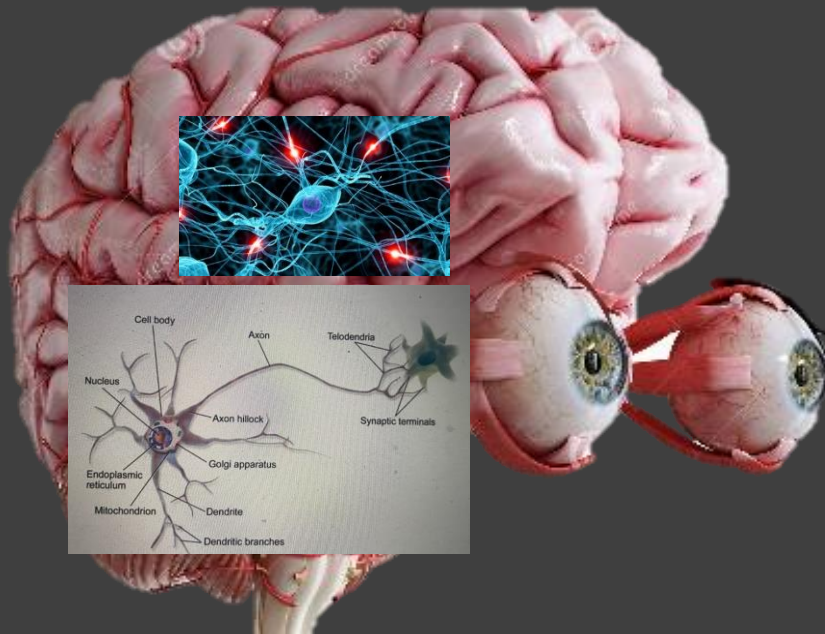




From human-computer competition to human- computer collaboration

Piergiacomo Calzavara-Pinton
Dermatology Department



• Human intelligence

How I diagnose a skin tumor?

»intuition«, «automatic» probability analysis



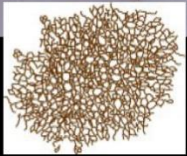
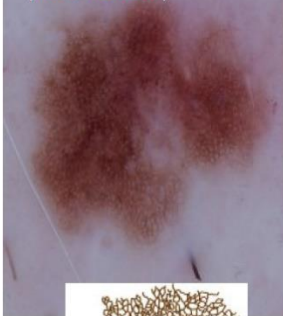
How I diagnose a skin tumor?

»intuition», probability analysis

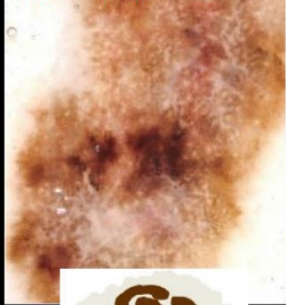
systematic analysis of visual data and integration
into existing models

1. Network (*lines*)

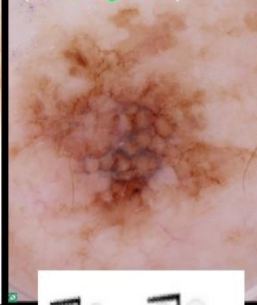
Pigment network
(*lines, reticular*)



Negative network
(*lines, reticular, white*)

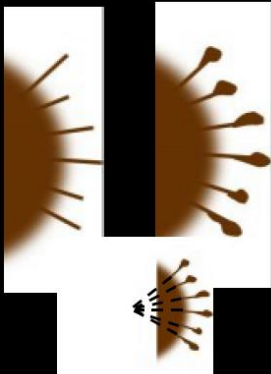


Angulated lines
(*lines, angulated*)



3. Streaks (*lines, radial*)

- Encompasses
 - radial streaming
 - pseudopods

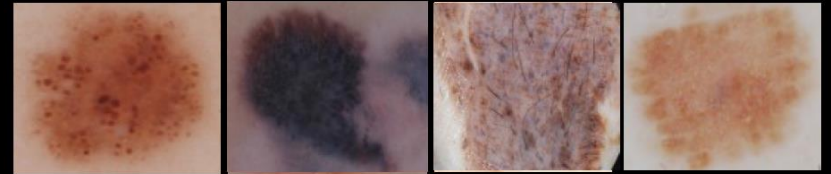


radial streaming

pseudopod

2. Globules (*clods, color*)

- symmetrical, round to oval, well demarcated structures
- > 0.1mm diameter
- nests of pigmented melanocytes at dermo-epidermal junction, or in dermis
- brown, black, blue, white (red globules = vascular)



4. Blotch (*structureless zone*)

- Large concentration of melanin pigment
- Throughout epidermis (with or without melanin in dermis)
- Visually obscuring the underlying structures

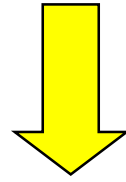


5. Blue white veil (*structureless zone, blue*)

- Bluish blotch with overlying white ground-glass haze
- Not associated with scar-like depigmentation or peppering/granularity
- Usually associated with palpable (raised) portion of the lesion



PATTERN ANALYSIS



a rete o reticolare

globulare

a zolle o acciottolato

omogeneo

starburst

parallelo

composto

polimorfo o multicomponente

lacunare

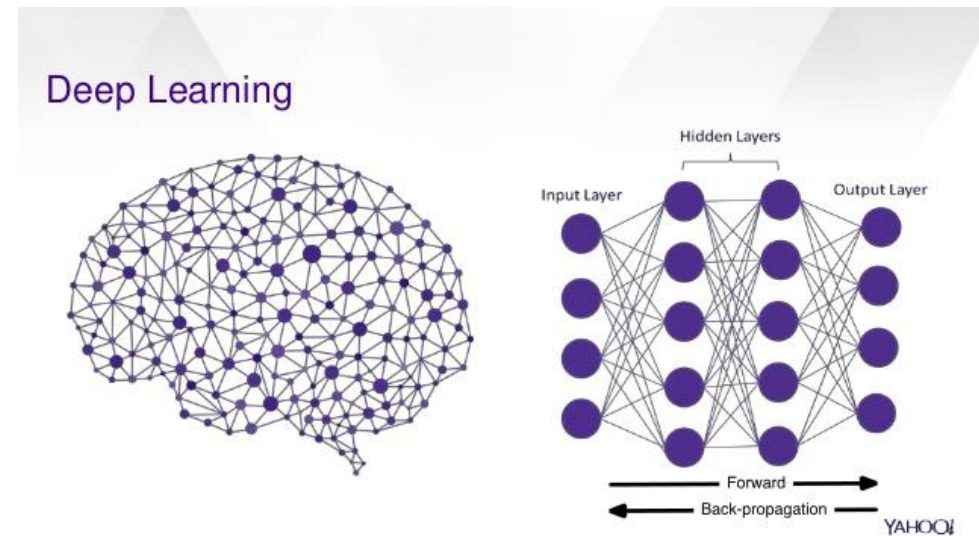
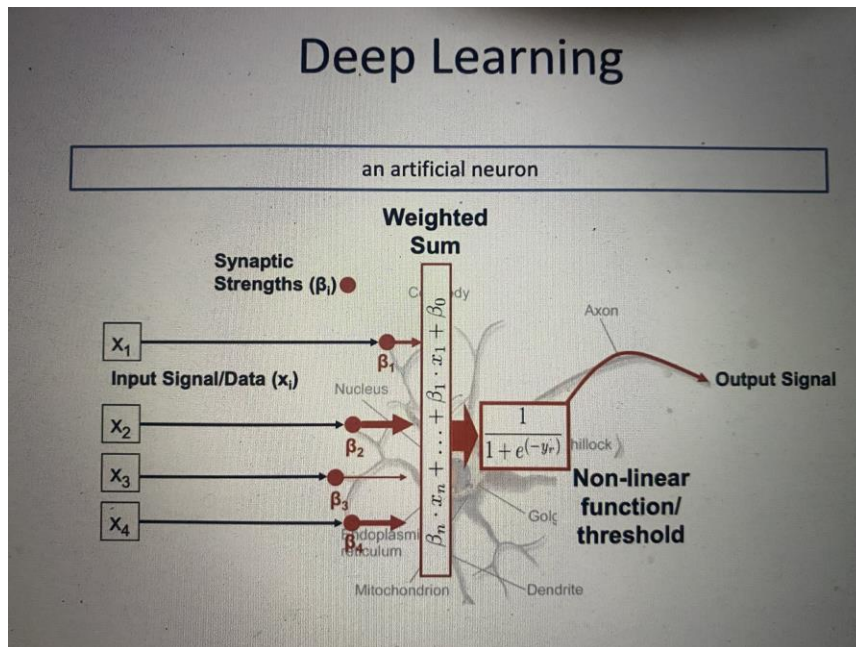
aspecifico

ARTIFICIAL INTELLIGENCE

MACHINE ANALYSIS: COMPUTERS ANALYSE IMAGES ACCORDING TO ALGORITHMS THAT I HAVE PROGRAMMED

MACHINE LEARNING: COMPUTERS LEARN AND PERFORM TASKS WITHOUT HAVING TO BE SPECIALLY PROGRAMMED BEFOREHAND

DEEP LEARNING: THE FUNCTION OF THE HUMAN BRAIN IS IMITATED WITH ARTIFICIAL NEURONS



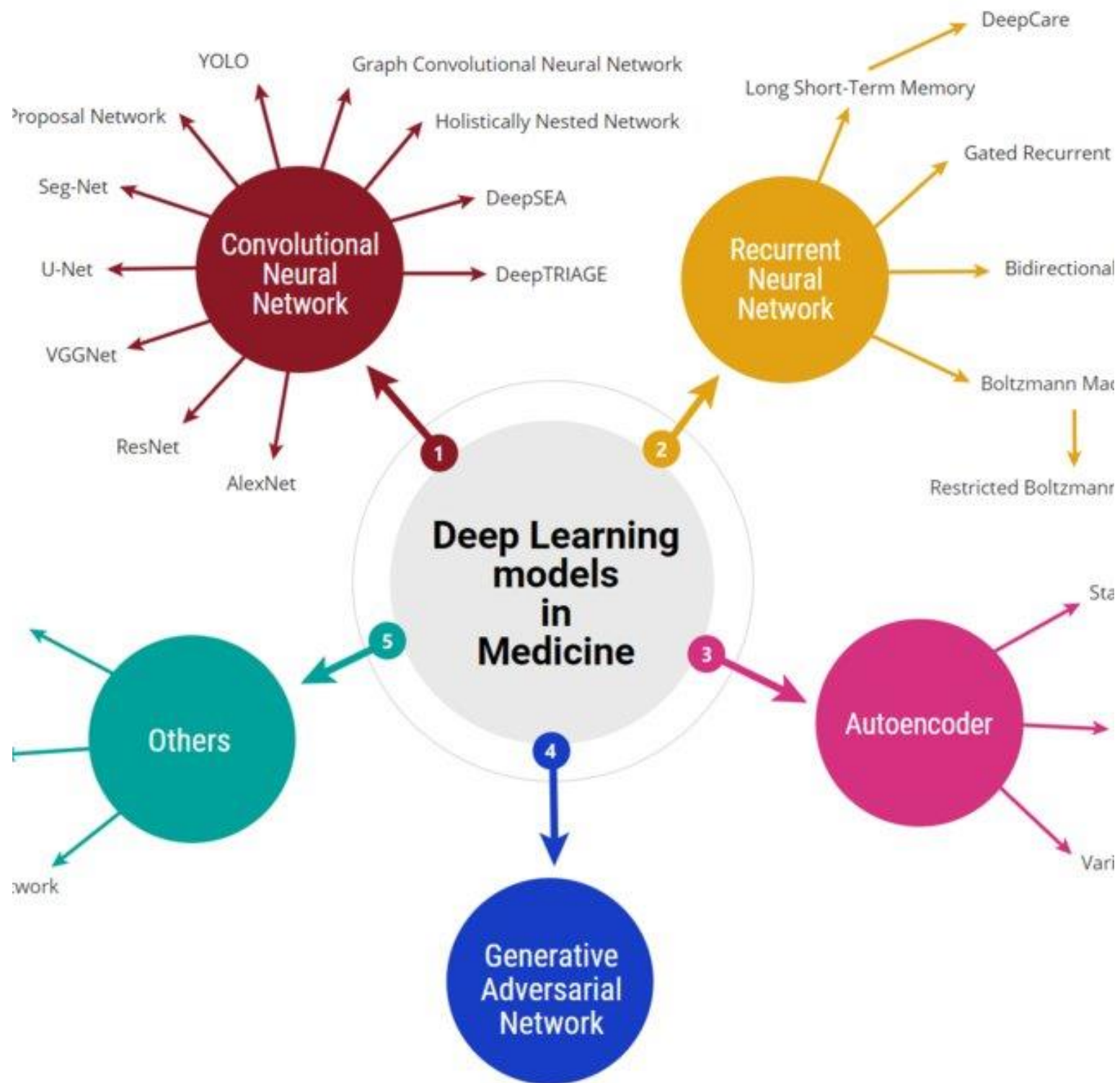
A.I. does not mean «consciousness»

