A Multi-task Framework for Skin Lesion Detection and Segmentation

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Skin cancer

- Malignant melanoma is by far the most deadly form of skin cancer
  - → 5 million death cases occurring annually [1]
- Survival rates improve to over 95%, following **early detection** and **diagnosis** of melanomas
- **Dermoscopy:** non-invasive imaging techniques
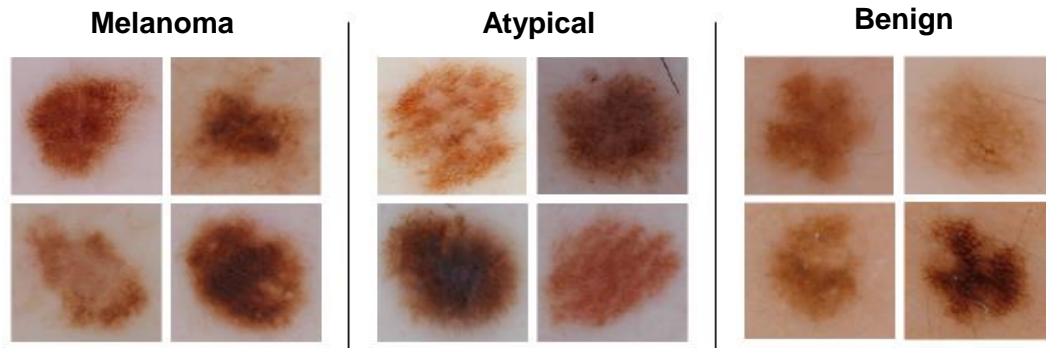 - → Detailed view of the morphological structures and patterns

Melanoma	Atypical	Benign

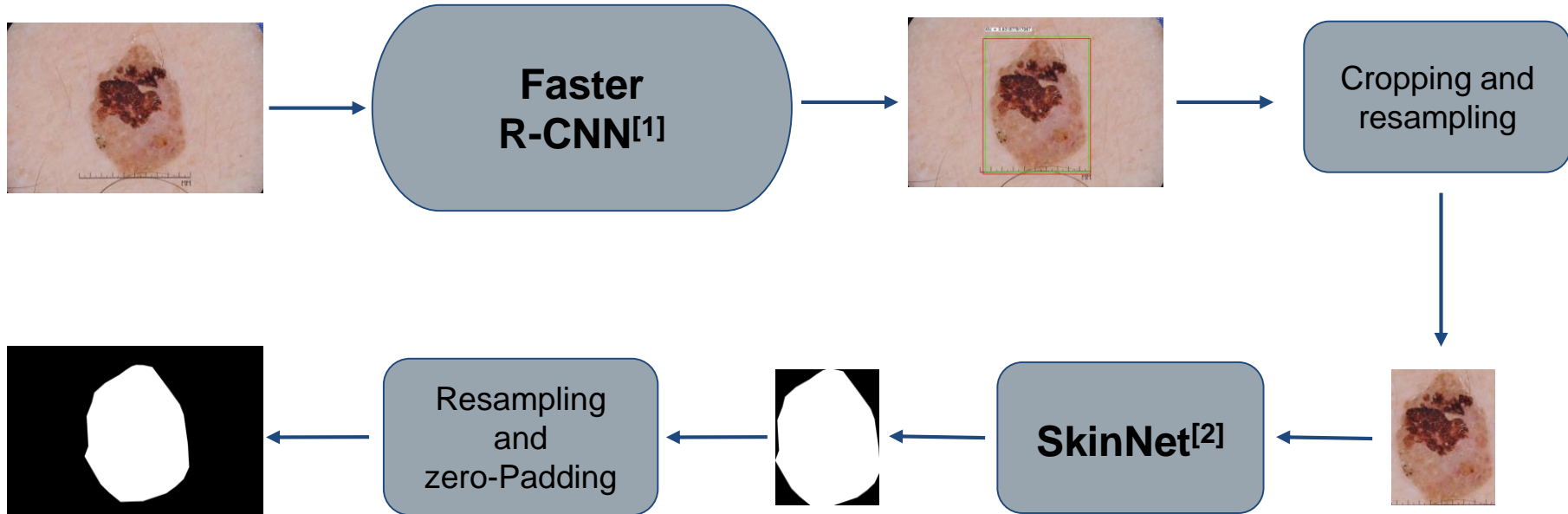Figure: Different types of Skin Cancer (ISIC 2017 Dataset)

