



UNIVERSITÀ DEGLI STUDI  
DI SALERNO

Corso di Laurea Magistrale in Informatica

# Una metodologia di **Explainable AI** per la diagnosi di malattie da **Tomografia Ottica Computerizzata (OCT)**

Candidato:  
*Pierluigi Liguori*

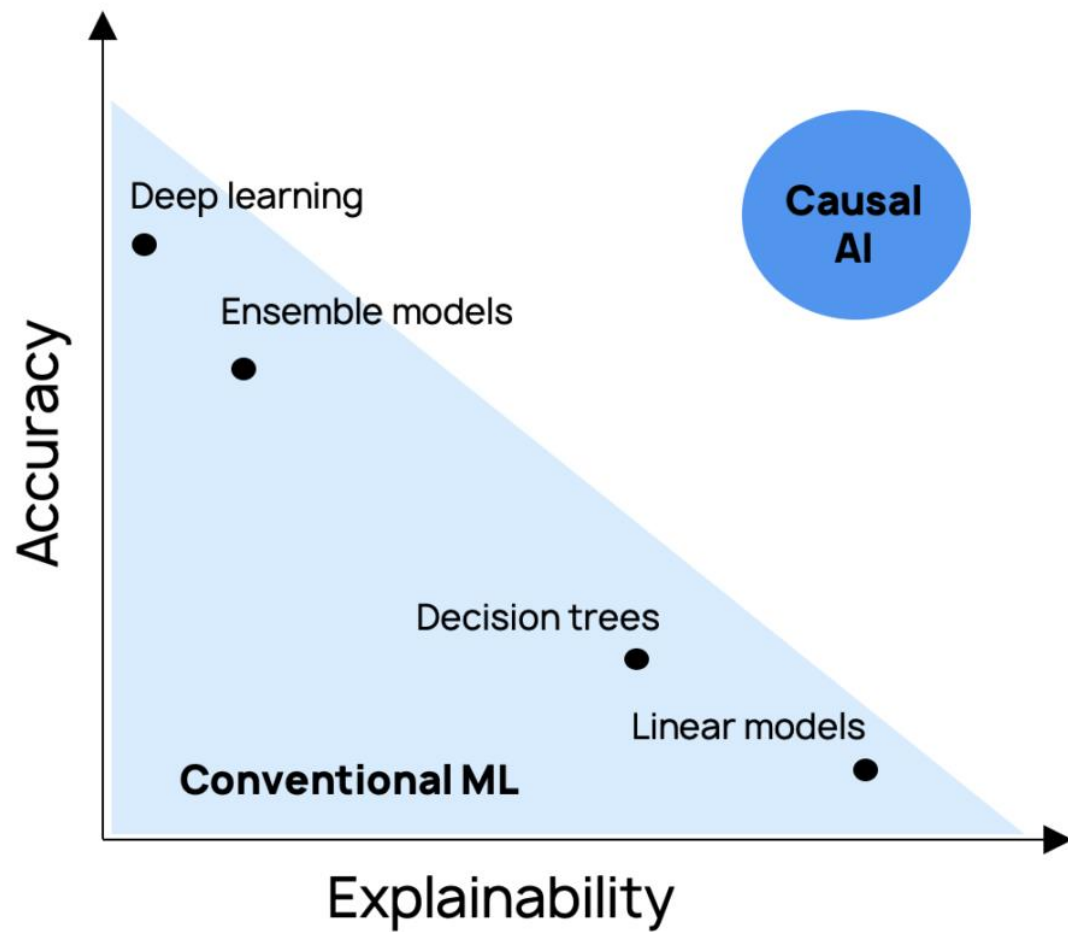
Relatori:  
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*Dott. Stefano Cirillo*  
*Dott. Gaetano Cimino*



# Healthcare nell'era dell' **Industria 4.0**

- Assistenza sanitaria **proattiva**
- Cure **customizzate** e monitoraggi **real-time**
- Supporto nel processo **diagnostico** con sistemi di AI





## Un trade-off per l' **explainability**

« Il settore sanitario ha bisogno di sistemi che diano spiegazioni per le predizioni generate »



**Textual**  
explanation



**Visual**  
explanation

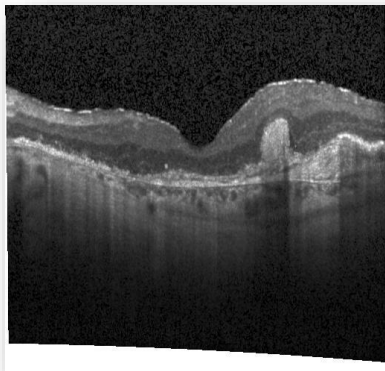
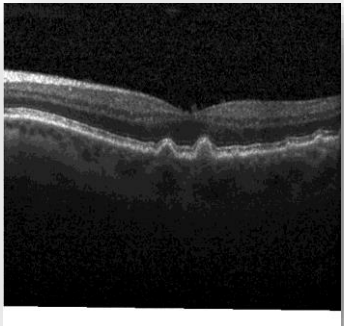


# Malattie rilevabili con la Tomografia ottica computerizzata

## AMD

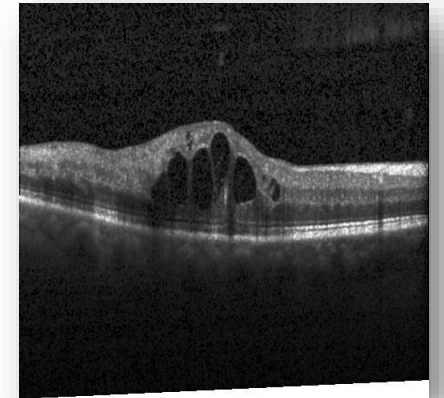
Degenerazione maculare senile

- Drusen
- Neovascolarizzazione coroideale (CNV)



