Mirikharaji et al., "A Survey on Deep Learning for Skin Lesion Segmentation", 2023				**Highlight:** Multiple datasets evaluated		**Highlight:** Multiple losses used	**Highlight:** Converted from reported Dice	**Highlight:** Performs CDE		**Highlight:** Uses post-processing	**Highlight:** Code released
Index	**Paper Title**	**Year**	**Venue**	**Datasets**	**Architectural Modules**	**Loss Function**	**Performance (Jaccard)**	**Cross-data Evaluation**	**Augmentation**	**Post-processing**	**Code Provided**
1	Jafari et al., Skin lesion segmentation in clinical images using deep learning	2016	peer-reviewed con	DermQuest	image pyramid	-	-	✗	-	✓	✗
2	He et al., Skin lesion segmentation via deep RefineNet	2017	peer-reviewed con	ISIC2016, *ISIC2017*	residual con., skip con., image pyramid	Dice, CE, DS	75.80%	✗	rotation	✓	✗
3	Bozorgtabar et al., Skin lesion segmentation using deep convolution networks guided by local	2017	peer-reviewed con	ISIC2016	-	-	80.60%	✗	rotation	✗	✗
4	Ramachandram and Taylor, Skin lesion segmentation using deep hypercolumn descriptors	2017	peer-reviewed jou	ISIC2017	-	CE	79.20%	✗	rotation, flipping, color jittering	✗	✗
5	Yu et al., Automated melanoma recognition in dermoscopy images via very deep residual netw	2017	peer-reviewed jou	ISIC2016	skip con., residual con.	-	82.90%	✗	rotation, translation, random noise, cropping	✗	✓
6	Bi et al., Dermoscopic image segmentation via multistage fully convolutional networks	2017	peer-reviewed jou	*ISIC2016*, PH2	-	CE	84.64%	✓	flipping, cropping	f	✗
7	Jafari et al., Extraction of skin lesions from non-dermoscopic images for surgical excision of m	2017	peer-reviewed jou	DermQuest	image pyramid	-	-	✗	-	✓	✗
8	Yuan et al., Automatic skin lesion segmentation using deep fully convolutional networks with ja	2017	peer-reviewed jou	*ISIC2016*, PH2	-	Tanimoto	84.70%	✓	flipping, rotation, scaling, shifting, contrast n	✓	✗
9	Ramachandram and DeVries, LesionSeg: semantic segmentation of skin lesions using deep c	2017	non peer-reviewed	ISIC2017	dilated conv.	CE	64.20%	✗	rotation, flipping	✓	✗
10	Bozorgtabar et al., Investigating deep side layers for skin lesion segmentation	2017	peer-reviewed con	ISIC2016	-	CE	82.90%	✗	rotations	✓	✗
11	Bi et al., Semi-automatic skin lesion segmentation via fully convolutional networks	2017	peer-reviewed con	ISIC2016	parallel m. s.	-	86.36%	✗	crops, flipping	✓	✗
12	Attia et al., Skin melanoma segmentation using recurrent and convolutional neural networks	2017	peer-reviewed con	ISIC2016	recurrent net.	-	93.00%	✗	-	✗	✗
13	Deng et al., Segmentation of dermoscopy images based on fully convolutional neural network	2017	peer-reviewed con	ISIC2016	parallel m. s.	-	84.10%	✗	-	✗	✗
14	Mishra and Daescu, Deep learning for skin lesion segmentation	2017	peer-reviewed con	ISIC2017	skip con.	Dice	84.20%	✗	rotation, flipping	✓	✗
15	Goyal et al., Multi-class semantic segmentation of skin lesions via fully convolutional networks	2017	peer-reviewed con	ISIC2017	-	CE, Dice	-	✗	-	✗	✗
16	Vesal et al., A multi-task framework for skin lesion detection and segmentation	2018	peer-reviewed con	*ISIC2017*, PH2	dilated conv., dense con., skip con.	Dice	88.00%	✓	-	✗	✗
17	Venkatesh et al., A deep residual architecture for skin lesion segmentation	2018	peer-reviewed con	ISIC2017	residual con., skip con.	Jaccard	76.40%	✗	rotation, flipping, translation, scaling	✓	✗