Rather, it is about

Machines that learn and derive

Machines that do not think and act like a human being

But can still play GGO or chess, drive a car or
recognize melanomas

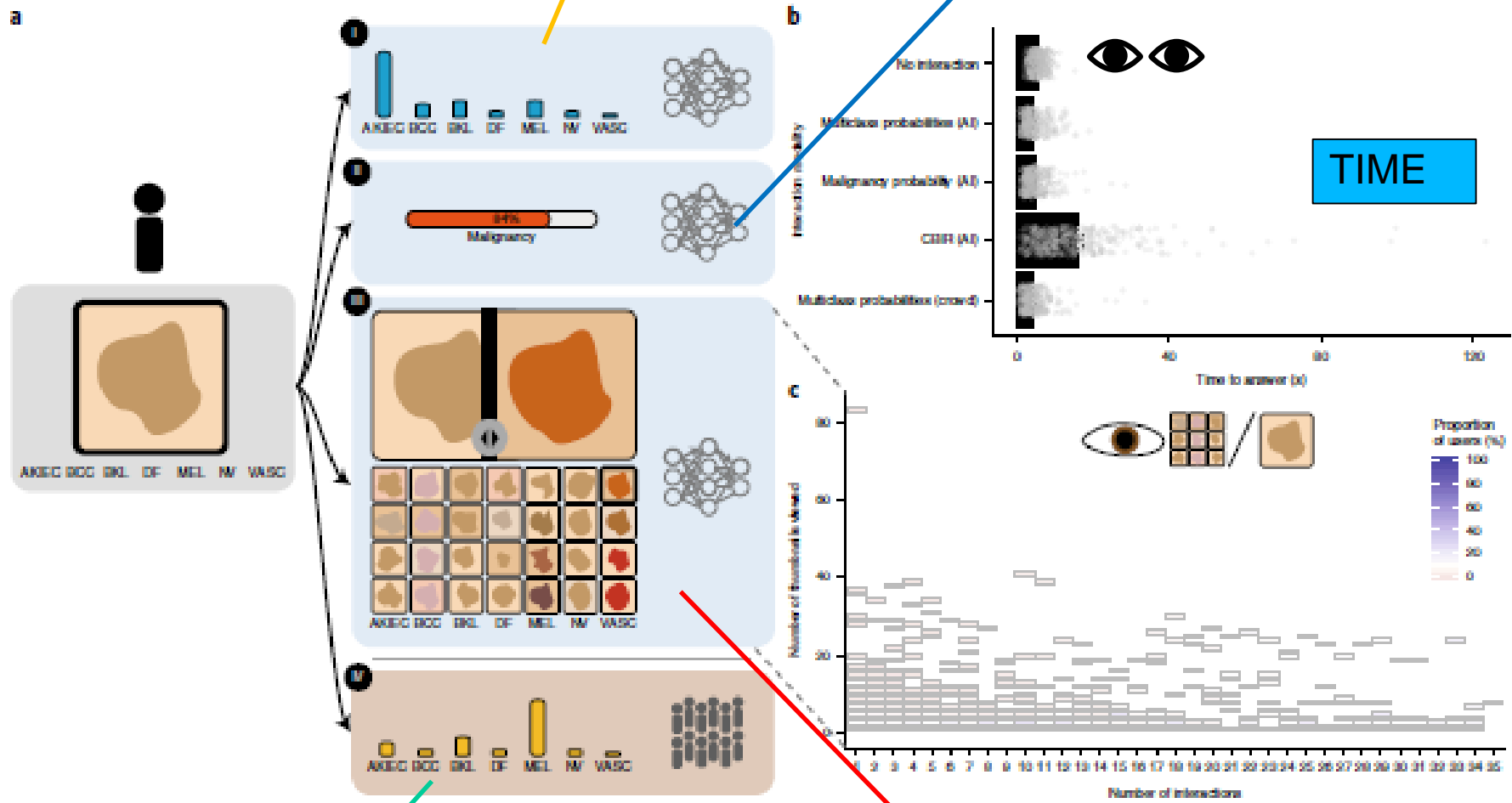


Human-computer collaboration for skin cancer recognition

Philipp Tschandl^{1,2}, Christoph Rinner^{2,17}, Zoe Apalla³, Giuseppe Argenziano⁴, Noel Codella⁵, Allan Halpern⁶, Monika Janda⁷, Aimilios Lallas³, Caterina Longo^{8,9}, Josep Malvehy^{10,11}, John Paoli^{12,13}, Susana Puig^{10,11}, Cliff Rosendahl¹⁴, H. Peter Soyer¹⁵, Iris Zalaudek¹⁶ and Harald Kittler¹

AI based multiclass probabilities

AI based probability of malignancy



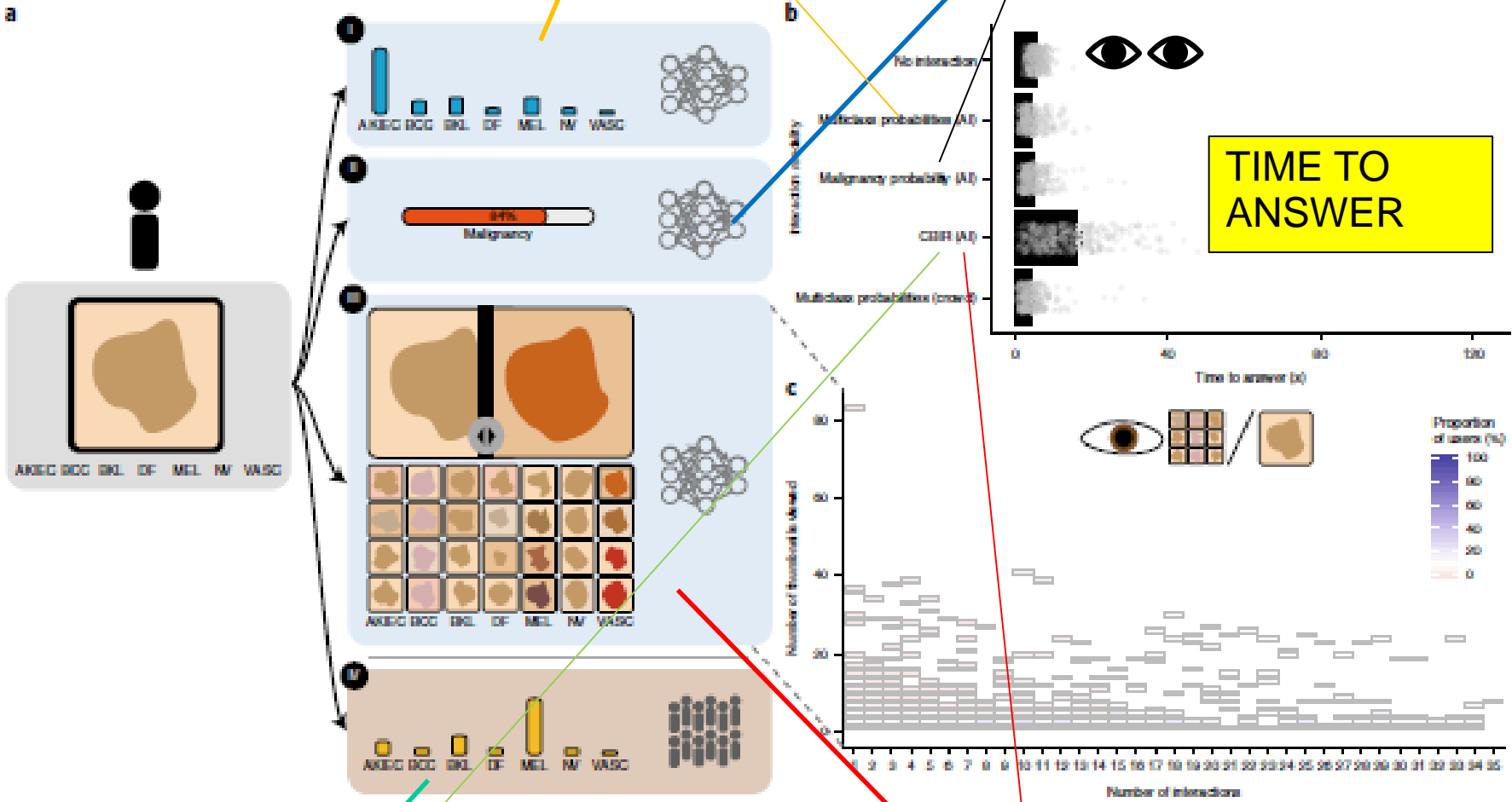
Crowd- based multiclass probabilities

AI- based CBIR (Content based image retrieval)

GAIN FROM DIFFERENT TYPES OF DECISION SUPPORT

AI based multiclass probabilities

AI based probability of malignancy



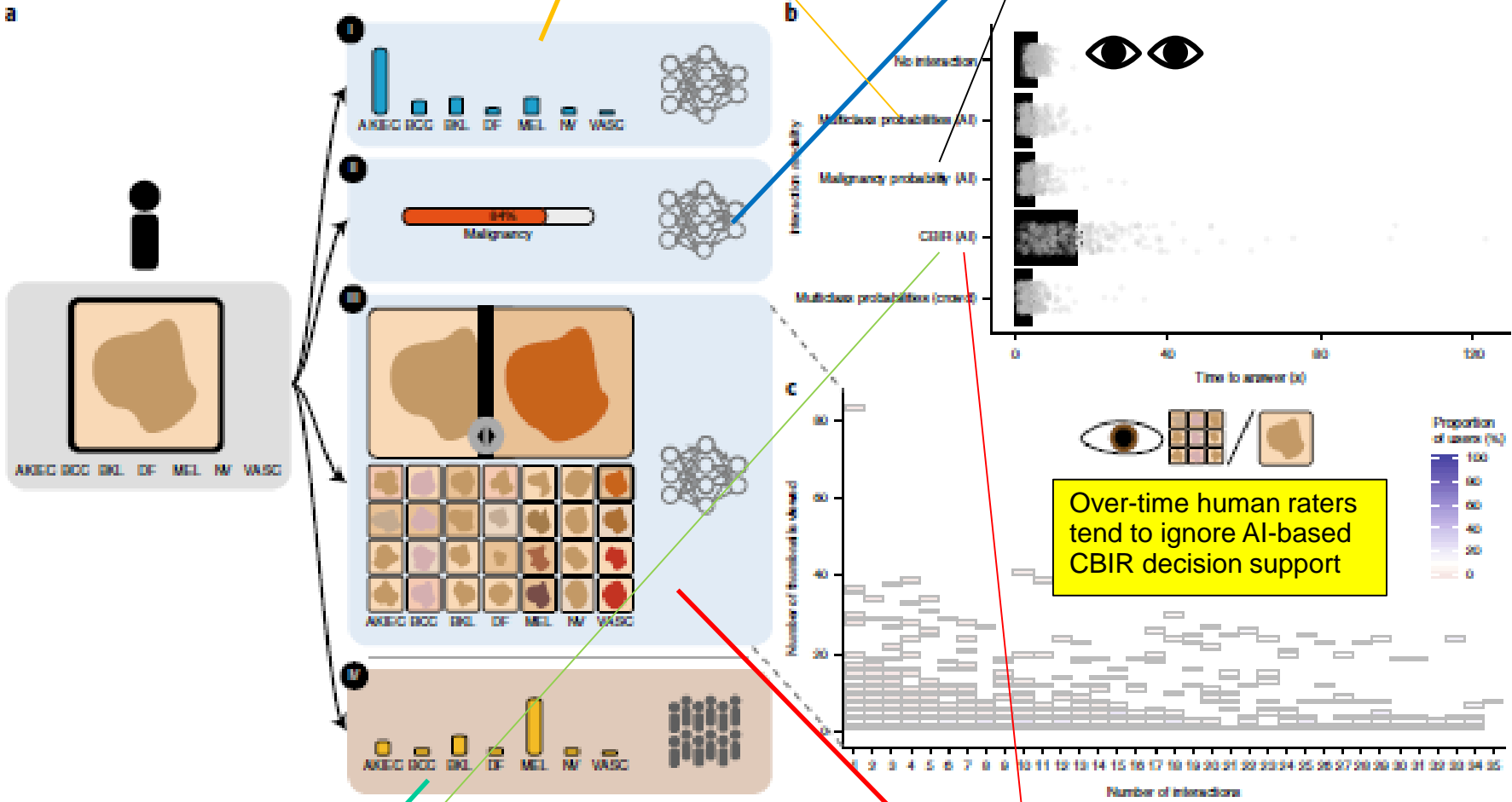
Crowd- based multiclass probabilities

AI- based CBIR (Content based image retrieval)