[1] Hansen et al. 2015

Motivation

- Fully automatic computer-aided-diagnosis system
    - → Accurately localize and segment the lesion prior sub-type classification
- Dermoscopy images have a high variation in terms of lesion and image sizes
    - → Loss of information due to downsampling
    - → Manual cropping has low precision
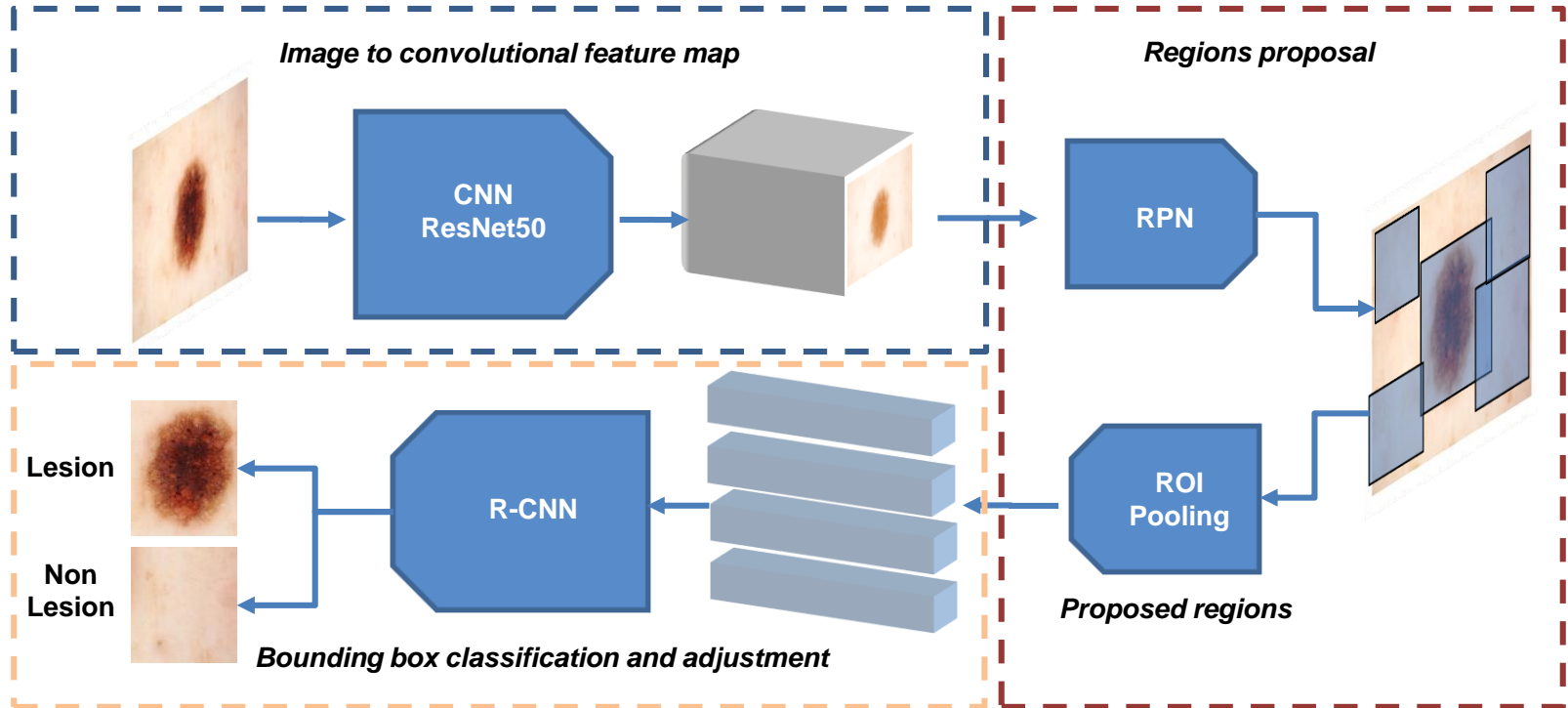   - → High similarity between the lesion and skin tissues result to false diagnosis