## DME

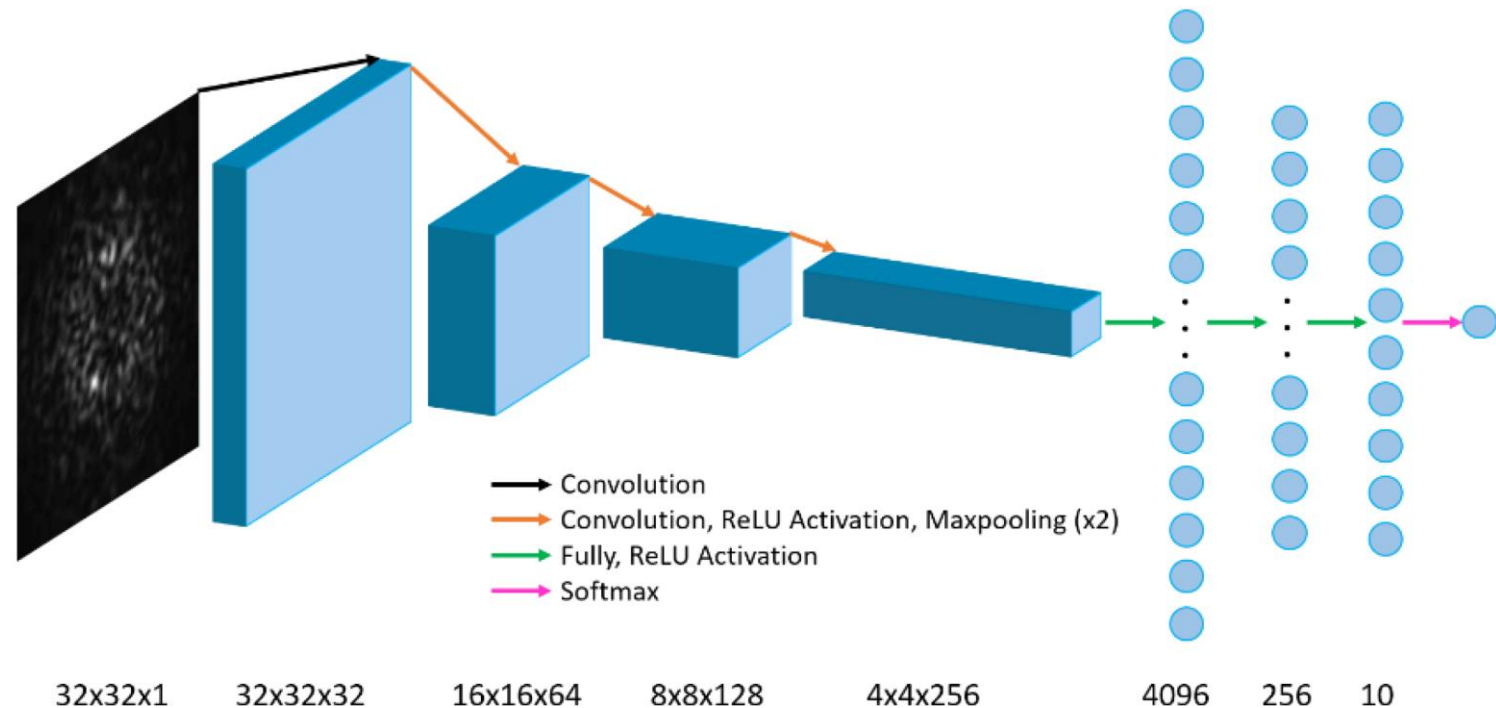
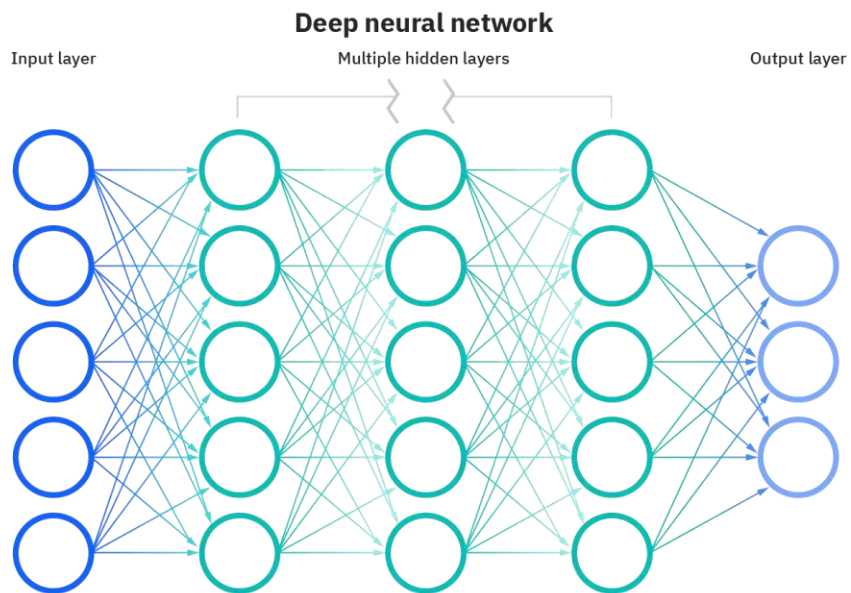
- edema maculare diabetico (DME)