18	Yang et al., Skin lesion analysis by multi-target deep neural networks	2018	non peer-reviewed	ISIC2017	skip con., parallel m.s. conv.	-	74.10%	✗	rotation, flipping	✗	✗
19	Sarker et al., SLSDeep: Skin lesion segmentation based on dilated residual and pyramid pooli	2018	peer-reviewed con	ISIC2016, *ISIC2017*	skip con., residual con., dilated conv., pyramid pooli	CE, EPE	78.20%	✗	rotation, scaling	✗	✓
20	Al-Masni et al., Skin lesion segmentation in dermoscopy images via deep full resolution convo	2018	peer-reviewed jou	*ISIC2017*, PH2	-	CE	77.10%	✓	rotation	✗	✗
21	Li et al., Deeply supervised rotation equivariant network for lesion segmentation in dermoscop	2018	peer-reviewed con	ISIC2017	skip con., residual con.	DS	77.23%	✗	flipping, rotation	✗	✓
22	Zeng and Zheng, Multi-scale fully convolutional DenseNets for automated skin lesion segment	2018	peer-reviewed con	ISIC2017	dense con., skip con., image pyramid	CE, L2, DS	78.50%	✗	flipping, rotation	✓	✗
23	DeVries and Taylor, Leveraging uncertainty estimates for predicting segmentation quality	2018	non peer-reviewed	ISIC2017	skip con.	CE	73.00%	✗	flipping, rotation	✗	✗
24	Izadi et al., Generative adversarial networks to segment skin lesions	2018	peer-reviewed con	DermoFit	skip con.	CE, ADV	81.20%	✗	flipping, rotation, elastic deformation	✗	✓
25	Li et al., Dense deconvolutional network for skin lesion segmentation	2018	peer-reviewed jou	ISIC2016, *ISIC2017*	skip con., residual con., dense con.	Jaccard, DS	76.50%	✗	-	✗	✗
26	Mirikharaji and Hamarneh, Star shape prior in fully convolutional networks for skin lesion segm	2018	peer-reviewed con	ISIC2017	residual con.	CE, Star shape	77.30%	✗	-	✗	✗
27	Pollastri et al., Improving skin lesion segmentation with generative adversarial networks	2018	peer-reviewed con	ISIC2017	-	Jaccard, L1	78.10%	✗	GAN	✓	✗
28	Vesal et al., SkinNet: A deep learning framework for skin lesion segmentation	2018	abstract	ISIC2017	dilated conv., dense con., skip con.	Dice	76.67%	✗	rotation, flipping, translation, scaling, color sl	✗	✗
29	Chen et al., A multi-task framework with feature passing module for skin lesion classification a	2018	peer-reviewed con	ISIC2017	residual con., dilated conv., parallel m.s. conv.	WCE	78.70%	✗	rotation, flipping, cropping, zooming, Gaussi	✓	✗
30	Jahanifar et al., Segmentation of skin lesions and their attributes using multi-scale convolution	2018	non peer-reviewed	ISIC2016, *ISIC2017*, ISIC2018	skip con., pyramid pooling, parallel m.s. conv.	Tanimoto	80.60%	✓	flipping, rotation, zooming, translation, shear	✓	✗
31	Mirikharaji et al., Deep auto-context fully convolutional neural network for skin lesion segmenta	2018	peer-reviewed con	ISIC2016	skip con.	CE	83.30%	✗	flipping, rottaion	✗	✗
32	Bi et al., Improving automatic skin lesion segmentation using adversarial learning based data a	2018	non peer-reviewed	ISIC2018	residual con.	CE	83.12%	✗	GAN	✗	✗
33	He et al., Dense deconvolution net: Multi path fusion and dense deconvolution for high resolut	2018	peer-reviewed jou	ISIC2016, *ISIC2017*	skip con., residual con., image pyramid	CE, Dice, DS	76.10%	✗	rotation	✓	✗