GAIN FROM DIFFERENT TYPES OF DECISION SUPPORT

AI based multiclass probabilities

AI based probability of malignancy



Crowd- based multiclass probabilities

AI- based CBIR (Content based image retrieval)

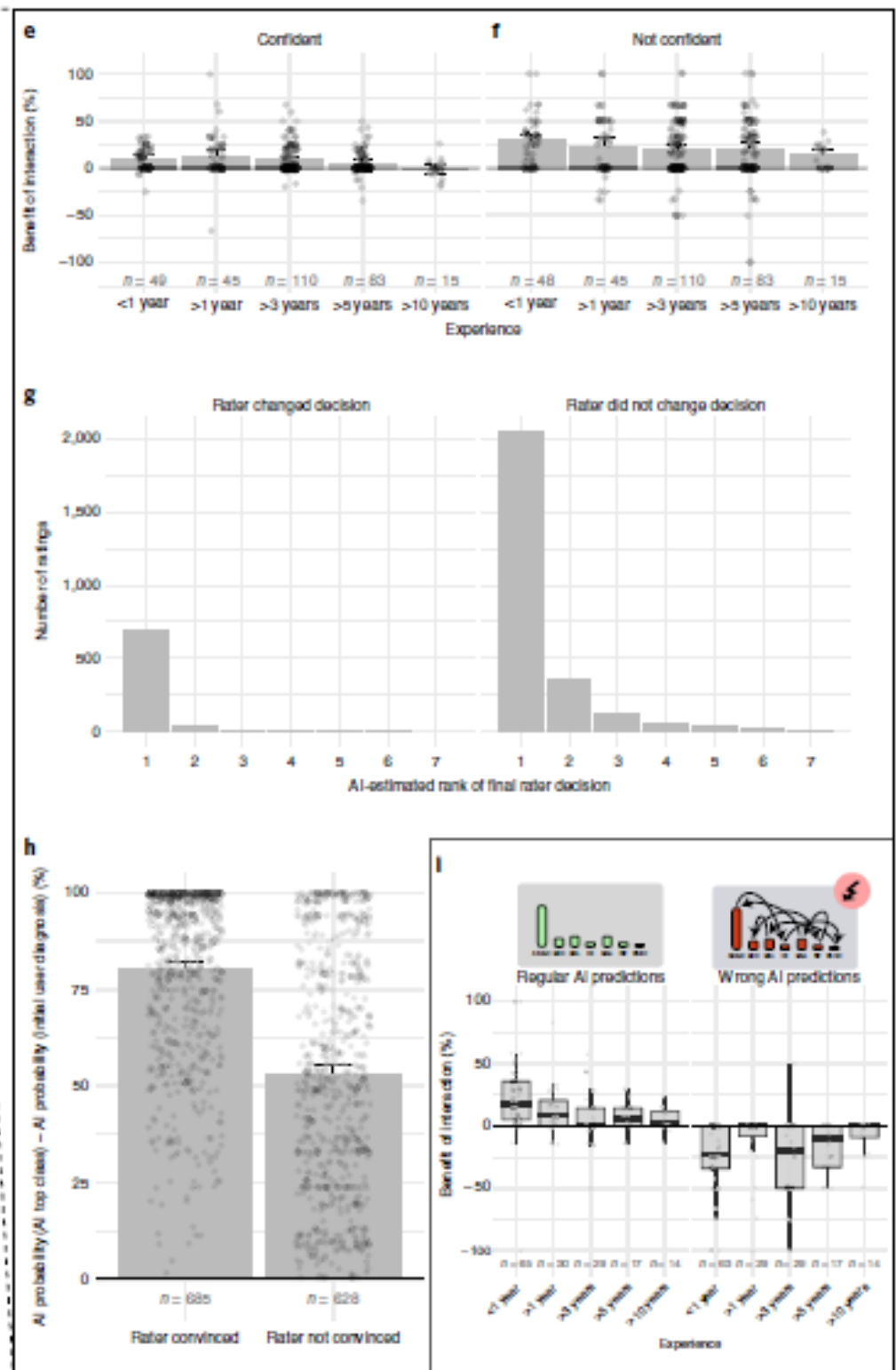
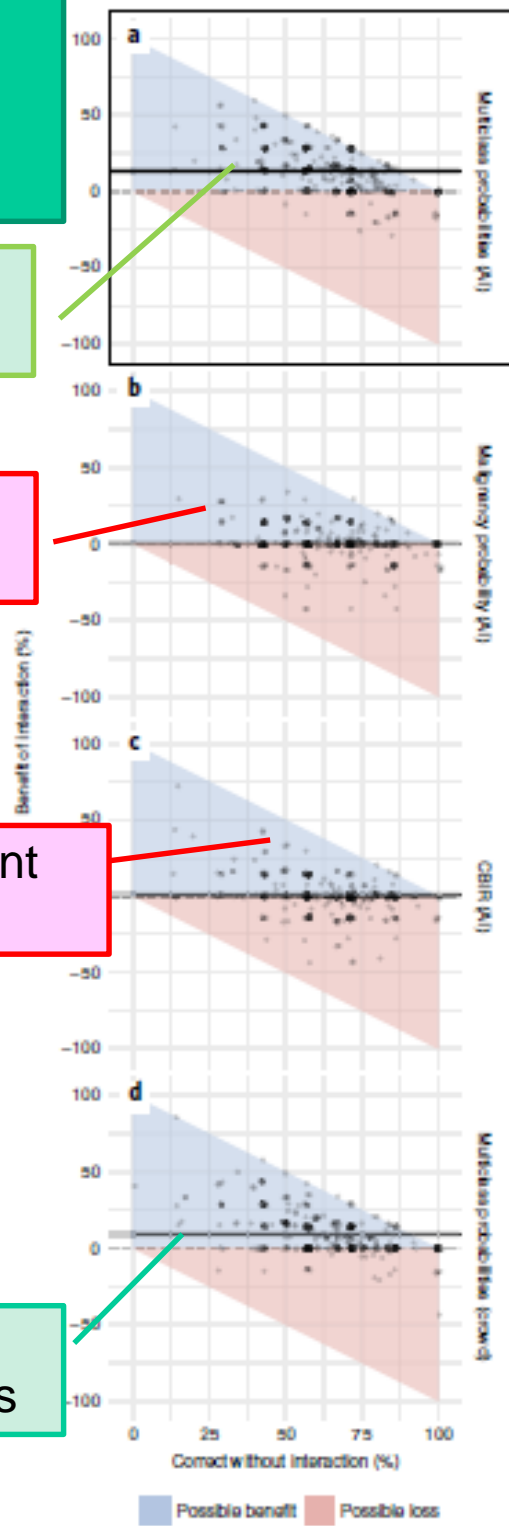
NET GAIN OF BENEFIT INTERACTION FROM DIFFERENT TYPES OF DECISION SUPPORT

AI based multiclass probabilities

AI based probability of malignancy

AI-based CBIR (Content based image retrieval)

Crowd-based multiclass probabilities

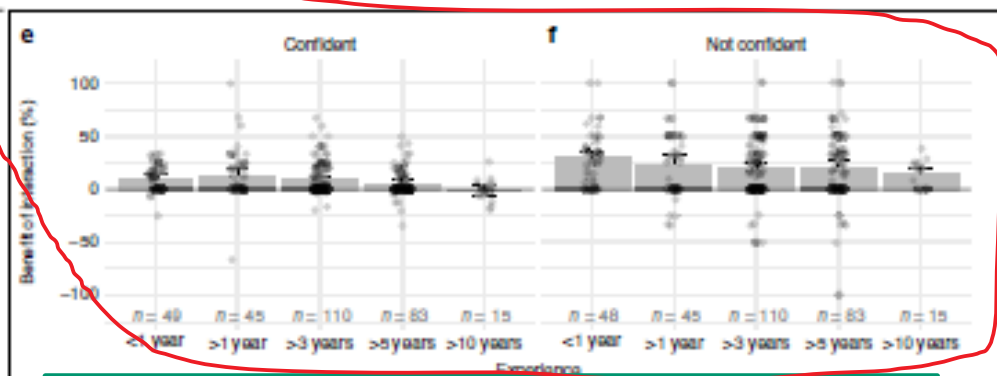
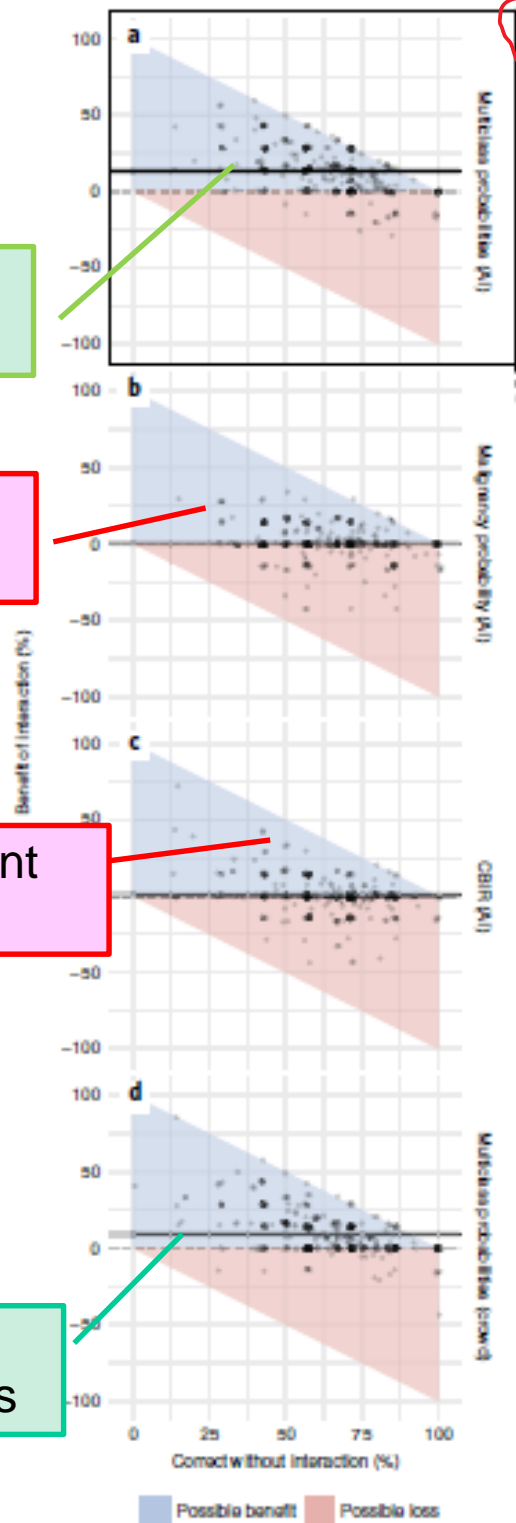