# OBIETTIVI



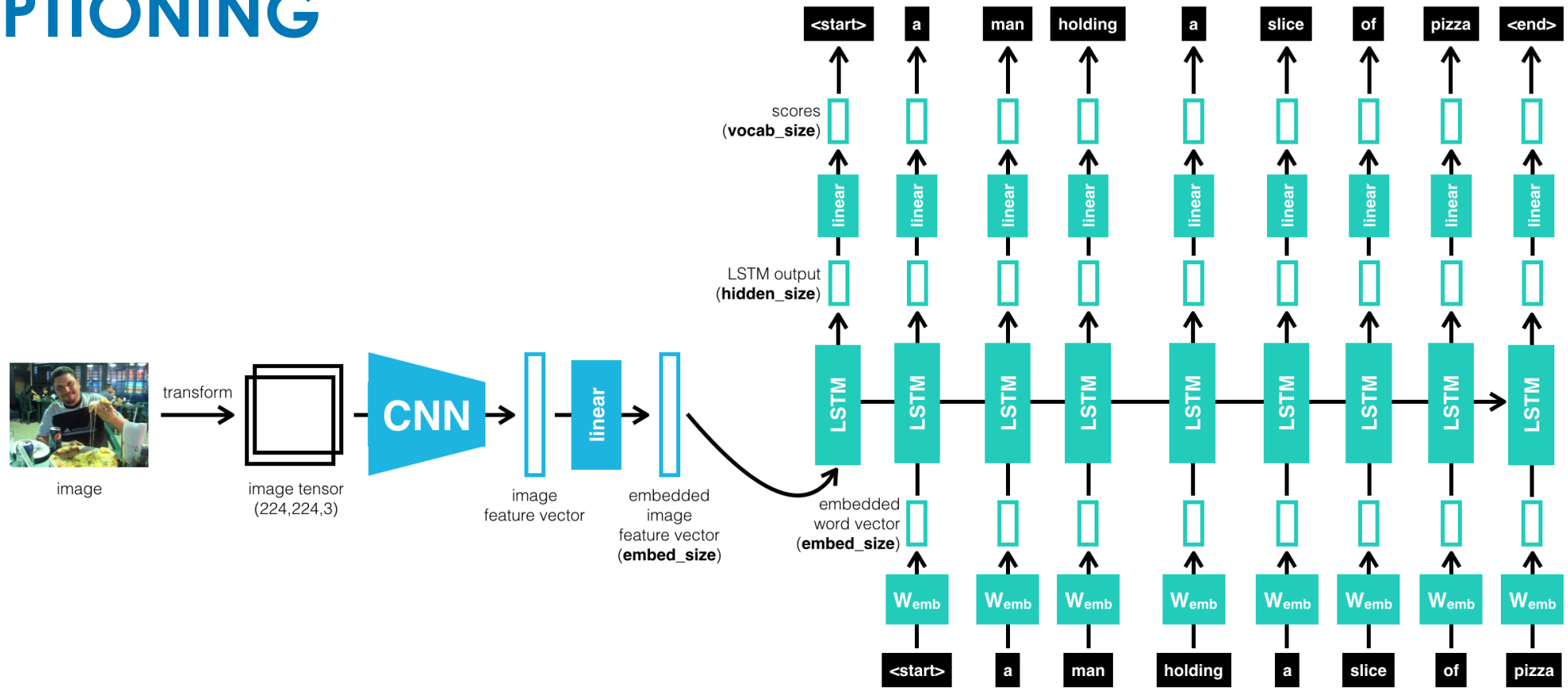
# IMAGE CLASSIFICATION



*Le Convolutional Neural Network” (CNN) estraggono delle features dall’immagine che provengono dall’applicazione di diversi filtri*

Spiegabile? **X**

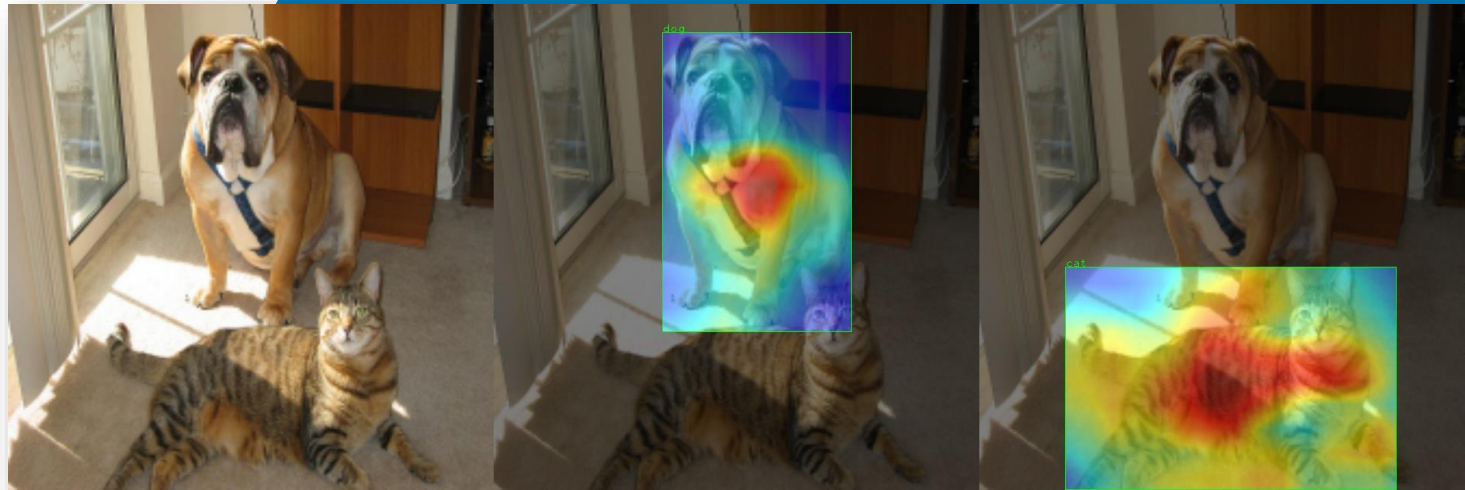
# IMAGE CAPTIONING



«a man holding a slice of pizza»

