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Melanoma Detection with Uncertainty Quantification

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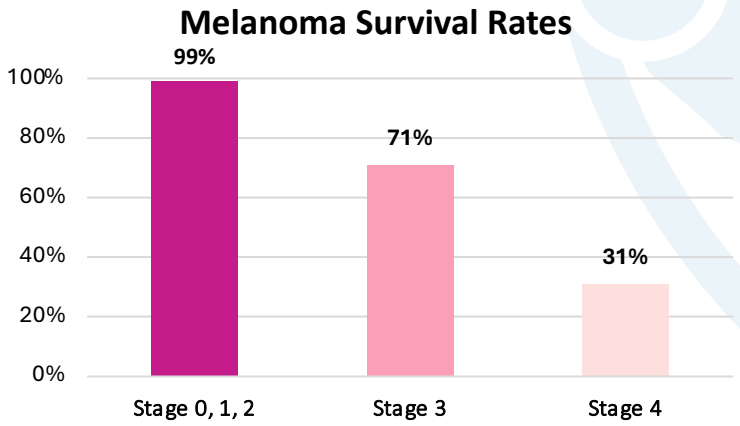
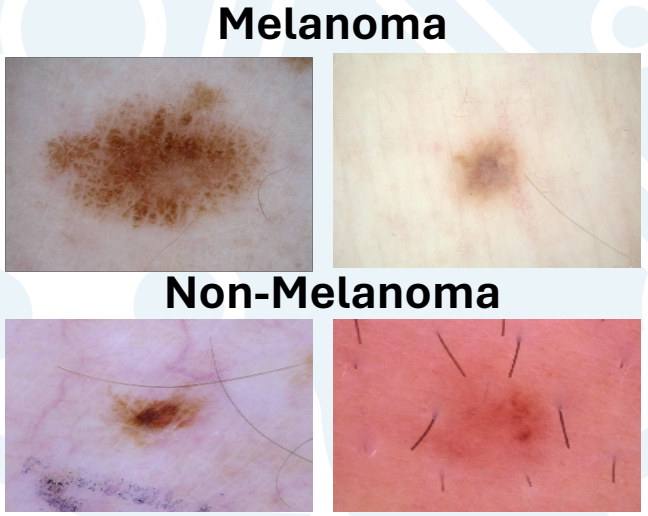
Importance of Early Detection

- Melanoma is the most aggressive skin cancer, causing 55,000 deaths annually[1].
- Early detection saves lives.
- Late detection increases mortality.
- Early detection is crucial as melanoma can mimic benign lesions.





[1]Schadendorf, D., et al. *Lancet*. 2018.

AI/ML in Melanoma Detection & Challenges

AI/ML improves diagnosis but has challenges:

- **No universal benchmark –** direct comparisons are challenging.
- **Lack of dataset combination studies –** limited data diversity.
- **Risk of misdiagnoses –** errors can occur.

DOG (0.97) CAT (0.99) DOG (0.87)

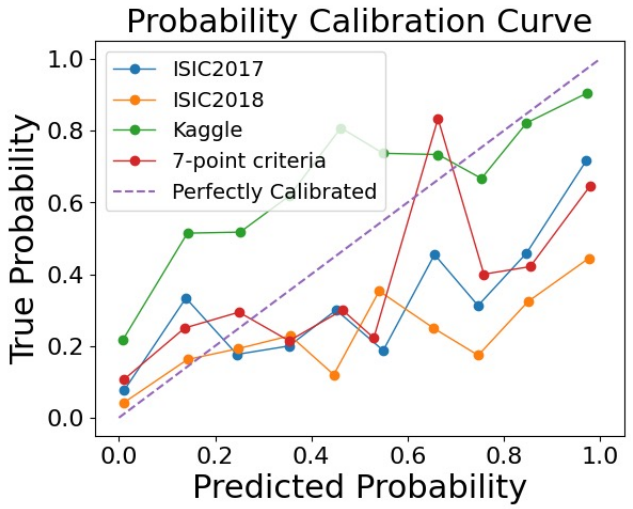
Our Method

- Combine up to 10 datasets for data diversity.
- Evaluate classification, calibration, and uncertainty.
  - 1000+ model comparison
- Reject unreliable diagnoses.