AI based multiclass probabilities

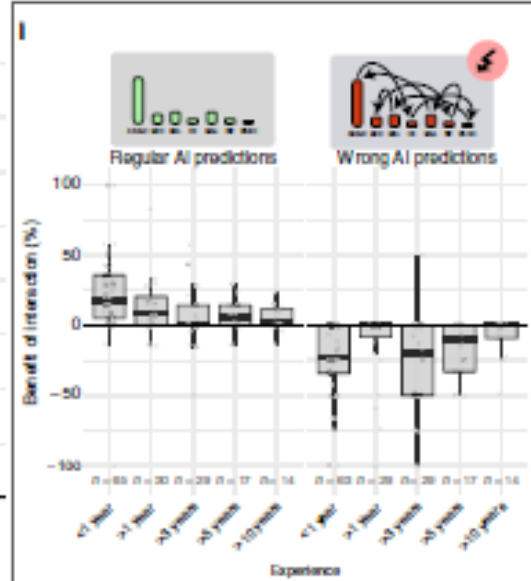
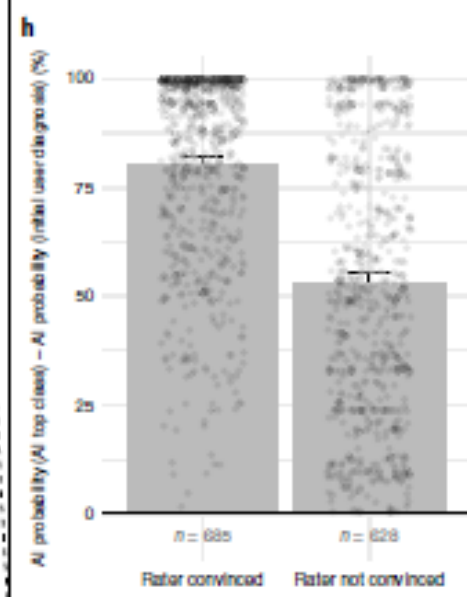
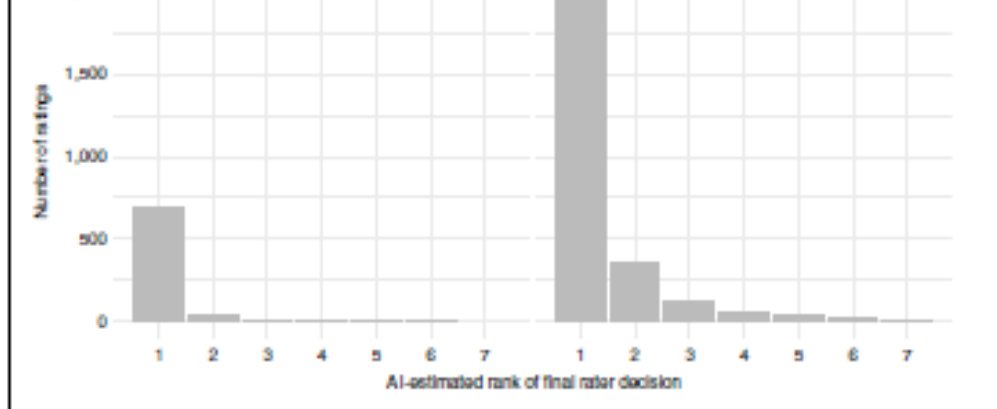
AI based probability of malignancy

AI-based CBIR (Content based image retrieval)

Crowd-based multiclass probabilities



NET GAIN OF BENEFIT DECREASES WITH EXPERIENCE AND CONFIDENCE.

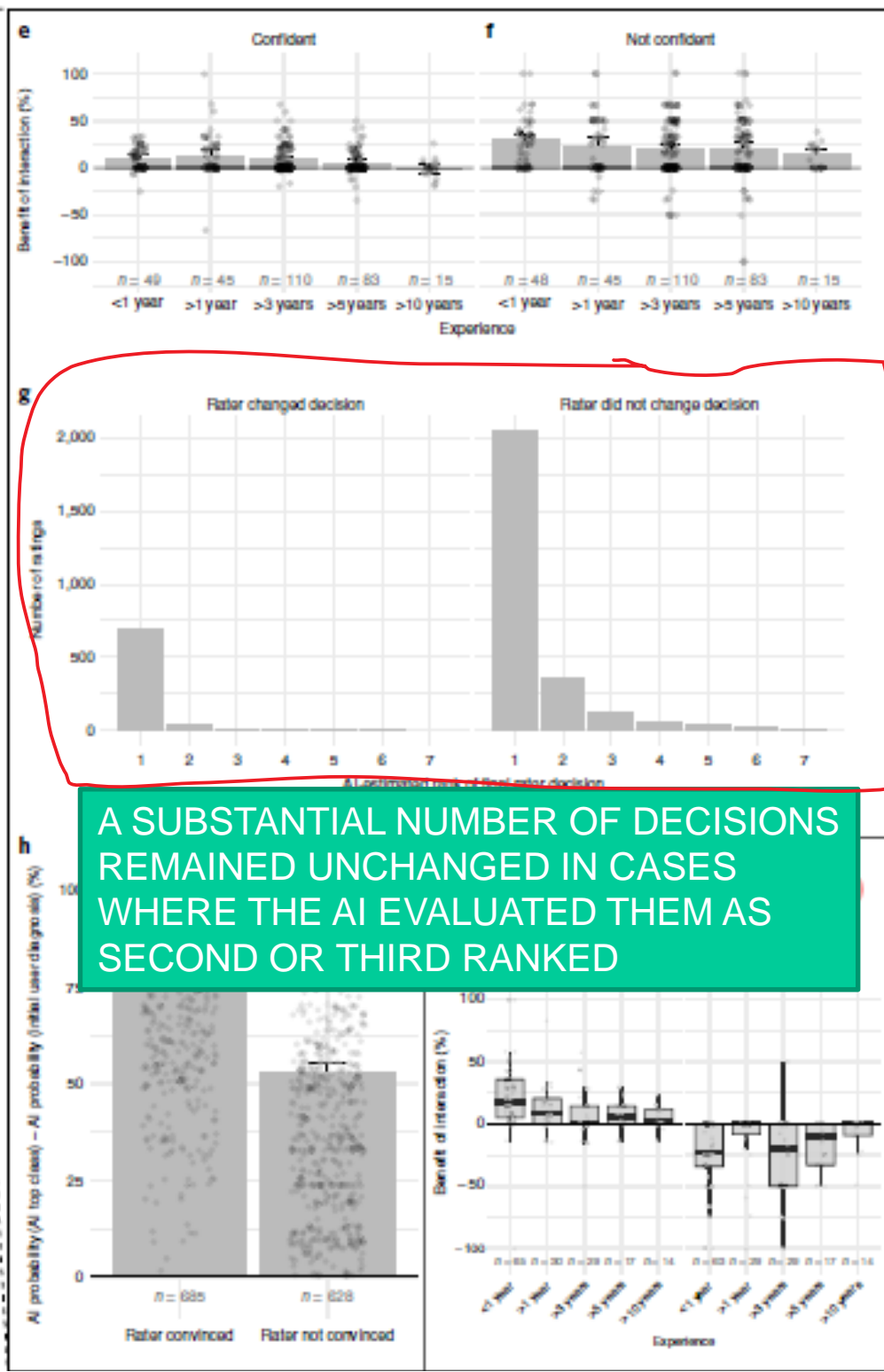
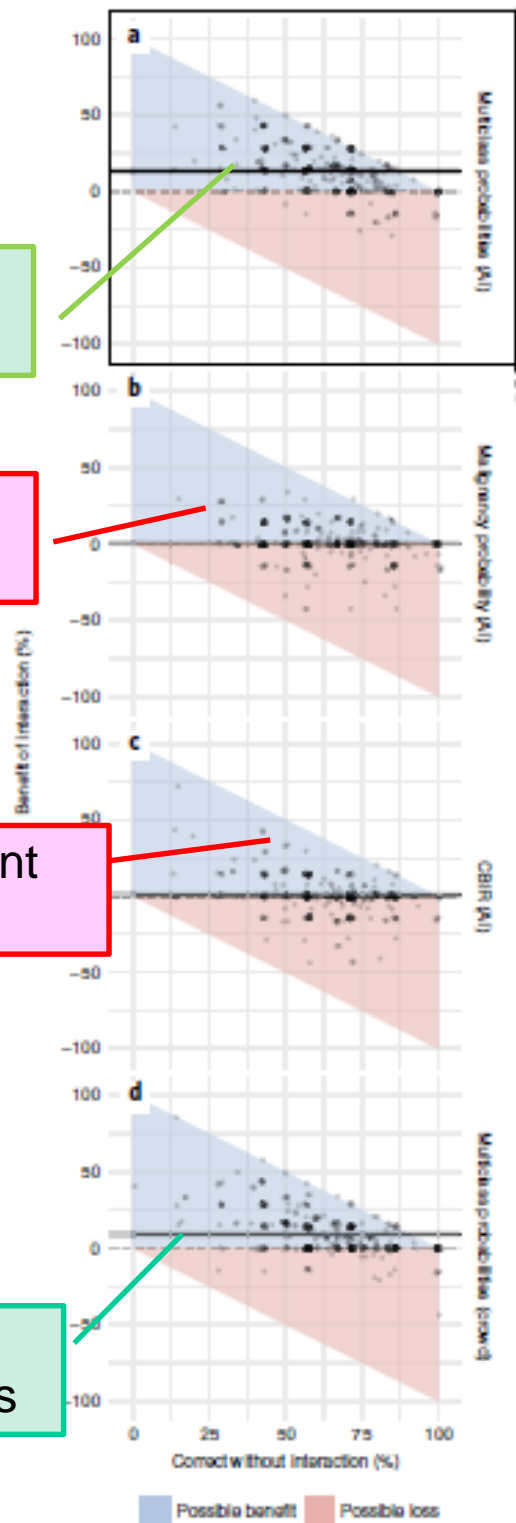


AI based multiclass probabilities

AI based probability of malignancy

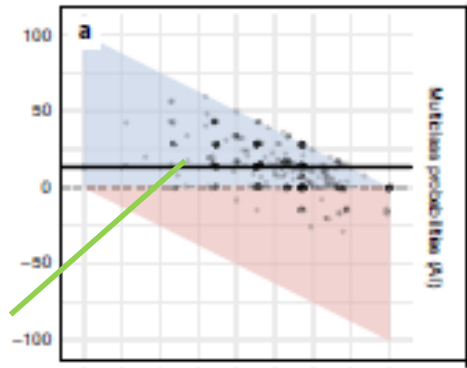
AI-based CBIR (Content based image retrieval)