34	Xue et al., Adversarial learning with multi-scale loss for skin lesion segmentation	2018	peer-reviewed con	ISIC2017	skip con., residual con., global conv., GAN	L1, DS, ADV	78.50%	✗	cropping, color jittering	✗	✗
35	Ebenezer and Rajapakse, Automatic segmentation of skin lesions using deep learning	2018	non peer-reviewed	ISIC 2018	skip con.	Dice	75.60%	✗	rotation, flipping, zooming	✓	✓
36	Goyal et al., Skin Lesion Segmentation in Dermoscopic Images with Ensemble Deep Learning	2019	peer-reviewed jou	*ISIC2017*, PH2	dilated conv., parallel m.s. conv., separable conv.	-	79.34%	✓	-	✓	✗
37	Azad et al., Bi-Directional ConvLSTM U-Net with Densley Connected Convolutions	2019	peer-reviewed con	ISIC2018	skip con., dense con., recurrent CNN	CE	74.00%	✗	-	✗	✓
38	Alom et al., Recurrent residual U-Net for medical image segmentation	2019	peer-reviewed jou	ISIC2017	skip con., residual con., recurrent CNN	CE	75.68%	✗	-	✗	✗
39	Yuan and Lo, Improving Dermoscopic Image Segmentation with Enhanced Convolutional-Dec	2019	peer-reviewed jou	ISIC2017	-	Tanimoto	76.50%	✗	rotation, flipping, shifting, scaling, random nc	✓	✗
40	Goyal et al., Skin lesion boundary segmentation with fully automated deep extreme cut metho	2019	peer-reviewed con	*ISIC2017*, PH2	dilated conv., parallel m.s. conv.	WCE	82.20%	✓	-	✗	✗
41	Bi et al., Step-wise integration of deep class-specific learning for dermoscopic image segment	2019	peer-reviewed jou	ISIC2016, *ISIC2017*, PH2	skip con., residual con.,	CE	77.73%	✓	flipping, cropping	✓	✗
42	Tschandl et al., Domain-specific classification-pretrained fully convolutional network encoders	2019	peer-reviewed jou	ISIC2017	skip con.	CE, Jaccard	76.80%	✗	flipping, rotation	✓	✗
43	Li et al., Transformation-consistent self-ensembling model for semi-supervised medical image	2021	peer-reviewed jou	ISIC2017	skip con., dense con., semi-supervised, ensemble	CE, L1	79.80%	✗	flipping, rotating, scaling	✓	✗
44	Zhang et al., Automatic skin lesion segmentation by coupling deep fully convolutional networks	2019	peer-reviewed jou	ISIC2016, *ISIC2017*	skip con.	CE	72.94%	✗	-	✗	✗
45	Baghersalimi et al., DermoNet: densely linked convolutional neural network for efficient skin le	2019	peer-reviewed jou	ISIC2016, *ISIC2017*, PH2	skip con., residual con., dense con.	Tanimoto	78.30%	✓	flipping, cropping	✗	✗
46	Jiang et al., Decision-Augmented Generative Adversarial Network for Skin Lesion Segmentatic	2019	peer-reviewed con	ISIC2017	residual con., dilated conv., GAN	ADV, L2	76.90%	✗	rotation, flipping	✗	✗
47	Tang et al., A multi-stage framework with context information fusion structure for skin lesion se	2019	peer-reviewed con	ISIC2016	skip con.	Tanimoto, DS	85.34%	✗	rotation, flipping	✗	✗
48	Bi et al., Improving Skin Lesion Segmentation via Stacked Adversarial Learning	2019	peer-reviewed con	ISIC2017	residual con.	CE	77.14%	✗	GAN	✗	✗
49	Abraham and Khan, A novel focal tversky loss function with improved attention U-Net for lesioi	2019	peer-reviewed con	ISIC2018	skip con., image pyramid, attention	TV, Focal	74.80%	✗	-	✗	✓
50	Cui et al., Ensemble Transductive Learning for Skin Lesion Segmentation	2019	peer-reviewed con	ISIC2018	dilated conv., parallel m.s. conv., separable conv.	-	83.00%	✗	-	✗	✗
51	Song et al., Dense-Residual Attention Network for Skin Lesion Segmentation	2019	peer-reviewed con	ISIC2017	skip con., residual con., dense con., attention mod.	CE, Jaccard	76.50%	✗	-	✗	✗
