SkinCON: Towards consensus for the uncertainty of skin cancer sub-typing through distribution regularized adaptive predictive sets (DRAPS)

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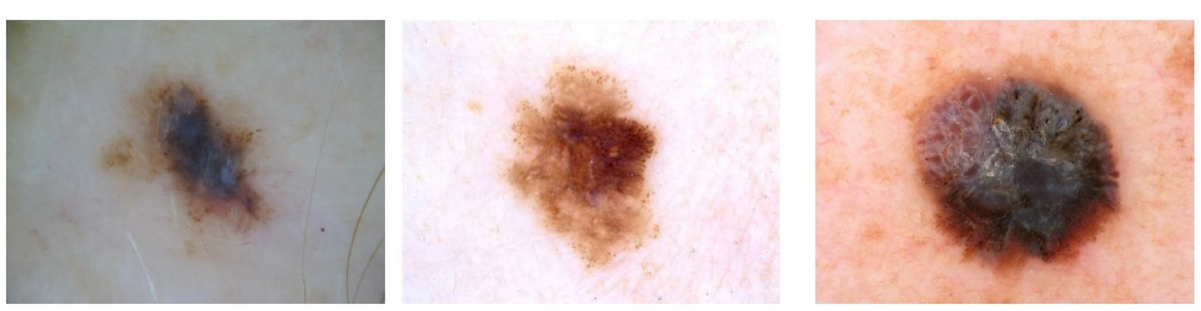
Argmax Prediction is not Reliable for Diagnosis



Prediction with **uncertainty estimation** provides more diagnostic indication!

Contribution

- We collect and curate the **first** multi-label skin cancer dataset **SkinCon** that reveals **instance-level empirical response distribution**.
- We propose a novel method **Distribution Regularized Adaptive Prediction Sets, DRAPS**, satisfying the coverage rate and achieving state-of-the-art conformal set size.

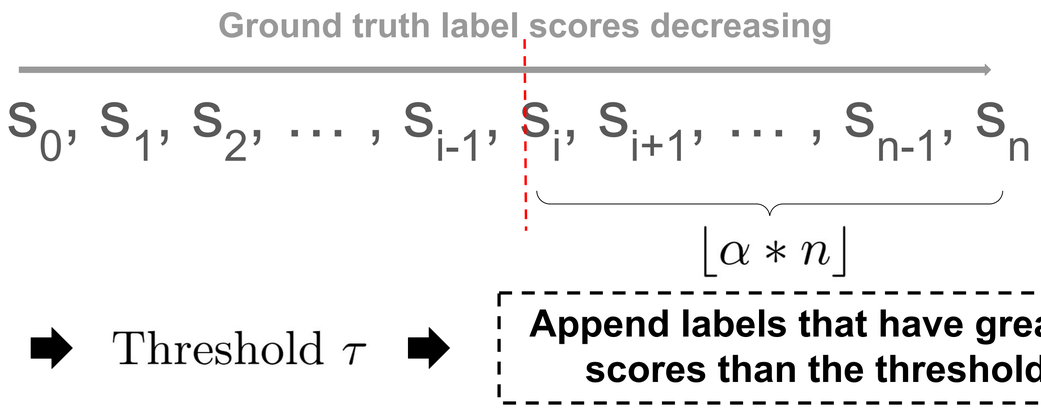
Prediction Set for Uncertainty Estimation

Imagine we have *n* data samples $\{(X_i, Y_i)\}_{i=1}^{n}$, and a discrete label Y_i. Given such data and a desired coverage level $1-\alpha \in (0,1)$,we seek to construct a prediction set $\hat{C}_{n,\alpha}$ for the unseen label of a new data point (X_{n+1}, Y_{n+1}) achieving marginal coverage; that is, obeying

$$\mathbb{P}[Y_{n+1} \in \hat{C}_{n,\alpha}(X_{n+1})] \geq 1-\alpha$$

Distribution Regularized Adaptive Predictive Sets (DRAPS)

Base model is trained with additional KL divergence loss via SkinCON empirical response distribution data.