Pipeline overview

[1] Ren et al. NIPS 2015.
[2] Vesal et al. Arxiv 2018.

Lesion Detection: Faster R-CNN[1]

Image to convolutional feature map

CNN ResNet50

Regions proposal

RPN

Proposed regions

ROI Pooling

R-CNN

Lesion

Non Lesion

Bounding box classification and adjustment
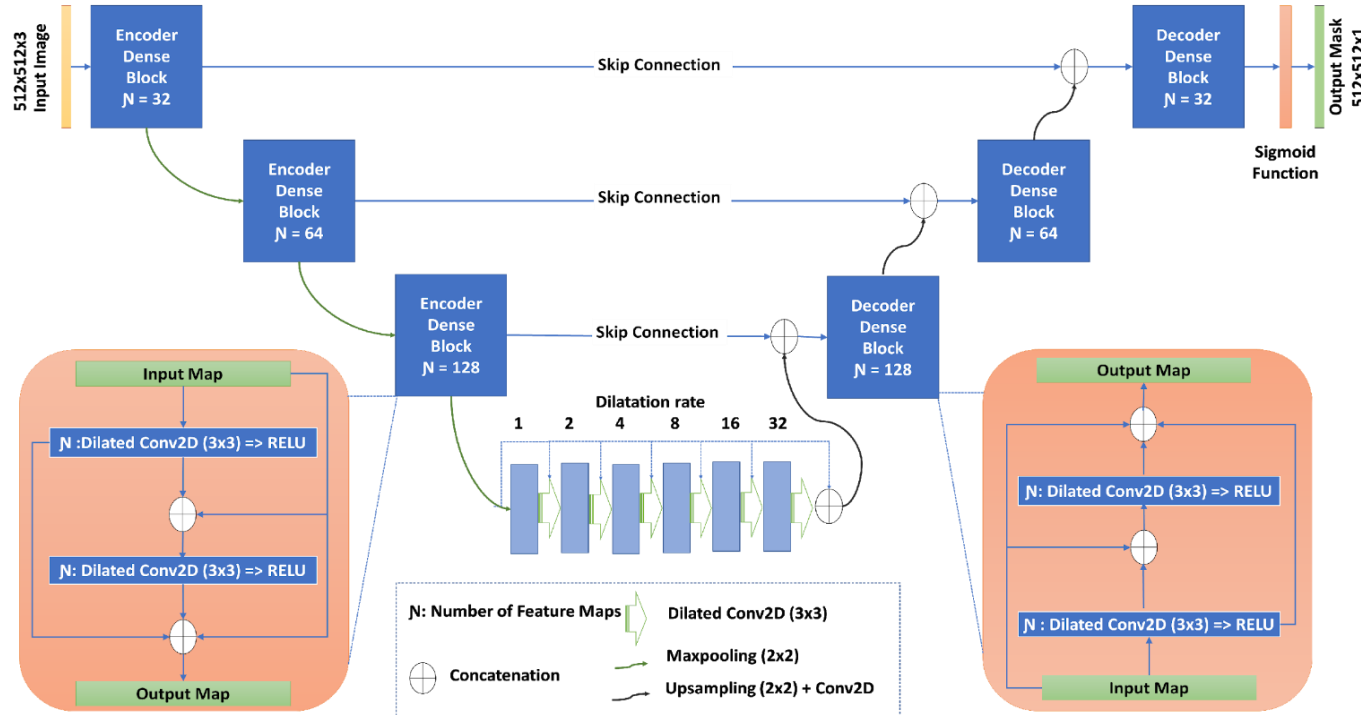
[1] Ren et al. NIPS 2015.