52	Singh et al., FCA-Net: Adversarial Learning for Skin Lesion Segmentation Based on Multi-Sca	2019	peer-reviewed jou	ISIC2016, *ISIC2017*, ISIC2018	skip con., residual con., factorized conv., attention n	CE, L1, EPE	78.65%	✗	-	✗	✓
53	Tan et al., Evolving ensemble models for image segmentation using enhanced particle swarm	2019	peer-reviewed jou	*ISIC2017*, DermoFit, PH2	dilated conv.	Dice	62.29%*	✓	-	✓	✗
54	Kaul et al., FocusNet: an attention-based fully convolutional network for medical image segme	2019	peer-reviewed con	ISIC2017	skip con., residual con., attention mod.	Dice	75.60%	✗	channel shift	✗	✗
55	De Angelo et al., Skin lesion segmentation using deep learning for images acquired from smar	2019	peer-reviewed con	*ISIC2017*, Private	skip con.	CE, Dice	76.07%	✗	flipping, shifting, rotation, color jittering	✓	✗
56	Zhang et al., DSM: A Deep Supervised Multi-Scale Network Learning for Skin Cancer Segmer	2019	peer-reviewed jou	*ISIC2017*, PH2	skip con., residual con., parallel m.s. conv.	CE, Dice, DS	78.50%	✓	flipping, rotation, whitening, contrast enhanc	✓	✗
57	Soudani and Barhoumi, An image-based segmentation recommender using crowdsourcing an	2019	peer-reviewed jou	ISIC2017	residual con.	CE	78.60%	✗	rotation, flipping	✗	✗
58	Mirikharaji et al., Learning to segment skin lesions from noisy annotations	2019	peer-reviewed con	ISIC2017	skip con.	WCE	68.91%*	✗	-	✗	✗
59	Nasr-Esfahani et al., Dense pooling layers in fully convolutional network for skin lesion segme	2019	peer-reviewed jou	DermQuest	dense con.,	WCE	85.20%	✗	rotation, flipping, cropping	✗	✗
60	Wang et al., Automated Segmentation of Skin Lesion Based on Pyramid Attention Network	2019	peer-reviewed con	*ISIC2017*, ISIC2018	skip con., residual con., parallel m.s. conv., attentio	WDice	77.60%	✗	copping, flipping	✗	✗
61	Sarker et al., MobileGAN: Skin Lesion Segmentation Using a Lightweight Generative Adversai	2019	non peer-reviewed	*ISIC2017*, ISIC2018	factrized conv., attention mod., GAN	CE, Jaccard, L1, ADV	77.98%	✗	flipping, gamma reconst., contrast adjust.	✗	✗
62	Tu et al., Dense-Residual Network With Adversarial Learning for Skin Lesion Segmentation	2019	peer-reviewed jou	*ISIC2017*, PH2	skip con., residual con., dense con., GAN	Jaccard, EPE, L1, DS, ADV	76.80%	✓	flipping	✗	✗
63	Wei et al., Attention-Based DenseUnet Network With Adversarial Training for Skin Lesion Segı	2019	peer-reviewed jou	ISIC2016, *ISIC2017*, PH2	skip con., residual con., attention mod., GAN	Jaccard, L1, ADV	80.45%	✓	rotation, flipping, color jittering	✗	✗
64	Ünver and Ayan, Skin lesion segmentation in dermoscopic images with combination of YOLO	2019	peer-reviewed jou	*ISIC2017*, PH2	-	L2	74.81%	✓	-	✓	✗
65	Al-masni et al., A Deep Learning Model Integrating FrCN and Residual Convolutional Network	2019	peer-reviewed con	ISIC2017	-	-	77.11%	✗	rotation, flipping	✗	✗
66	Canalini et al., Skin lesion segmentation ensemble with diverse training strategies	2019	peer-reviewed con	ISIC2017	dilated conv., parallel m.s. conv., separable conv.	CE, Tanimoto	85.00%	✗	rotating, flipping, shifting, shearing, scaling, (	✓	✗
67	Wang et al., Dermoscopic Image Segmentation Through the Enhanced High-Level Parsing an	2019	peer-reviewed con	ISIC2017	residual con.	WCE	78.10%	✗	flipping, scaling	✗	✗