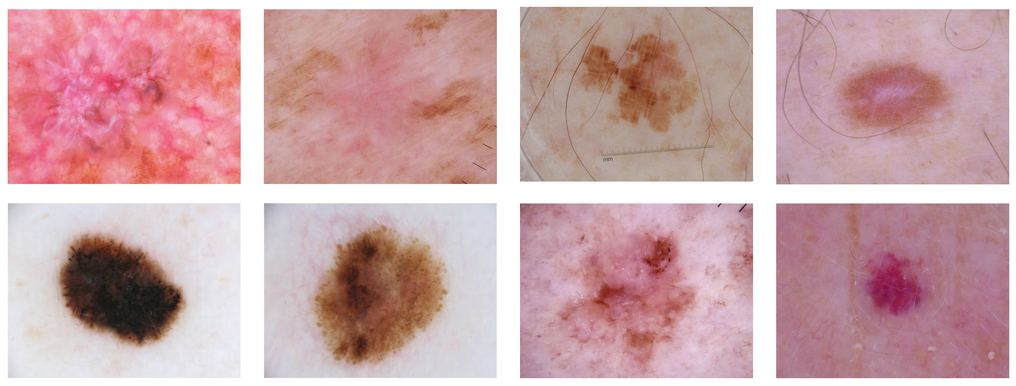


DRAPS Performance

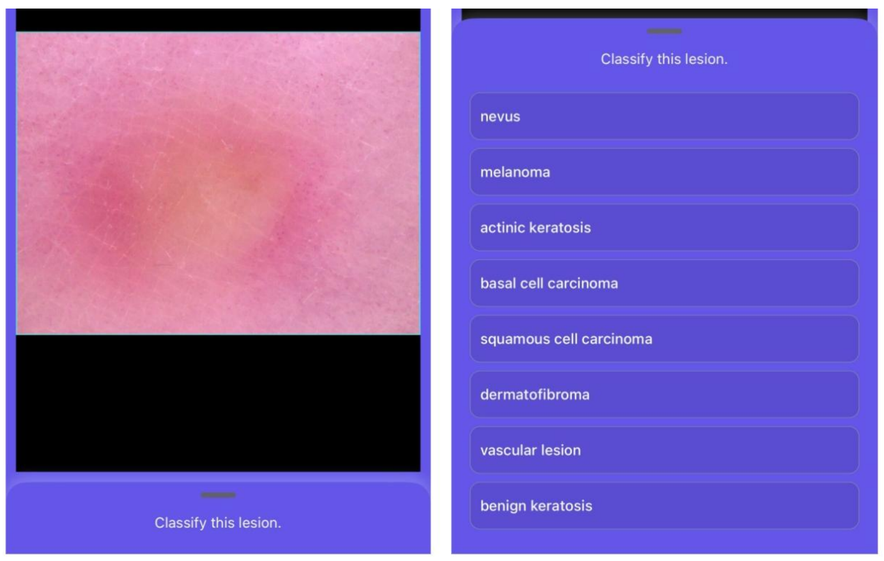
Model	Accuracy		Coverage			Size		
	Top-1	Top-5	Naive	RAPS	Ours	Naive	RAPS	Ours
ResNet18	91.62	99.94	0.928	0.964	0.935	1.278	1.183	**1.054**
ResNet50	92.07	100.0	0.935	0.967	0.941	1.165	1.192	**1.104**
ResNet101	93.02	100.0	0.947	0.961	0.931	1.367	1.163	**1.047**
ResNet152	91.50	99.94	0.934	0.961	0.936	1.241	1.167	**1.021**
ResNeXt101	92.77	99.87	0.938	0.972	0.941	1.050	1.179	**1.006**
VGG16	91.52	99.87	0.927	0.961	0.924	1.056	1.213	**1.008**
ShuffeNet	89.85	99.56	0.923	0.968	0.926	1.241	1.414	**1.154**
DenseNet161	92.83	99.94	0.941	0.971	0.936	1.141	1.146	**1.034**

SkinCON Dataset

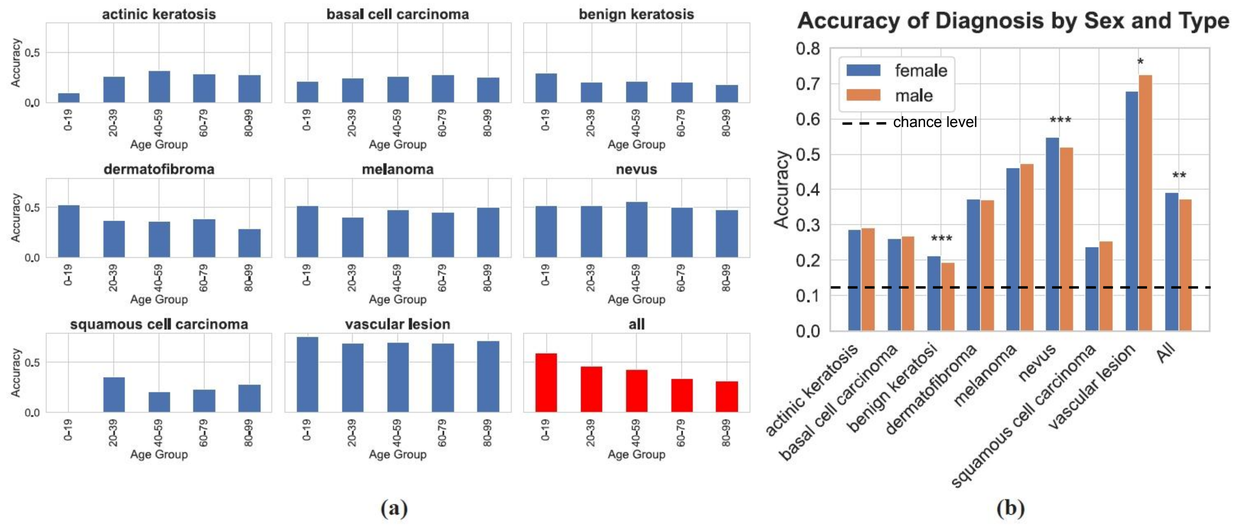
- **25,330** skin cancer images from the ISIC 2019 challenge dataset
- **937,167** diagnostic trials from **10,509** proficient participants
- **8** skin cancer types include: actinic keratosis, basal cell carcinoma, benign keratosis, dermatofibroma, melanoma, nevus, squamous cell carcinoma, and vascular lesion.
- An instance-level empirical response distribution dataset



Diagnosis Annotation UI



Diagnostic Biases over Age, Sex, and Lesion Type



Diverse Response Distributions in SkinCON Dataset