



Features extraction in progress...

Features collection request accepted. The program is now collecting data from your face and from the sensor you are wearing.

Please keep an eye on the terminal to control if errors occur within the start of data extraction and ensure to remain in the webcam frame continuing to wear the sensor correctly in order to get a great dataset.

Press the button below to terminate the acquisition and produce the dataset.

[Terminate data acquisition](#)



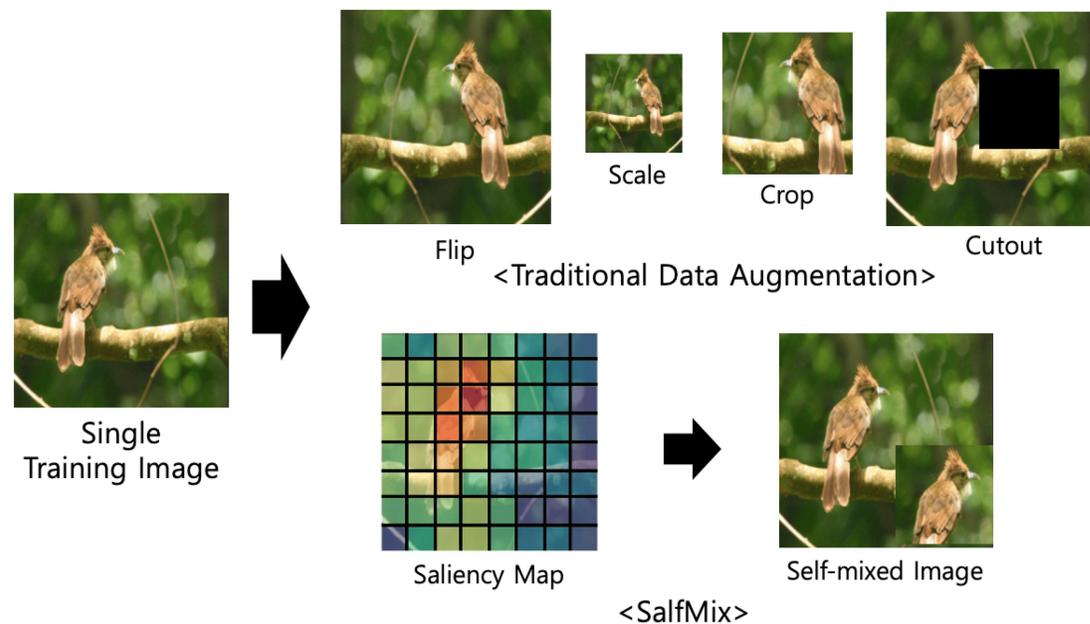
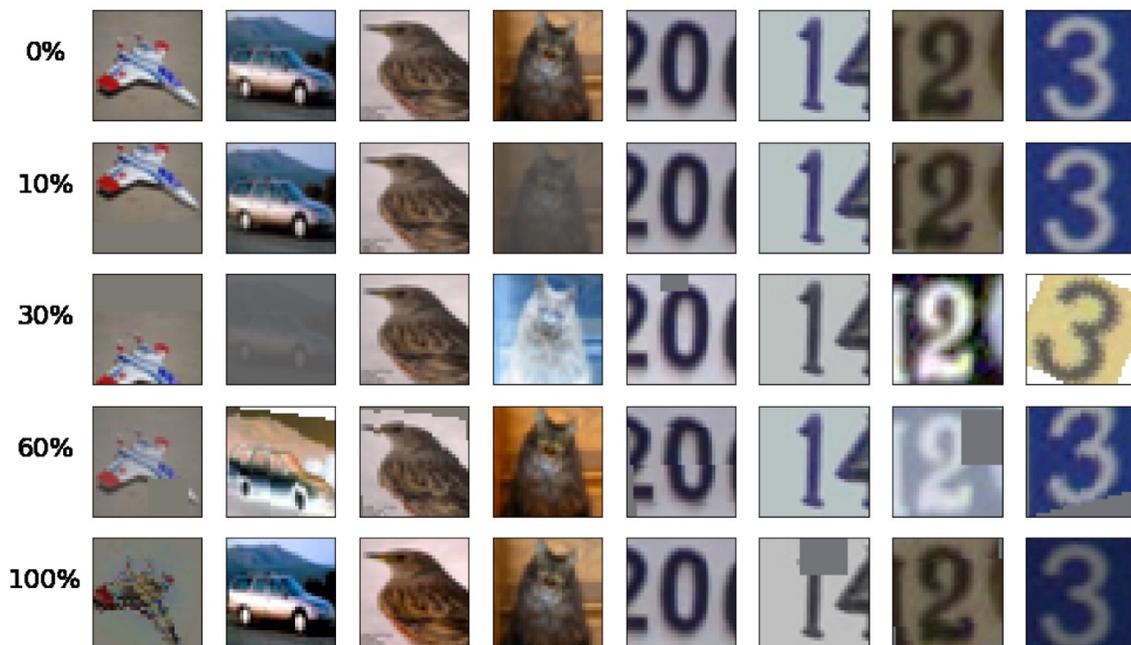
	id	gaze_0_x	gaze_0_y	gaze_1_x	gaze_1_y	gaze_angle_x	gaze_angle_y	AU01_c	
	0	1	0.082010	0.062940	-0.124776	0.080031	-0.022	0.072	0
	1	1	0.078303	0.060465	-0.128854	0.077414	-0.025	0.069	0
	2	1	0.080084	0.059067	-0.130403	0.076090	-0.025	0.068	0
	3	1	0.081053	0.058107	-0.129042	0.074312	-0.024	0.067	0
	4	1	0.082496	0.059614	-0.128192	0.076915	-0.023	0.069	0