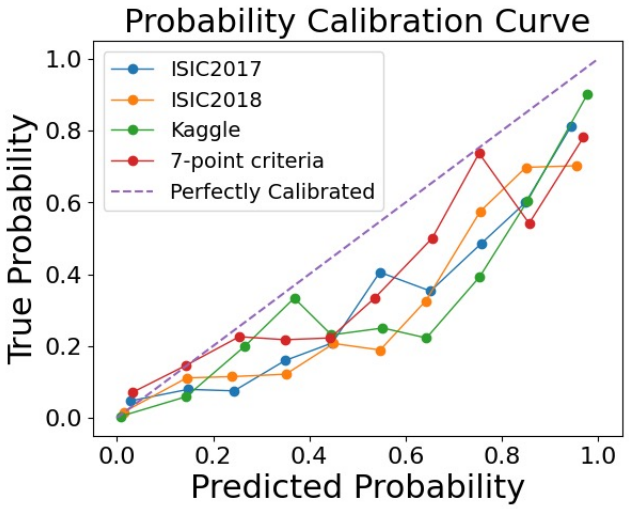
Data Combining

Data combination improves accuracy and calibration.

Single dataset



5-combined dataset



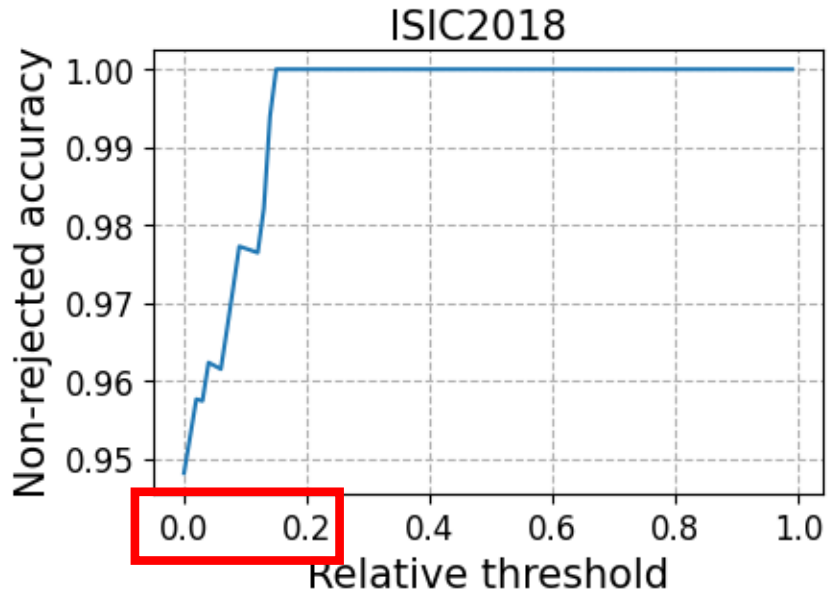
- 93.2% (5-combined dataset) Vs. 71.5% (single dataset) accuracy
  - **21.7%** improvement
- Better calibration: ↑ reliability, ↓ overconfidence.

"Some predictions still remain uncertain"

Uncertainty Evaluation & Rejection

Rejection Improves Accuracy.

- Shannon entropy[2] quantifies diagnosis uncertainty.
- Rejecting uncertain diagnoses improves accuracy.
- Find an optimal threshold (0-20%) from the best calibration[3,4] scores.