Detected lesions
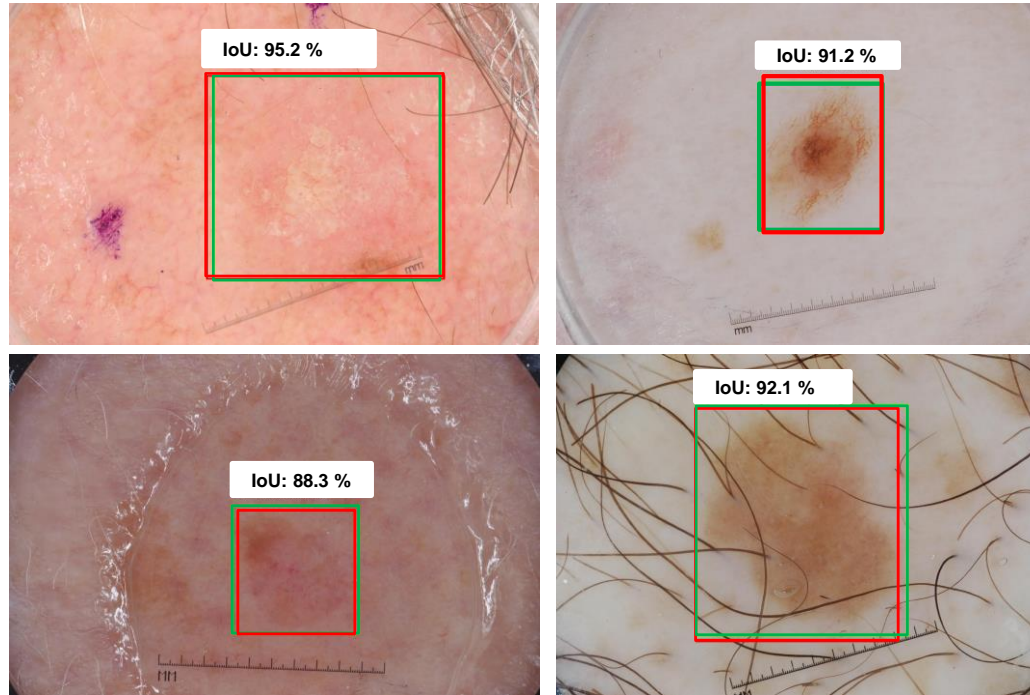
Ground Truth   **Predicted Bounding Box**

Lesion segmentation: SkinNet

[1] Vesal et al. Arxiv 2018.

Loss functions

- **Faster R-CNN**
    - RPN : MSE + Binary Cross Entropy
    - Bounding Box Regression and Classification : MSE + Binary Cross Entropy
- **SkinNet**
    - Dice Coefficient Loss

- **Training parameters:**
    - Optimizer → Adam
    - Learning rate → 0.0001
    - Batch size → 12
    - Epochs → 25

Datasets

Dataset	Training Data	Validation Data	Test Data	Total
ISBI 2017[1]	2000	150	600	2750
PH2[2]	-	-	200	200

- **Cross Validation**:

Training Data	**Validation Data**	**Testing Data**

5 Fold-Cross Validation

[1] N C. F. Codella et al. ISBI 2018.
[2] T. Mendonça et al. EBMC 2013.