# VISUAL EXPLAINABILITY

- **Heatmap** che evidenziano le regioni di interesse

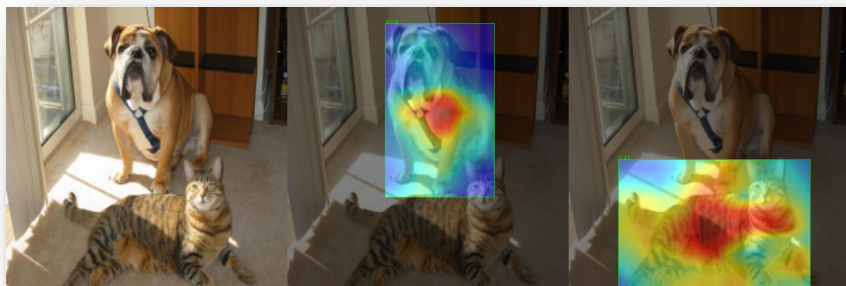
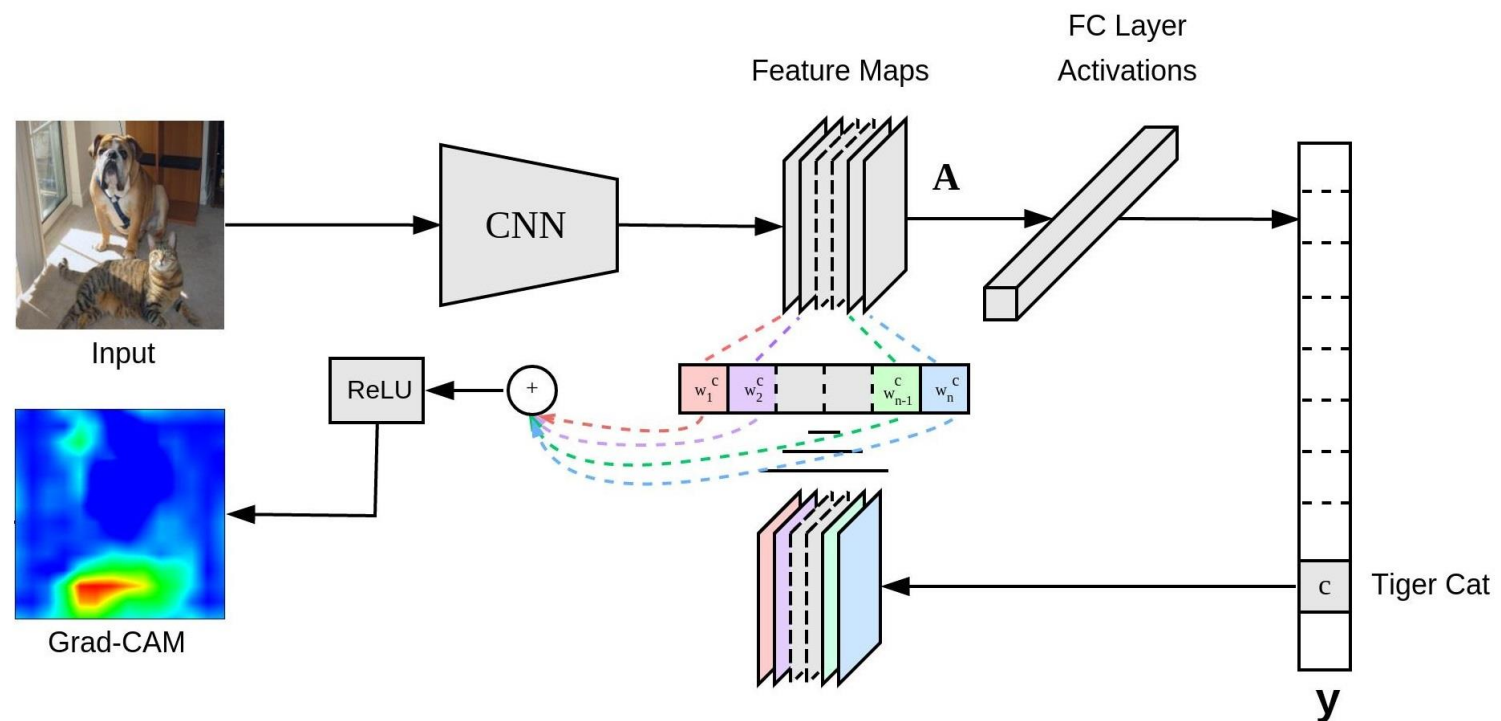






# VISUAL EXPLAINABILITY: Grad-CAM

- Con blocchi convoluzionali si ottengono delle **features map**
- Calcolo del **gradiente** della classe predetta
- Combinazione dei pesi ottenuti con le features map
- Overlapping della **heatmap**





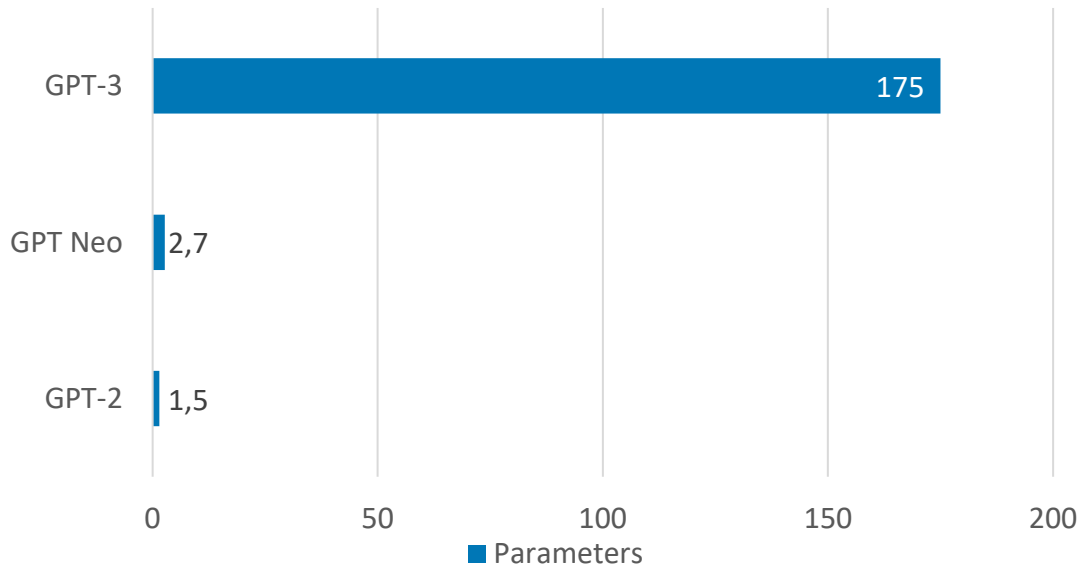
# CONTEXT GENERATION CON GENERATIVE PRE-TRAINED TRANSFORMER (GPT)

**Input:** If you have severe breathing problems, you should get help immediately.

**Output:** You may not need hospitalization for respiratory problems for which there is pain or even full internal combustion. Breathing is particularly hard in the high-pitched high pitch, low pitched pitches. Air you inhale and exhale can cause a shortening in your breathing, so a ventilator is best. Doping can be administered on your own. If you fall, you must be at least 1 kilometer away from you to be considered for the testing. Your turn-of-the-seat's softness may be a sign that something has gone wrong. Your depth should not exceed the mean of your seat height when wearing the seatbelt.

**Diagnosis**

I find that certain tests can be useful. For example, when you operate an airbag to fight off an airplane, it might help if you may identify the shoe blade with a blood test. Be careful of vibration due to the uneven ground between your toes. Dry air may also reduce your stomach acid. Additionally, when you are starting to plan an exercise routine, consider the daily nature of the exercise. Check to make sure you are doing a proper recovery.