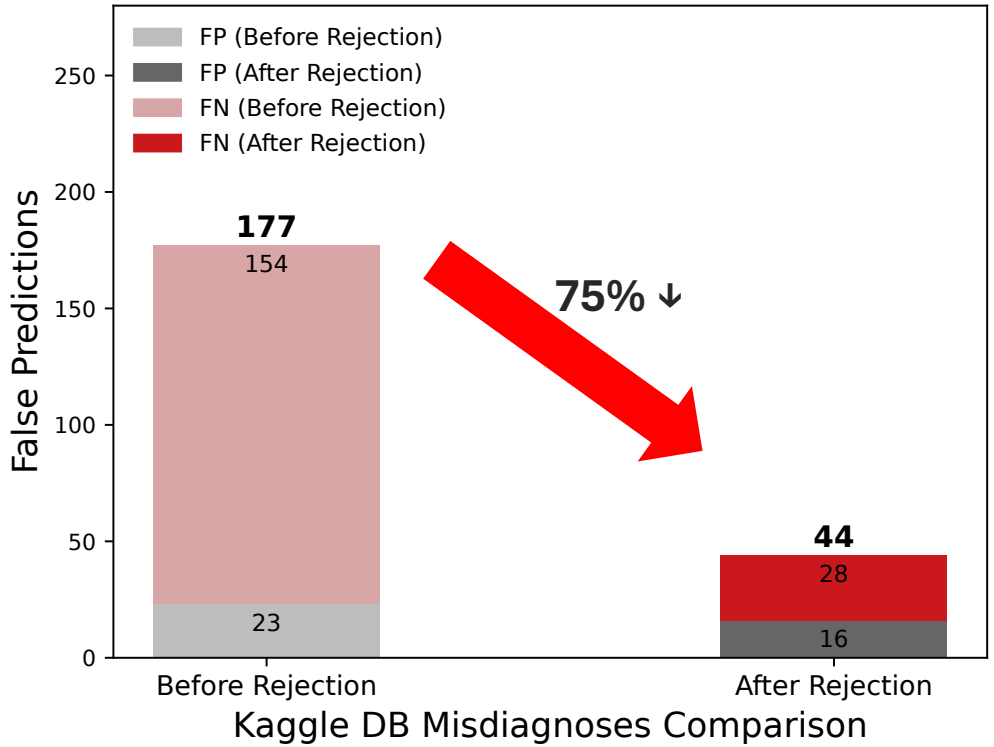


"How much does rejection reduce misdiagnoses?"

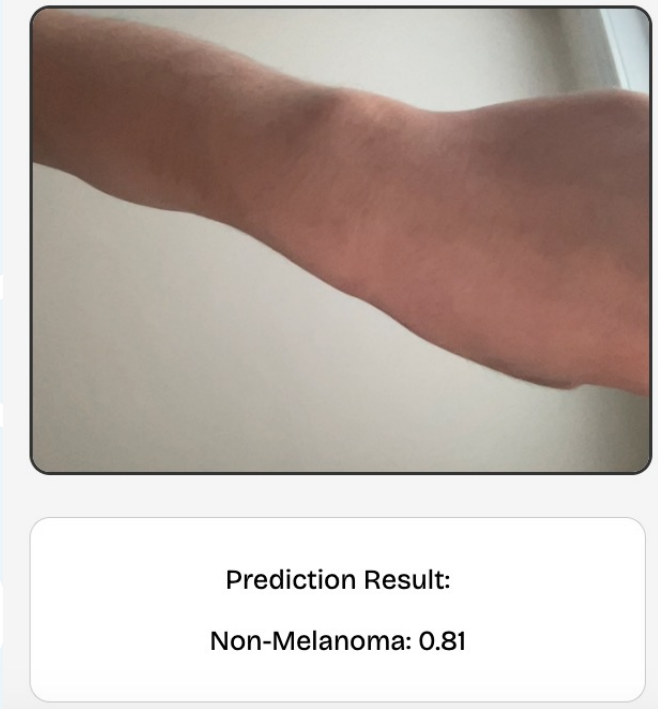
[2]Rudnicki, Łukasz. J. Russ. Laser Res. 2011. [3]Expected Calibration Error (ECE), C Guo, et al. PMLR. 20
[4]Brier, Glenn W. Mon. Weather Rev. 1950.

Misdiagnoses Reduction

- **40.5%** reduction across all benchmarks.
  - 593 to 240 (↓ 353 reduction).
  - 52% FPs, 48% FNs
- Kaggle benchmark benefits the most (**75% reduction**)



Web-based Melanoma Detector



- **https://mpsych.github.io/melanoma/**
  - Instant melanoma detection with a smartphone
  - We utilize our trained model for web deployment.

Try it!

Takeaways

- Combining datasets improves accuracy and calibration.
- Rejecting uncertain cases reduces misdiagnoses.
- Deeper networks (e.g., ResNet152) and Kaggle benchmark benefit the most from rejection.

Our work is open source.

- Actively seeking internship opportunities - Let’s connect!

GitHub

Code

Website

Author

Melanoma Detector

Try it!

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