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Results: Quantitative

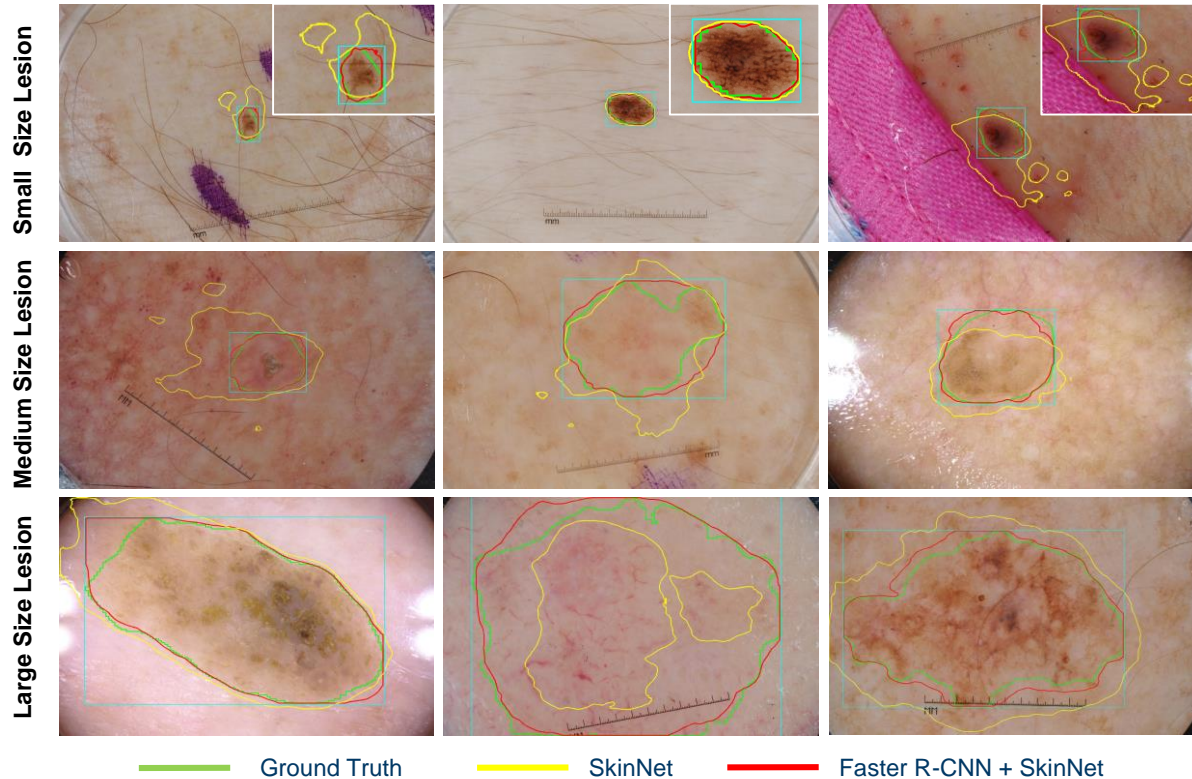| Datasets	Methods		Accuracy		Dice		Jaccard
ISBI2017	Yuan et. al. [1]		0.934		0.849		0.765
	SLSDeep [2]		0.936		0.878		0.782
	NCARG [3]		0.953		0.904		0.832
	FrCN [4]		0.956		0.896		0.813
	SkinNet		0.932		0.851		0.767
	FRCNN + SkinNet	1.0 %	**0.968**	3.4 %	**0.934**	4.8 %	**0.880**
PH2	FrCN [4]		0.952		0.914		0.841
	FRCNN + SkinNet		**0.964**		**0.946**		**0.899**

[1] Yuan et al. ISBI 2018.
[2] Sarkar et al. MICCAI 2018.
[3] Guo et al. 2018.
[4] Al-Masani et al. CMPB 2018.

Results: Qualitative

Small Size Lesion / Medium Size Lesion / Large Size Lesion

Ground Truth   SkinNet   Faster R-CNN + SkinNet

Summary and outlook

- **Conclusion:**
    - We propose a joint localization and segmentation approach for dermoscopy images
        - ➢ Significantly **outperformed** the state-of-the-art (**at the time of submission** for ISIC 2017 dataset)
    - Faster R-CNN achieved an accuracy of **94.0%** at **0.9** IoU threshold**.**
    - Detected bounding boxes prevent SkinNet from **over segmentation**

- **Outlook:**
    - Evaluating the network on **diverse dataset**
    - Elastic and adversarial data augmentation

Thank you for your attention!!!