Crowd- based multiclass probabilities

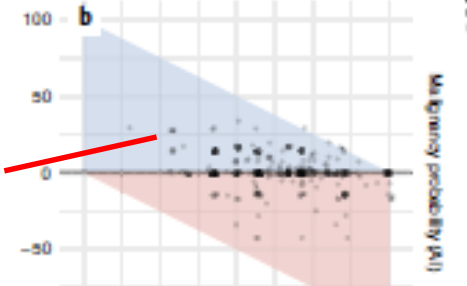


A SUBSTANTIAL NUMBER OF DECISIONS REMAINED UNCHANGED IN CASES WHERE THE AI EVALUATED THEM AS SECOND OR THIRD RANKED

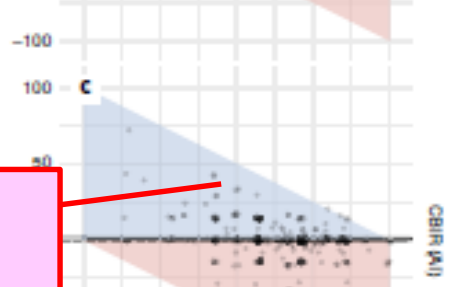
AI based multiclass probabilities



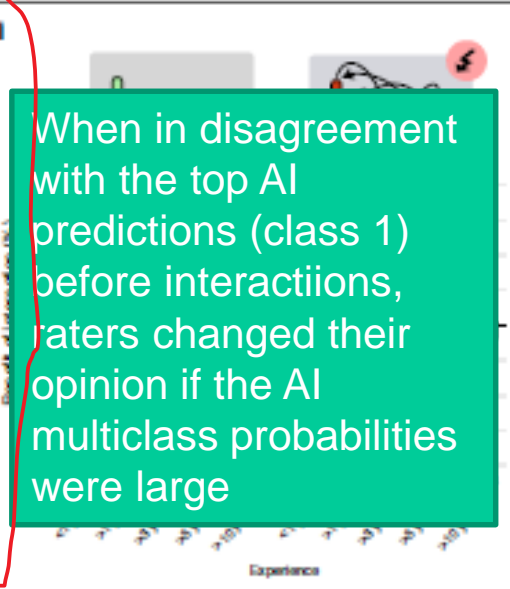
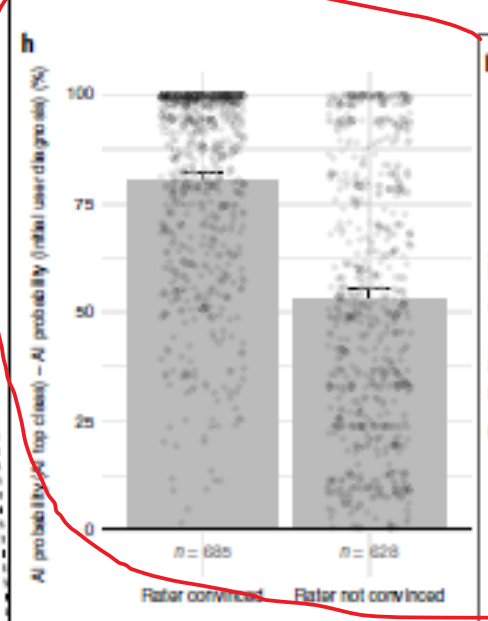
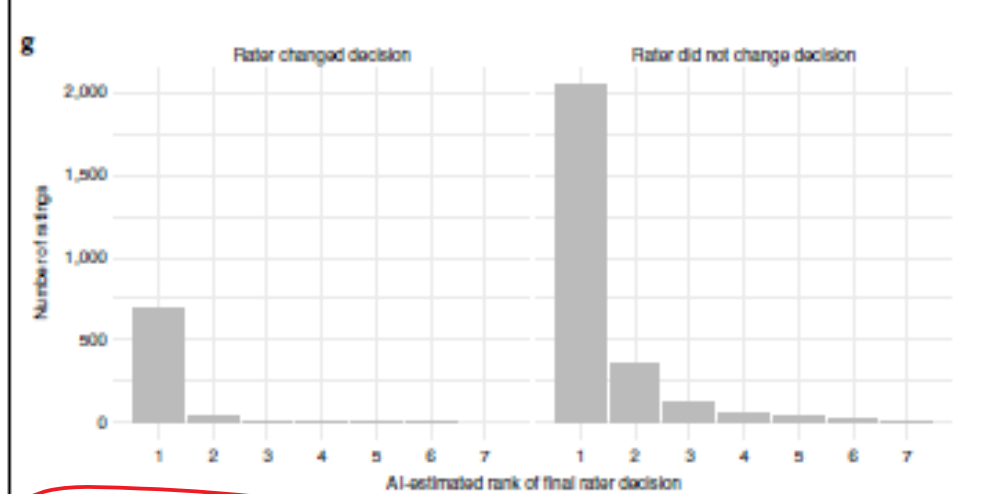
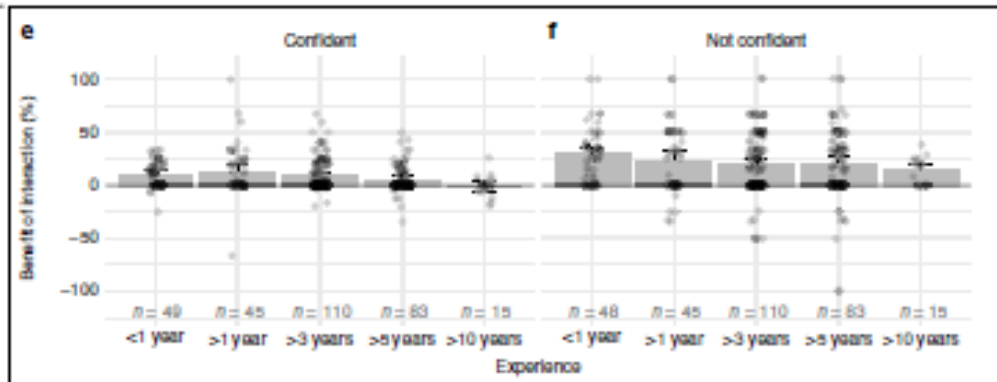
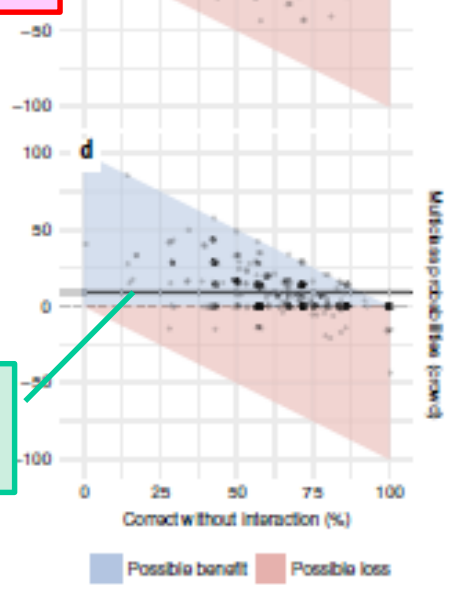
AI based probability of malignancy



AI-based CBIR (Content based image retrieval)



Crowd-based multiclass probabilities



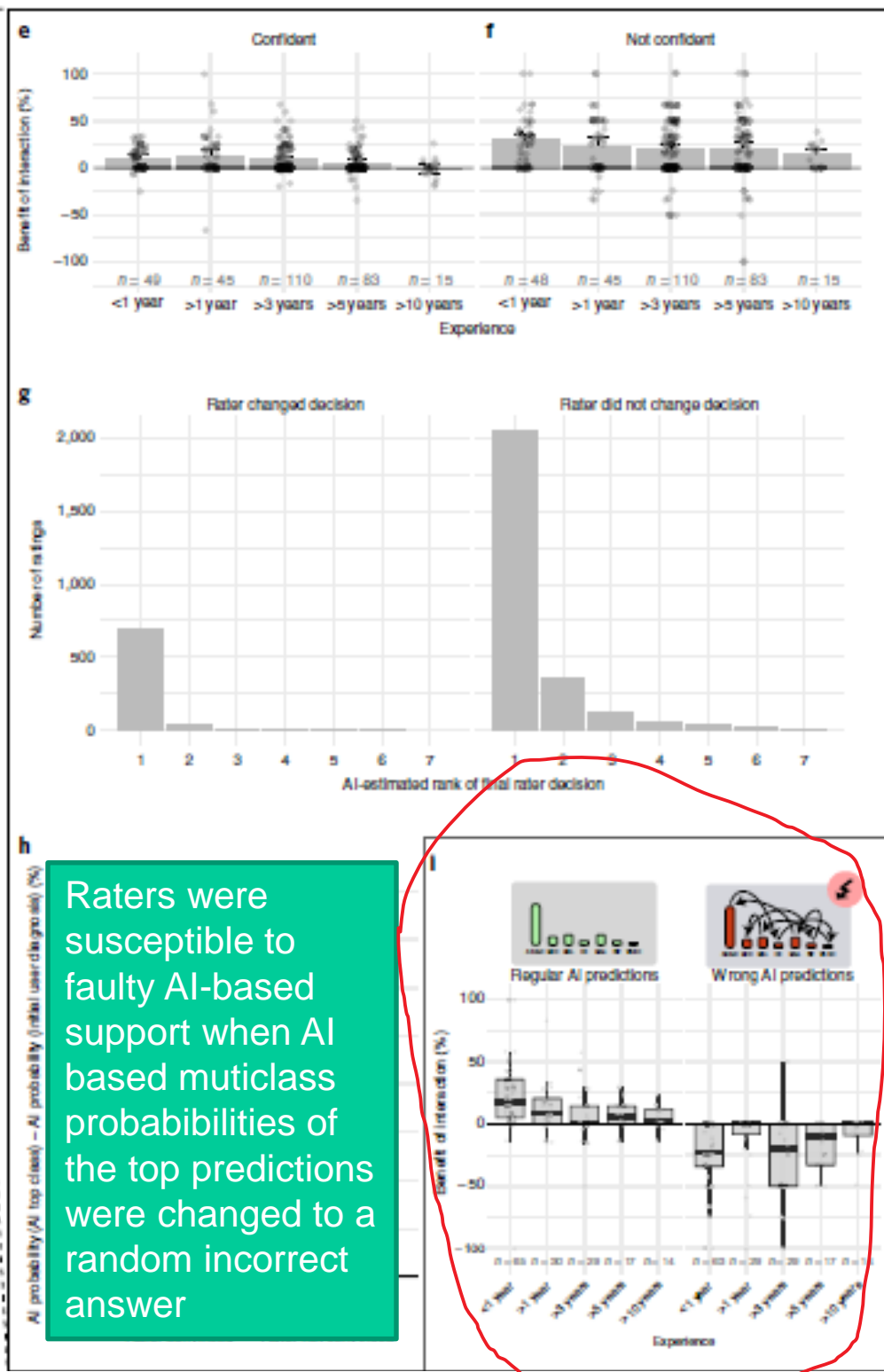
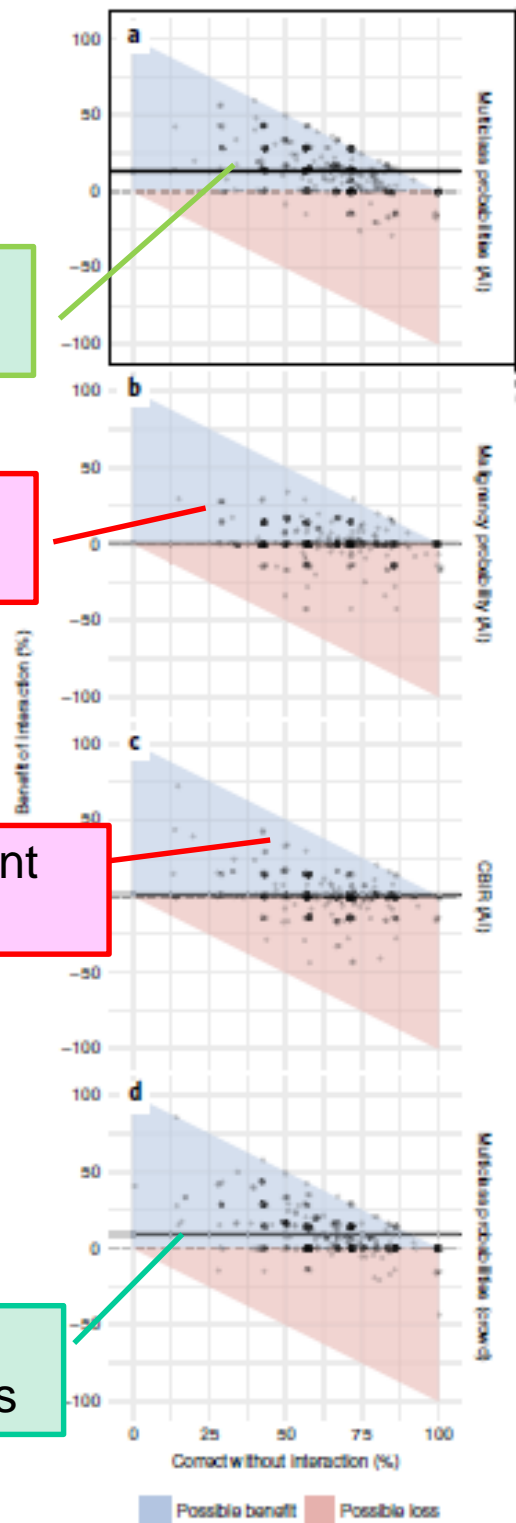
When in disagreement with the top AI predictions (class 1) before interactions, raters changed their opinion if the AI multiclass probabilities were large

AI based multiclass probabilities

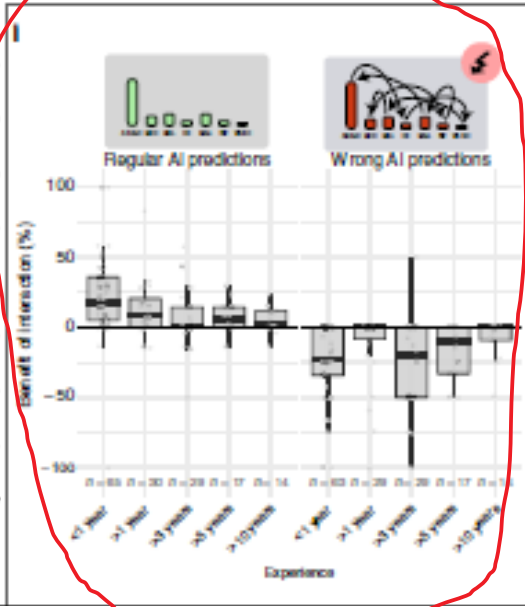
AI based probability of malignancy

AI-based CBIR (Content based image retrieval)