68	Alom et al., Skin cancer segmentation and classification with improved deep convolutional neu	2020	peer-reviewed con	ISIC2018	skip con., residual con., recurrent CNN	CE	88.83%	✗	flipping	✗	✗
69	Pollastri et al., Augmenting Data with GANs to Segment Melanoma Skin Lesions	2020	peer-reviewed jou	ISIC2017	-	Tanimoto	78.90%	✗	GAN, flipping, rotation, shifting, scaling, colo	✗	✗
70	Liu et al., Skin Lesion Segmentation Based on Improved U-Net	2019	peer-reviewed con	ISIC2017	skip con., dilated conv.	CE	75.20%	✗	scaling, cropping, rotation, flipping, image de	✗	✗
71	Abhishek and Hamarneh, Mask2Lesion: Mask-constrained adversarial skin lesion image synth	2019	peer-reviewed con	*ISIC2017*, PH2	skip con.	-	68.69%*	✓	rotation, flipping, GAN	✗	✓
72	Shahin et al., Deep convolutional encoder-decoders with aggregated multi-resolution skip con	2019	peer-reviewed con	ISIC 2018	skip con., image pyramid	Generalized, Dice	73.80%	✗	rotation, flipping, zooming	✗	✗
73	Adegun and Viriri, An enhanced deep learning framework for skin lesions segmentation	2019	peer-reviewed con	ISIC2017	-	Dice	83.00%	✗	elastic	✗	✗
74	Taghanaki et al., Improved inference via deep input transfer	2019	peer-reviewed con	ISIC 2017	skip con.	Dice, L1, SSIM	69.35%*	✗	rotation, flipping, gradient-based, perturbatic	✗	✗
75	Saini et al., Detector-SegMentor Network for Skin Lesion Localization and Segmentation	2019	peer-reviewed con	*ISIC 2017*, ISIC 2018, PH2	skip con., multi-task	Dice	84.90%	✗	rotation, flipping, shearing, stretch, crop, cor	✗	✗
76	Wang et al., Bi-directional dermoscopic feature learning and multi-scale consistent decision fu	2019	peer-reviewed jou	ISIC2016, *ISIC2017*	skip con., residual con., dilated conv.	WCE	81.47%	✗	flipping, scaling	✗	✗
77	Kamalakannan et al., Self-Learning AI Framework for Skin Lesion Image Segmentation and C	2019	peer-reviewed jou	ISIC Archive	skip con.	CE	-	✗	-	✗	✗
78	Hasan et al., DSNet: Automatic dermoscopic skin lesion segmentation	2020	peer-reviewed jou	*ISIC2017*, PH2	skip con., dense con., separable conv.	CE, Jaccard	77.50%	✓	rotation, zooming, shifting, flipping	✗	✓
79	Al Nazi and Abir, Automatic Skin Lesion Segmentation and Melanoma Detection: Transfer Lea	2020	peer-reviewed con	*ISIC2018*, PH2	skip con.	Dice	80.00%	✓	rotation, zooming, flipping, elastic dist., Gaus	✗	✓
80	Deng et al., Weakly and Semi-supervised Deep Level Set Network for Automated Skin Lesion	2020	peer-reviewed con	*ISIC2017*, PH2	dilated conv., parallel m.s. conv., separable conv., s	Dice, Narrowband suppression	83.90%	✓	rotation	✓	✗
81	Xie et al., A Mutual Bootstrapping Model for Automated Skin Lesion Segmentation and Classifi	2020	peer-reviewed jou	*ISIC2017*, PH2	dilated conv., parallel m.s. conv., separable conv.	Dice, Rank	80.40%	✓	cropping, scaling, rotation, shearing, shifting	✗	✓
82	Zhang et al., Kappa loss for skin lesion segmentation in fully convolutional network	2020	peer-reviewed con	SCD, ISIC2016, *ISIC2017*, ISIC2018	skip con.	Kappa Loss	84.00%*	✗	rotation, shifting, shearing, zooming, flipping	✗	✓
83	Saha et al., Leveraging adaptive color augmentation in convolutional neural networks for deep	2020	peer-reviewed con	ISIC2017, *ISIC2018*	skip con., dense con.	CE	81.90%	✗	color jittering, rotation, flipping, translation	✗	✗