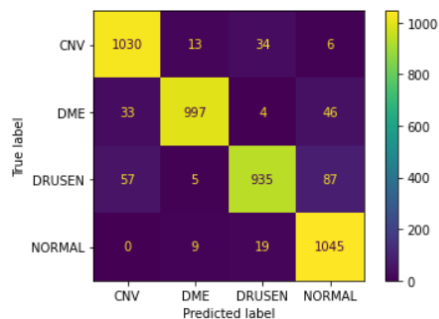


# VALUTAZIONE SPERIMENTALE



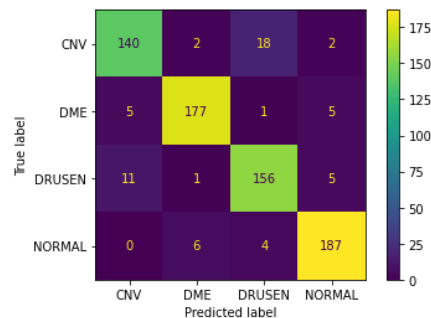
**Densenet-161**

24000 img  
100 x 100  
PCA



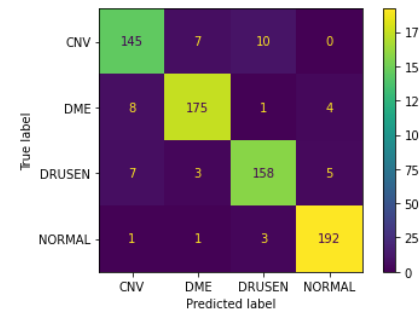
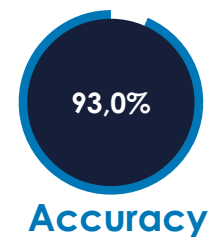
**Densenet-121**