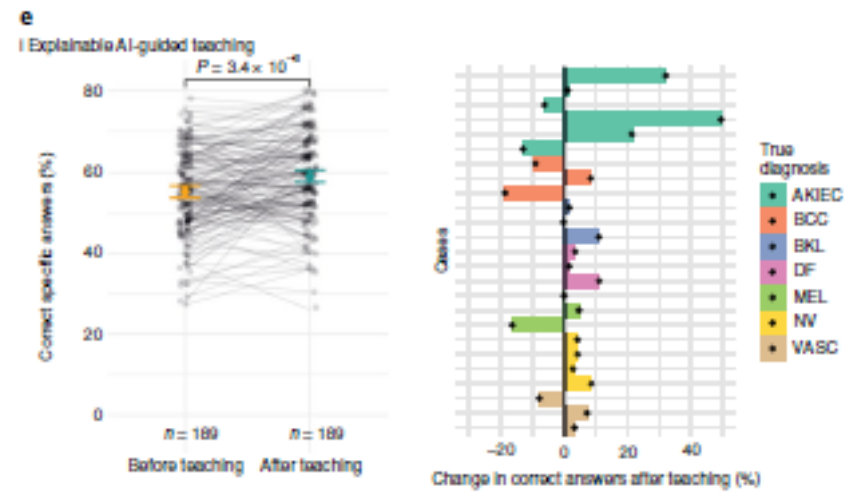
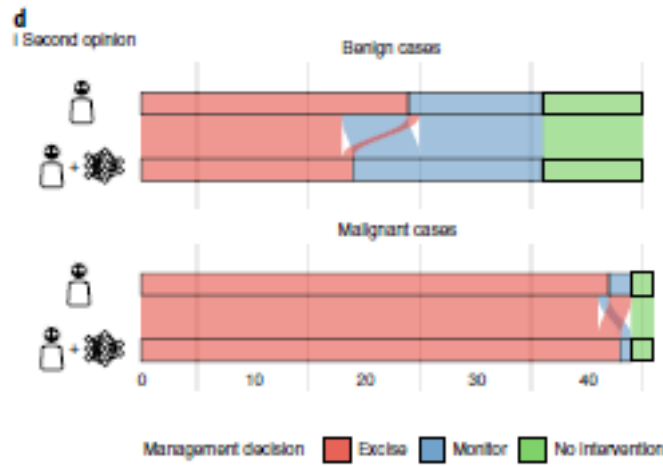
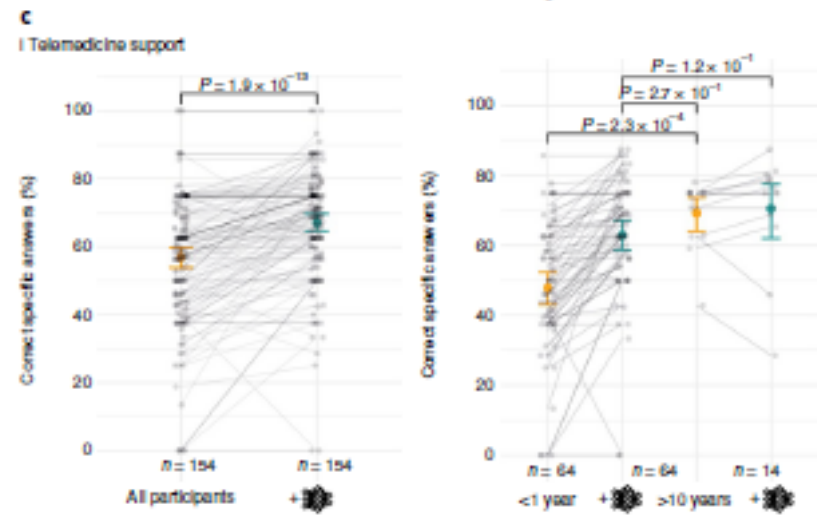
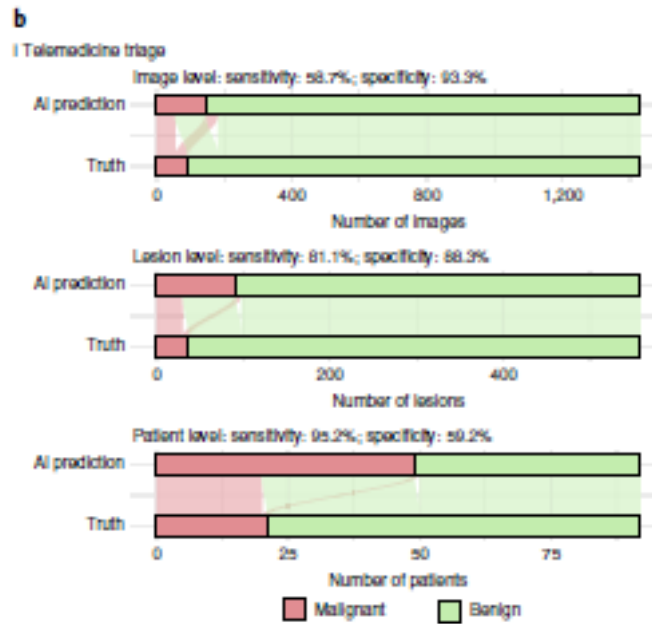
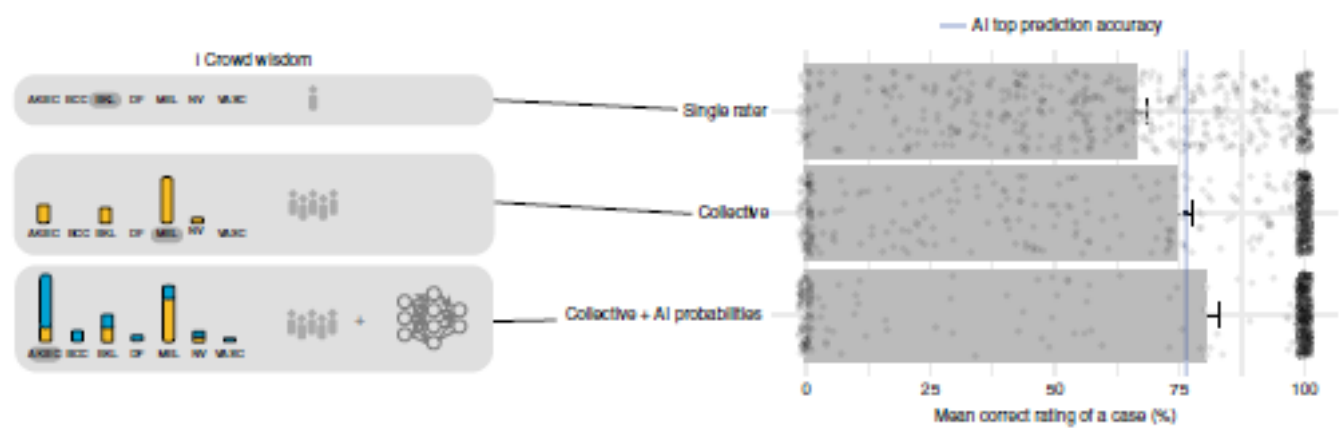
Crowd- based multiclass probabilities



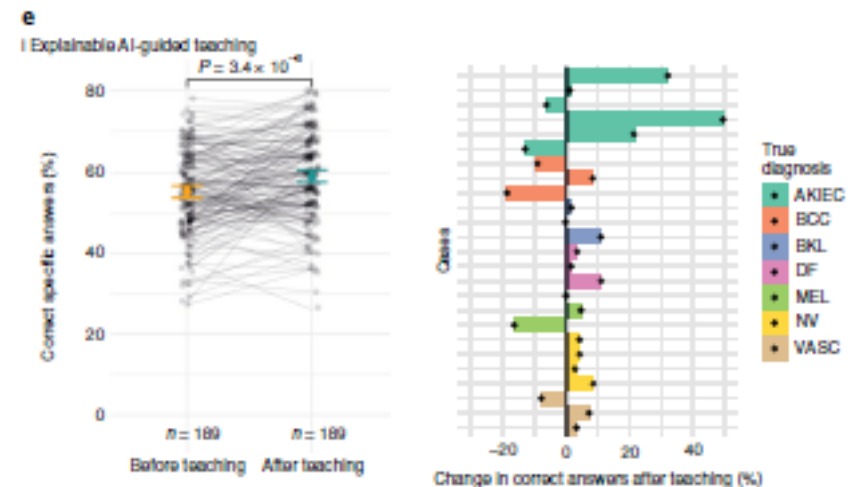
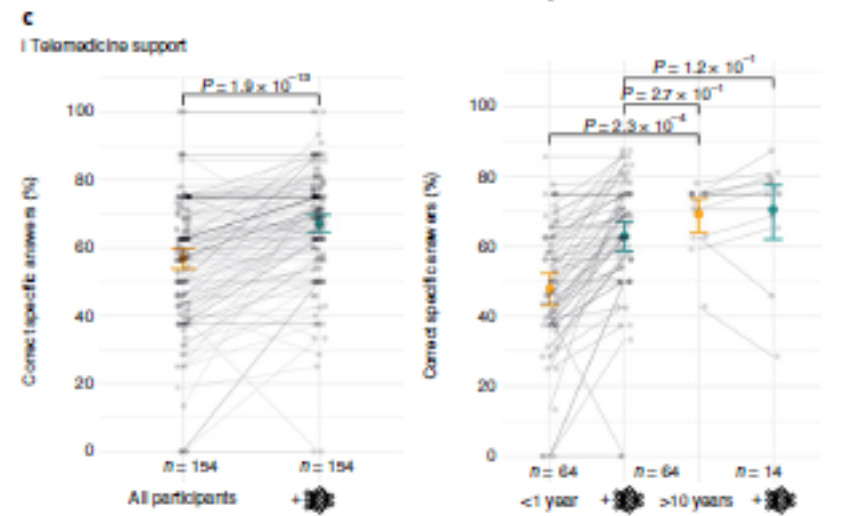
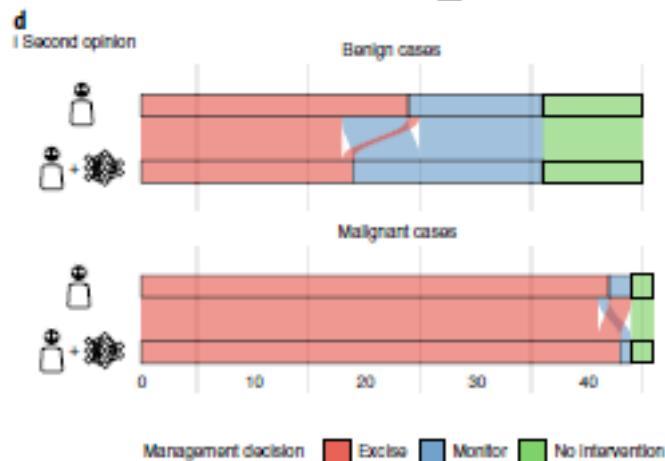
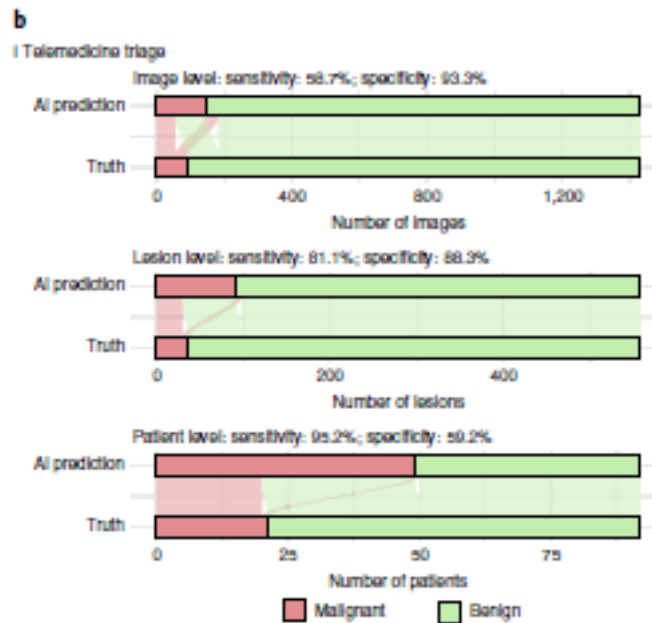
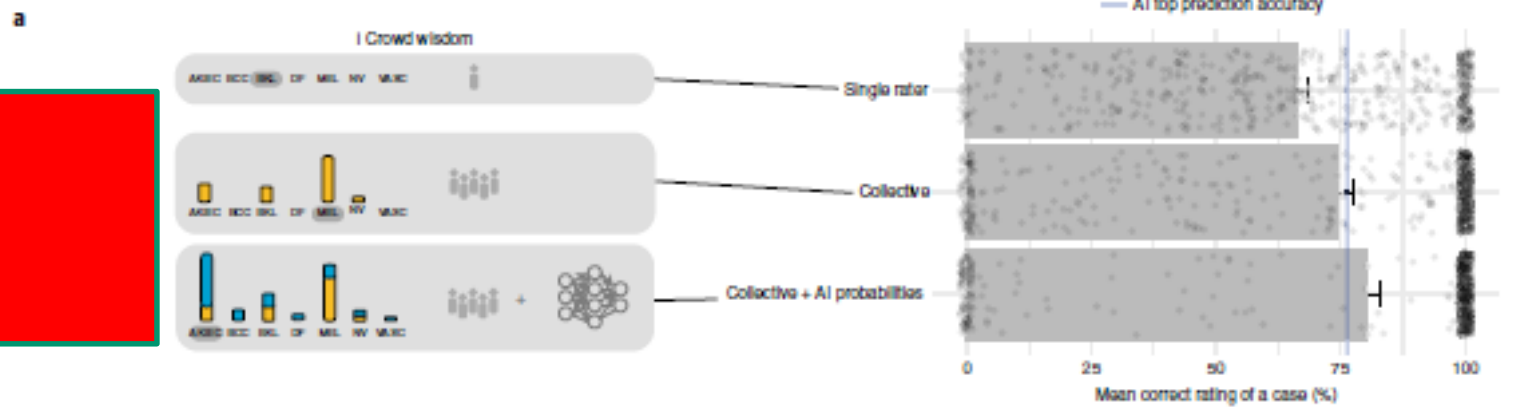
Raters were susceptible to faulty AI-based support when AI based multiclass probabilities of the top predictions were changed to a random incorrect answer