	67392	400	0.057415	-0.149977	-0.143566	-0.121270	-0.044	-0.137	0
	67393	400	0.057313	-0.149406	-0.143716	-0.120715	-0.044	-0.136	0
	67394	400	0.057270	-0.148547	-0.143747	-0.119794	-0.044	-0.135	0
	67395	400	0.056576	-0.149564	-0.143961	-0.120783	-0.044	-0.136	0
	67396	400	0.056668	-0.149601	-0.143986	-0.120848	-0.044	-0.136	0

676648 rows x 39 columns

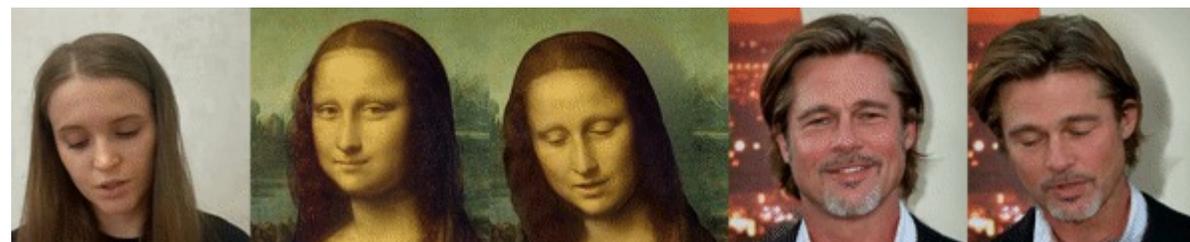
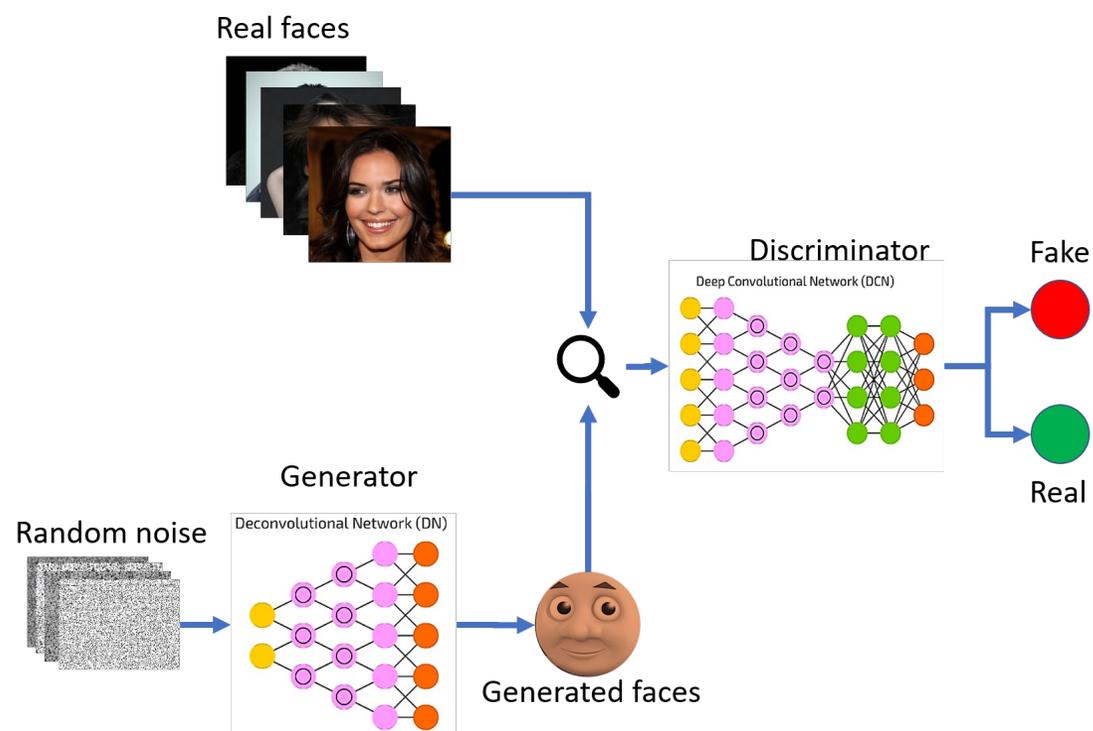
DATA AUGMENTATION

Arricchimento del dataset con dati generati artificialmente, riguardanti eventi rari che possono verificarsi durante la guida o condizioni difficilmente rappresentabili dal simulatore (incidenti stradali o guasti del veicolo).



GAN

Generative Adversarial Networks, un tipo di algoritmo di deep learning in grado di generare finti dati di ogni tipo (immagini, video, suoni, ...) con caratteristiche molto simili a quelle dei dati del mondo reale.



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GRAZIE

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