4000 img  
224 x 224  
**Visual XAI**



**VGG19**

4000 img  
224 x 224  
**Visual XAI**



**Densenet-121 VGG19**

800 img  
224 x 224  
**Textual XAI**

**BLEU-1**  
0.438  
**BLEU-2**  
0.189



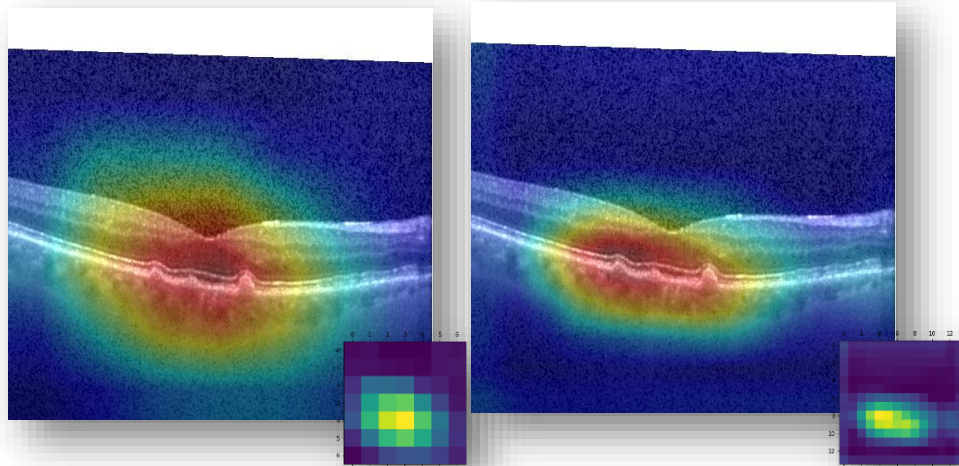
800 img  
224 x 224  
**Textual XAI**

**BLEU-1**  
0.422  
**BLEU-2**  
0.177

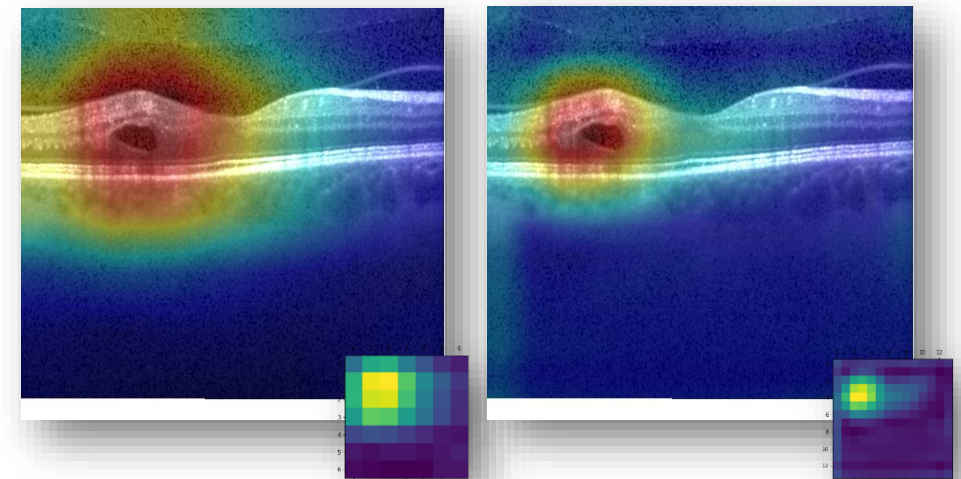


# Grad-CAM: Densenet-121 VS VGG19

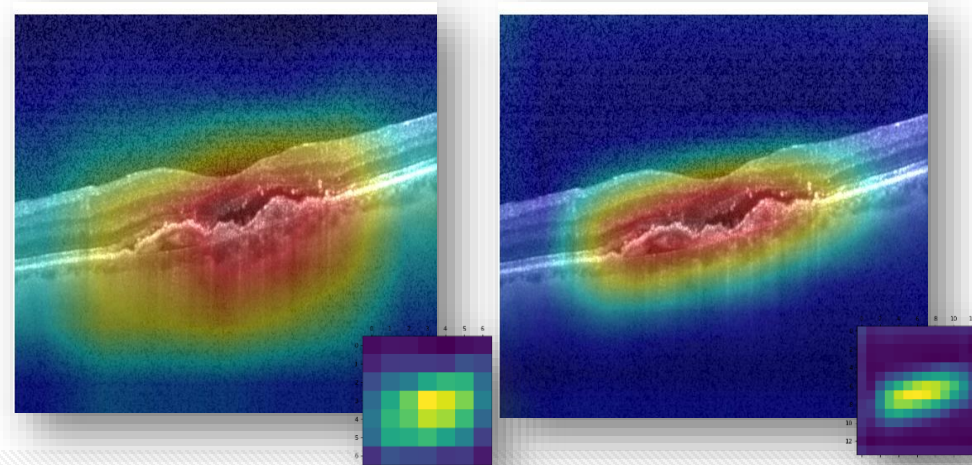
DRUSEN



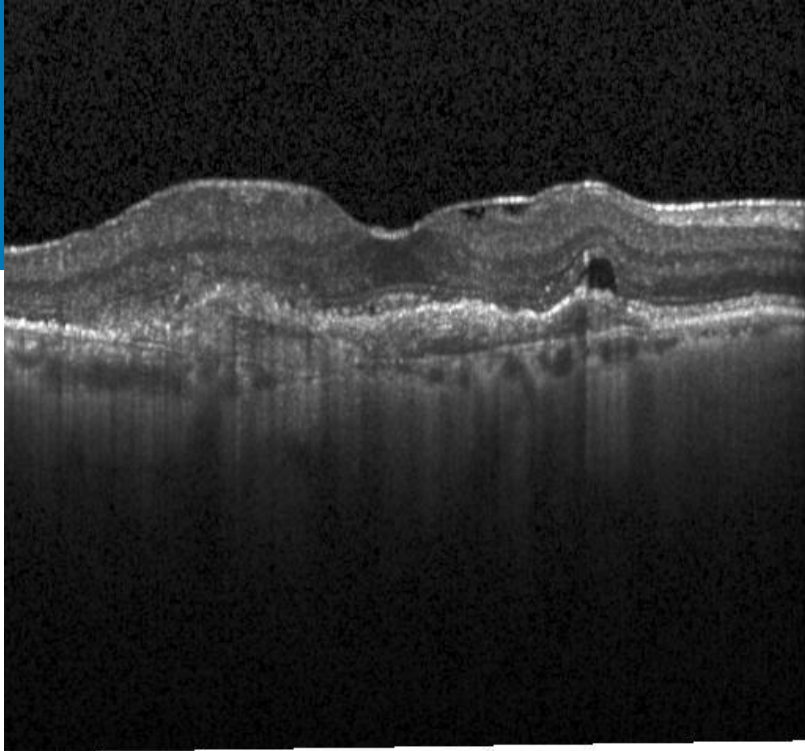
DME