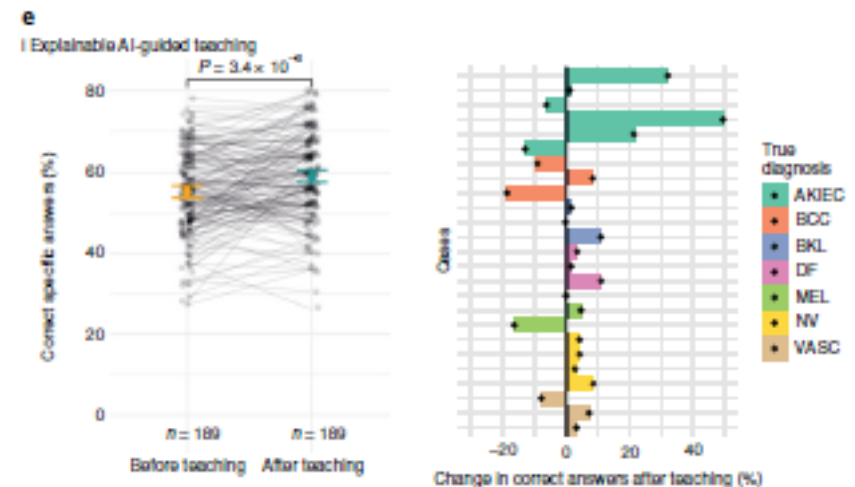
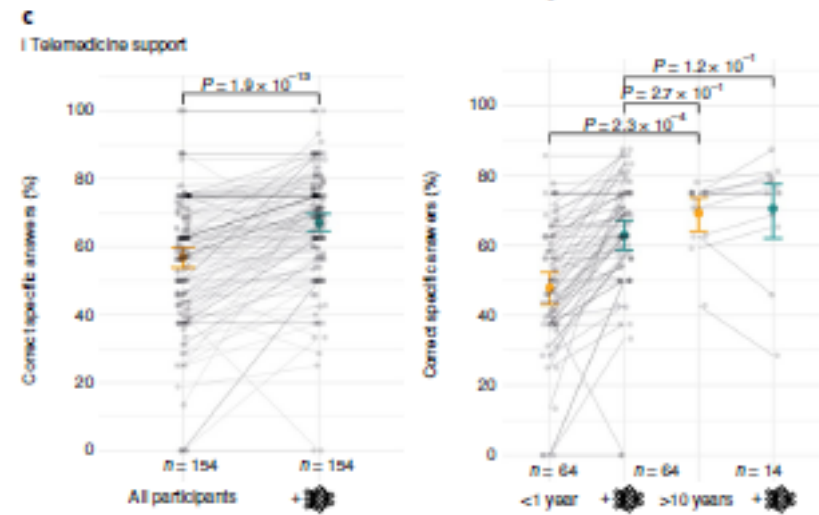
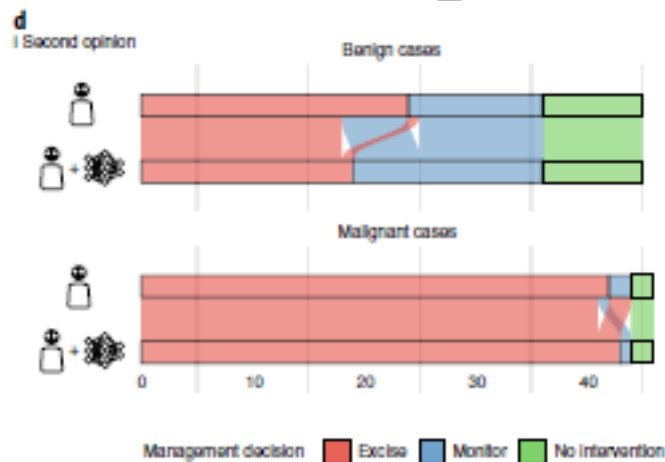
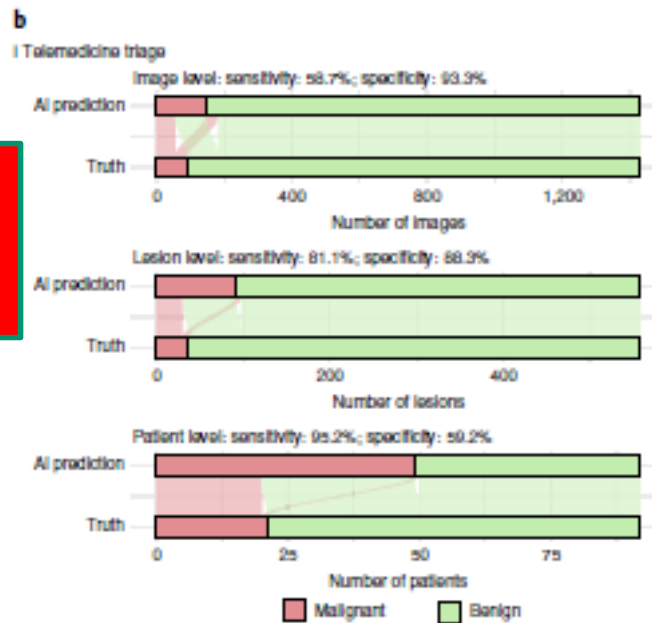
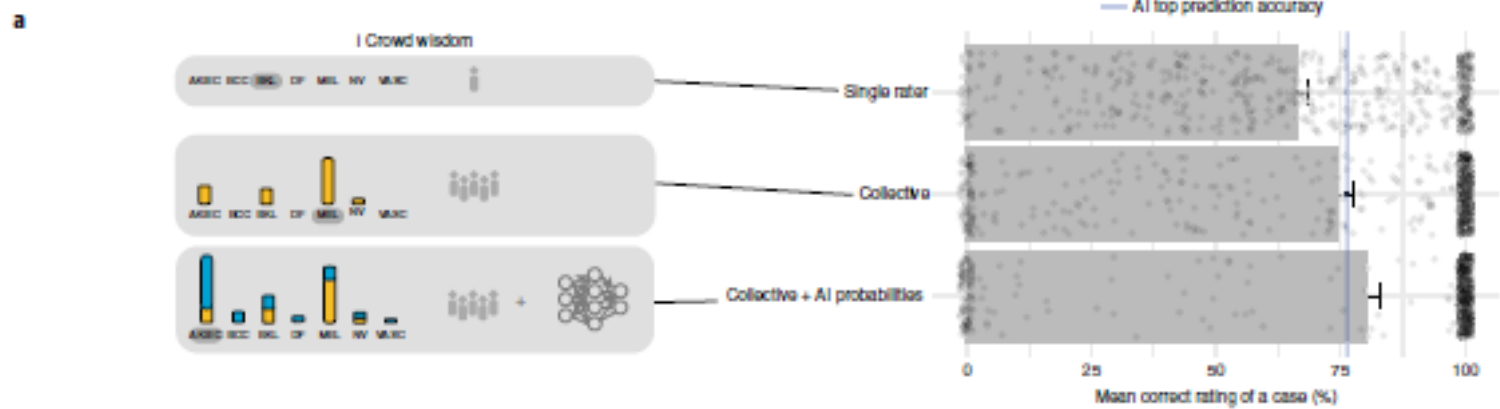