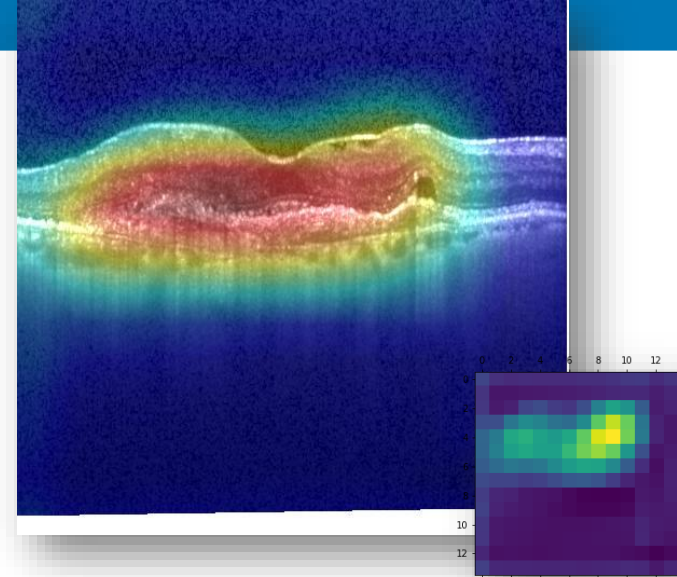
CNV



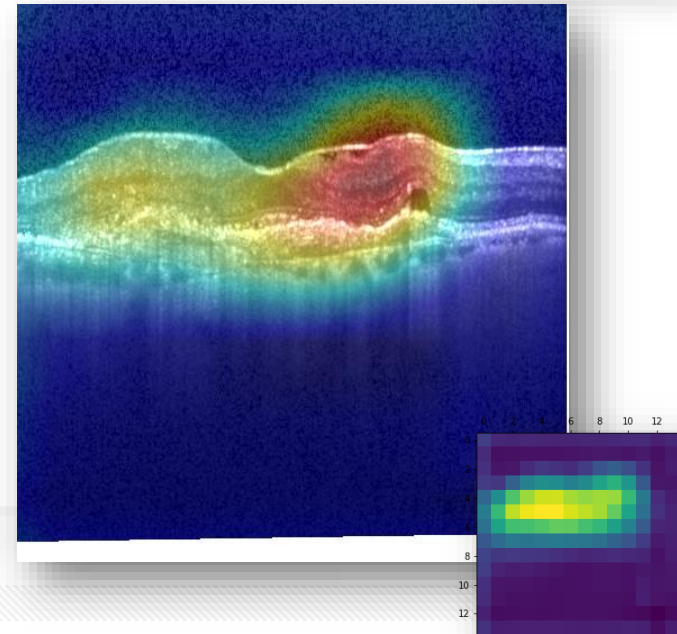




**True label:** CNV  
**Class Grad-Cam:** CNV



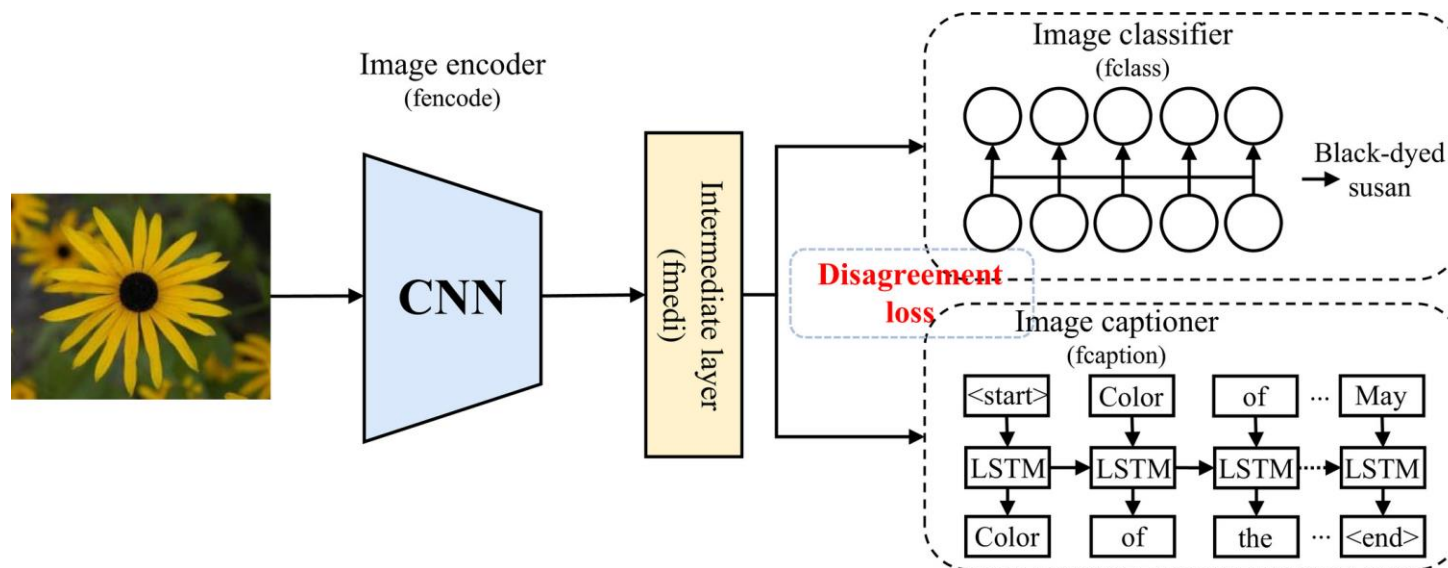
**True label:** CNV  
**Class Grad-Cam:** DME



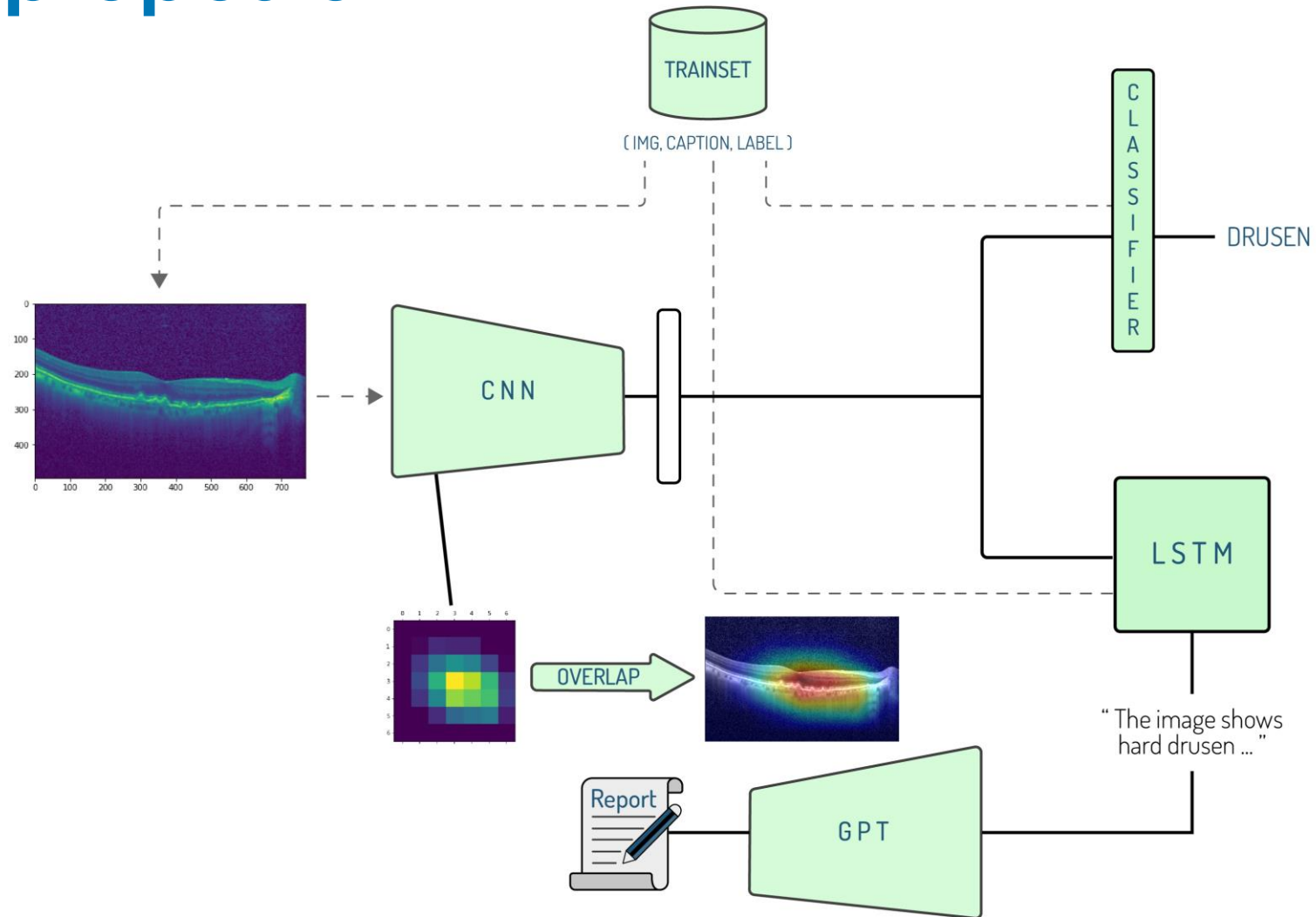


# MULTI-TASK LEARNING

- Apprendimento in cui le **feature** tra task correlati vengono **condivise**
- Riduce rischio **overfitting**
- **Generalizza** meglio rispetto ad un addestramento separato dei singoli task