HUMAN-COMPUTER COLLABORATION IN DIFFERENT SCENARIOS

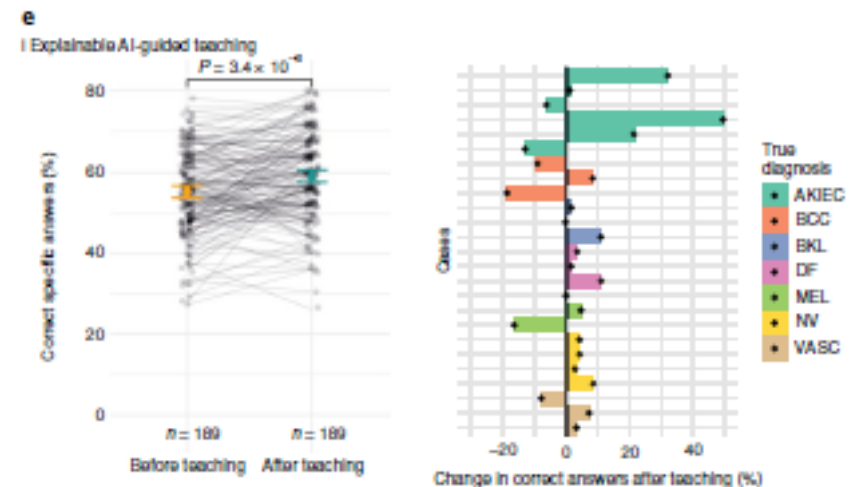
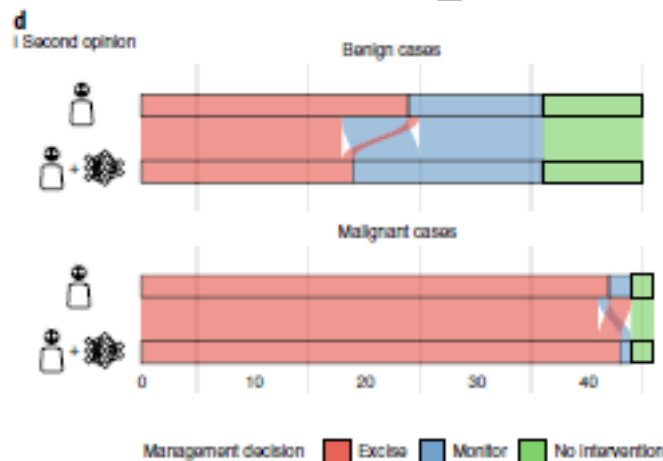
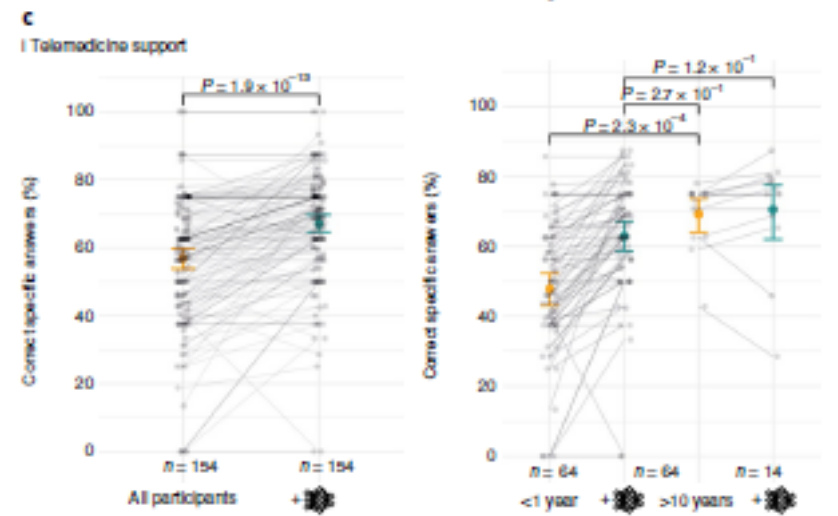
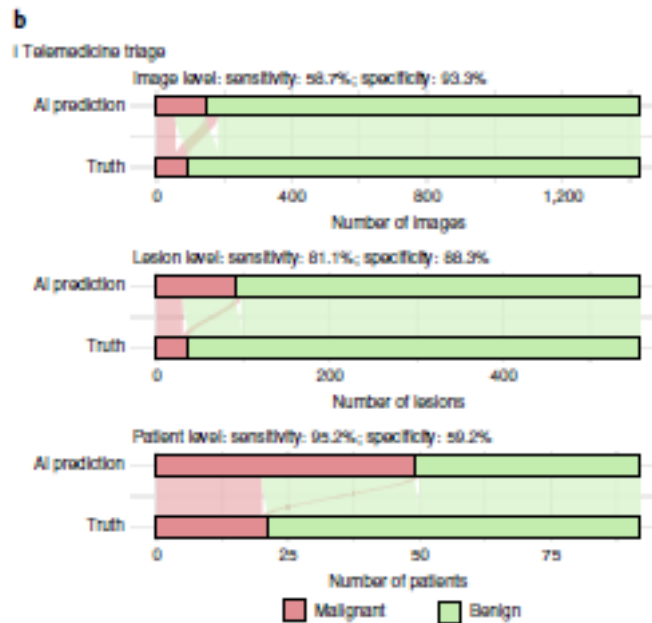
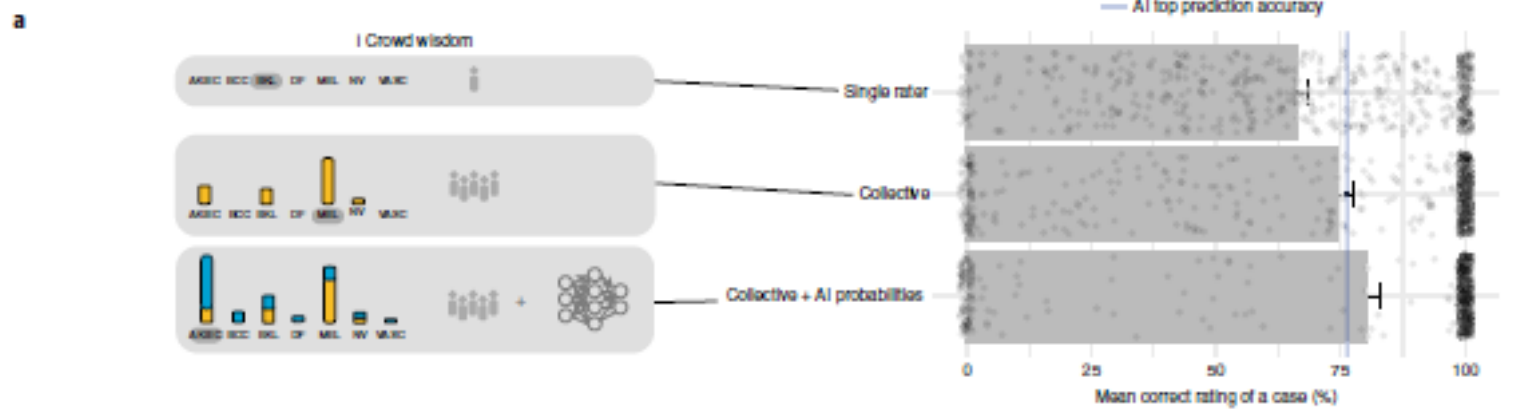


Accuracy of single rater vs collective vs collective + AI

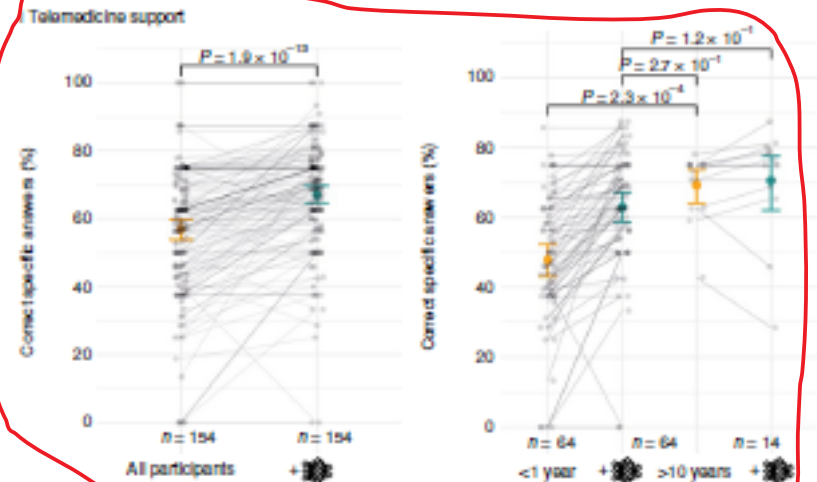
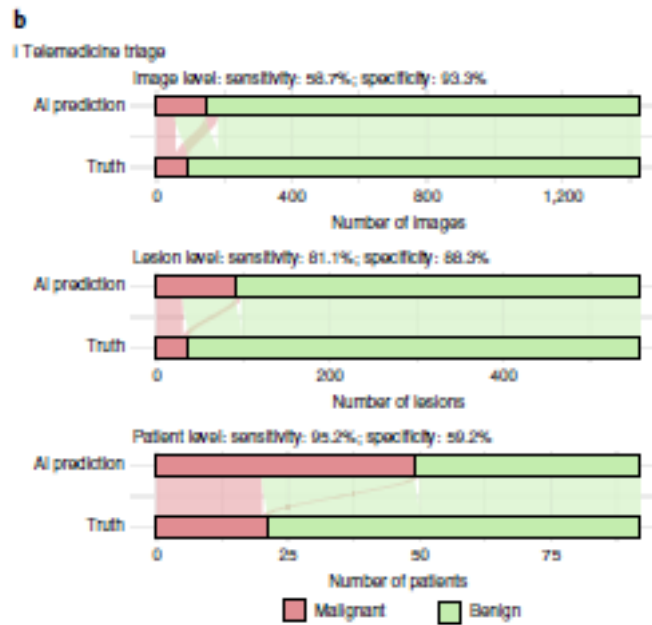
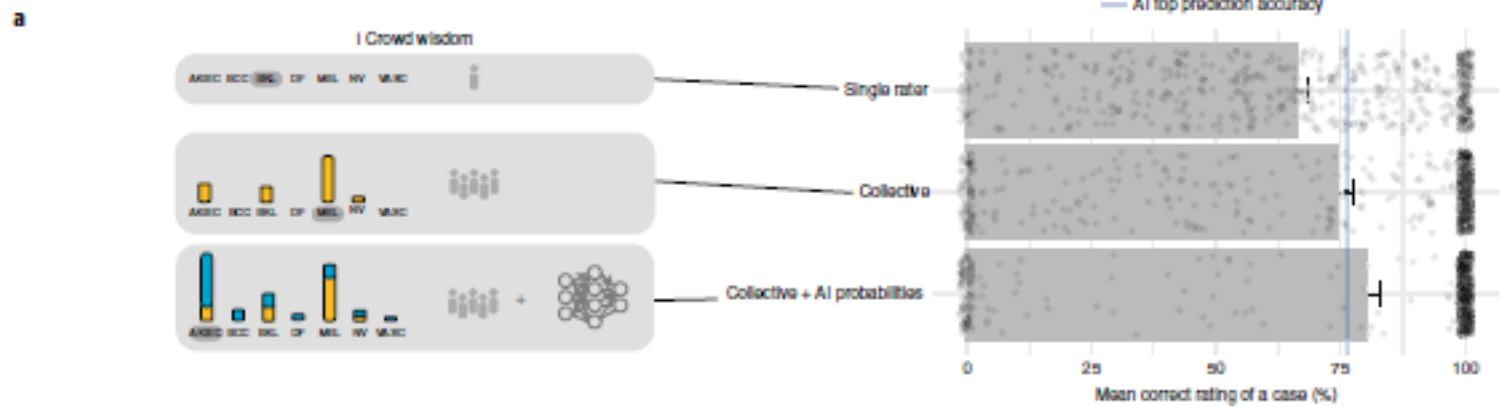




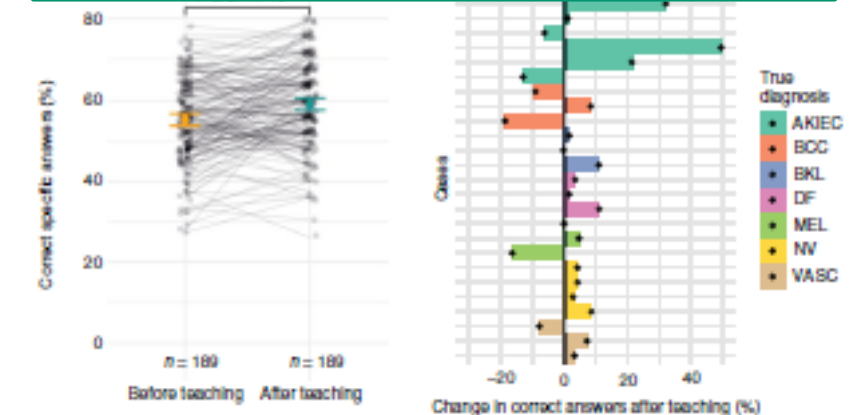
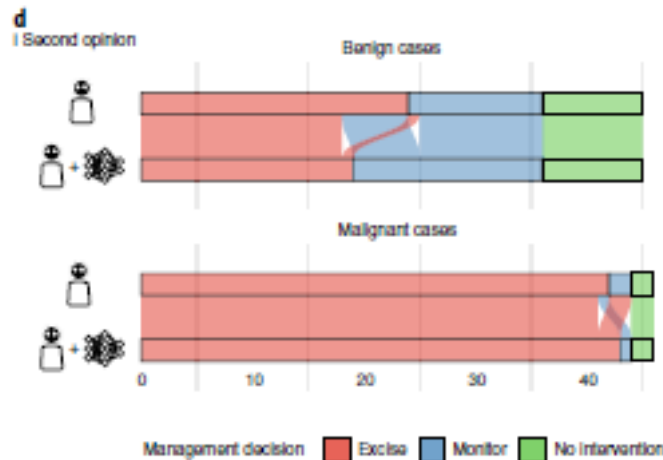
Performance of CNN predictions in a screening setting



Changes of raters decisions with AI based support in a telemedical setting with dermoscopic images



Switch of management decisions using CNN predictions as a second opinion



Good-quality AI-based support of clinical decision-making improves diagnostic accuracy over that of either AI or physicians alone

The least experienced clinicians gain the most from AI-based support. However they changed their opinion even if they were confident and right and AI was wrong

The net gain with respect to the frequency of correct diagnoses decreases with experience and confidence

AI-based multiclass probabilities outperformed content-based image retrieval (CBIR) representations of AI in the mobile technology environment

AI-based support has utility in simulations of second opinions and telemedicine triage

Faulty AI can mislead the entire spectrum of clinicians, including experts



Artificial intelligence and melanoma diagnosis:
ignoring human nature may lead to
false predictions

Aimilios Lallas¹, Giuseppe Argenziano²

AI does not work reliably on out-of distribution images

Faulty AI could result from the application of AI algorithms on examples beyond the domain of images on which the AI was trained or the more remote possibility of adversarial attacks

The optimal operating points to balance the potential benefits of AI based triage with the risks of filtering out patients with skin cancer remain to be determined

Improvement with not-pigmented lesions is needed