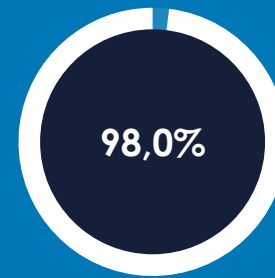
# Modello **proposto**



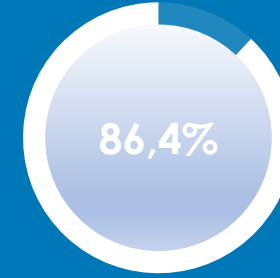
# Valutazione modello **Multi-Task**

**Densenet-121**

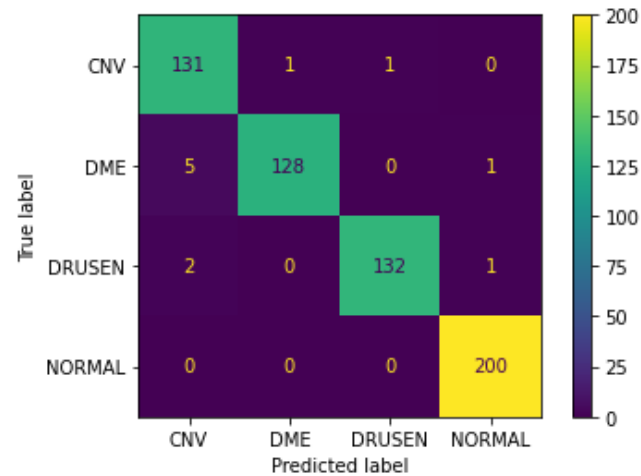
800 img  
224 x 224  
Visual XAI + Textual XAI



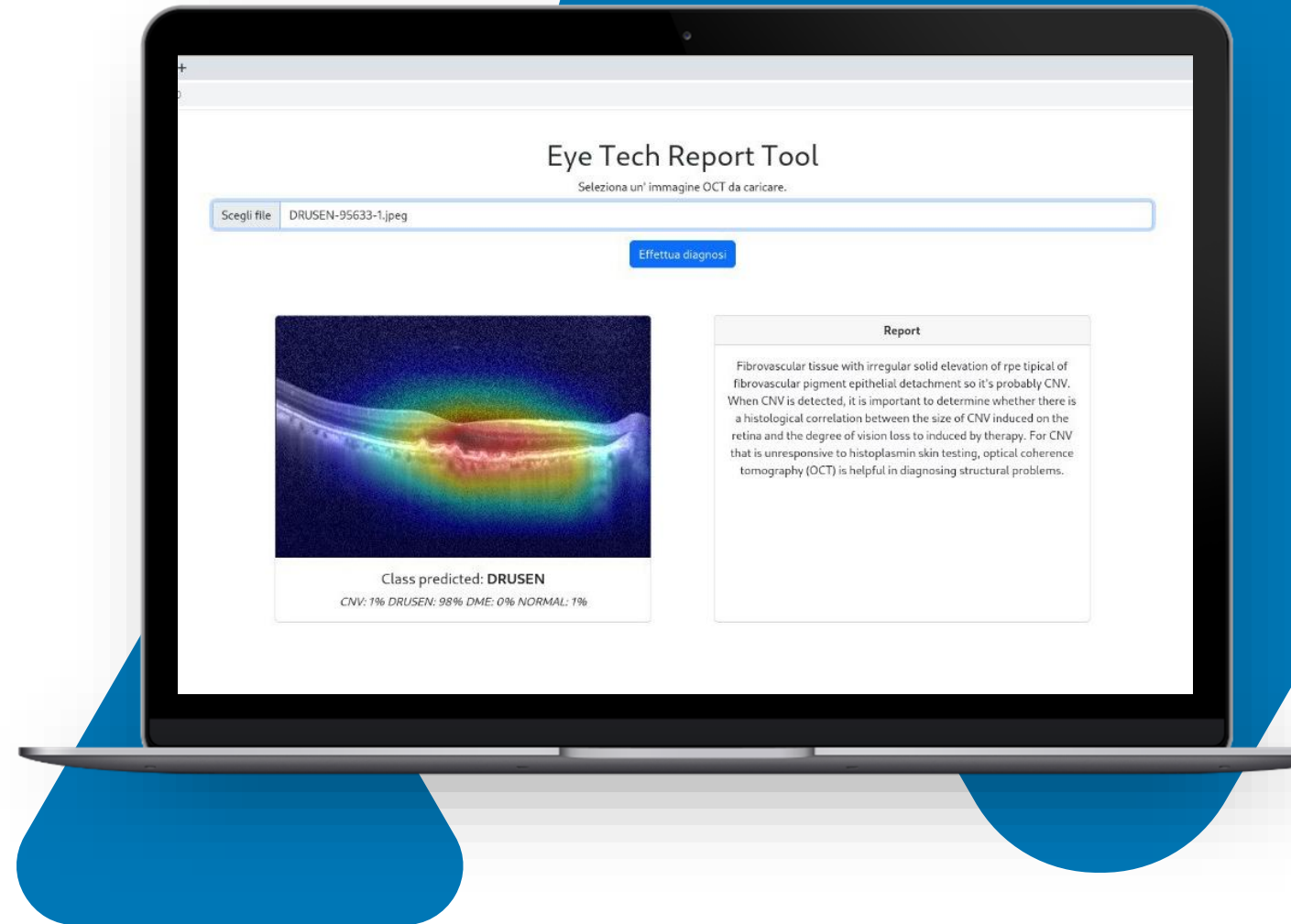
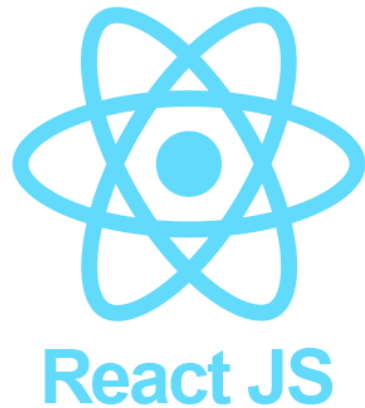
Accuracy



Agreement



# Eye Tech Report Tool



# Conclusioni e sviluppi futuri

- Si fornisce una **visual explainability**
- Il modello **Multi-Tasking** ha performance migliori rispetto a modelli che risolvono singoli task in modo autonomo sullo stesso dominio
- Aumentare **didascalie** del dataset
- Aumentare **capacità computazionale** per training di modelli più complessi
- Supporto da parte di specialisti per la valutazione dei report di **GPT-2** e **GPT-Neo**







Grazie per  
l'attenzione