84	Henry et al., MixModule: Mixed CNN Kernel Module for Medical Image Segmentation	2020	peer-reviewed con	ISIC 2018	skip con., parallel m. s. conv., attention mod.	-	78.04%	✗	color jittering, rotation, cropping, flipping, shi	✗	✓
85	Jafari et al., DRU-Net: An Efficient Deep Convolutional Neural Network for Medical Image Seg	2020	peer-reviewed con	ISIC 2018	skip con., residual con., dense con.	CE	75.50%	✗	-	✗	✓
86	Li et al., A generic ensemble based deep convolutional neural network for semi-supervised me	2020	peer-reviewed con	ISIC 2018	skip con., residual con., ensemble, semi-supervisec	CE, Dice	75.50%	✗	-	✗	✗
87	Guo et al., Complementary network with adaptive receptive fields for melanoma segmentation	2020	peer-reviewed con	ISIC 2018	skip con., dilated conv., parallel m. s. conv.	Focal, Jaccard	77.60%	✗	-	✗	✓
88	Li et al., A multi-task self-supervised learning framework for scopy images	2020	peer-reviewed con	ISIC 2018	skip con., residual con., self-supervised	MSE, KL div.	87.74%*	✗	-	✗	✗
89	Jiang et al., Skin Lesion Segmentation Based on Multi-Scale Attention Convolutional Neural N	2020	peer-reviewed jou	*ISIC2017*, PH2	skip con., residual con., attention mod.	CE	73.35%	✗	flipping	✗	✗
90	Qiu et al., Inferring Skin Lesion Deep Convolutional Neural Networks	2020	peer-reviewed jou	*ISIC2017*, PH2	ensemble	-	80.02%	✗	translation, rotation, shearing	✓	✗
91	Xie et al., Skin lesion segmentation using high-resolution convolutional neural network	2020	peer-reviewed jou	ISIC2016, *ISIC2017*, PH2	attention mod.	CE	78.30%	✗	rotation, flipping	✗	✗
92	Zafar et al., Skin lesion segmentation from dermoscopic images using convolutional neural ne	2020	peer-reviewed jou	*ISIC2017*, PH2	skip con., residual con.	CE	77.20%	✗	rotation	✗	✗
93	Azad et al., Attention Deeplabv3+: Multi-level Context Attention Mechanism for Skin Lesion Se	2020	peer-reviewed con	*ISIC 2017*, ISIC 2018, PH2	dilated conv., attention mod.	-	96.98%	✗	-	✗	✓
94	Nathan and Kansal, Lesion Net--Skin Lesion Segmentation Using Coordinate Convolution anc	2020	non peer-reviewed	ISIC 2016, *ISIC 2017*, ISIC 2018, PH2	skip con., residual con.	CE, Dice	78.28%	✗	rotation, flipping, shearing, zoom	✗	✗
95	Mirikharaji et al., D-LEMA: Deep Learning Ensembles from Multiple Annotations-Application to	2021	peer-reviewed con	*ISIC Archive*, PH2, DermoFit	skip con., residual con., ensemble	CE	72.11%	✗	-	✗	✗
96	Öztürk and Özkaya, Skin lesion segmentation with improved convolutional neural network	2020	peer-reviewed jou	*ISIC2017*, PH2	residual con.	-	78.34%	✓	-	✗	✗
97	Abhishek et al., Illumination-based Transformations Improve Skin Lesion Segmentation in Der	2020	peer-reviewed con	*ISIC 2017*, DermoFit, PH2	skip con.	Dice	75.70%	✓	rotation, flipping	✗	✓
98	Kaymak et al., Skin lesion segmentation using fully convolutional networks: A comparative exp	2020	peer-reviewed jou	ISIC 2017	-	-	72.50%	✗	-	✗	✗
99	Bagheri et al., Two-stage Skin Lesion Segmentation from Dermoscopic Images by Using Deep	2020	peer-reviewed jou	*ISIC2017*, DermQuest	dilated conv., parallel m.s. conv., separable conv.	-	79.05%	✓	rotation, flipping, brightness change, resizinç	✗	✗
100	Jayapriya and Jacob, Hybrid fully convolutional networks-based skin lesion segmentation and	2020	peer-reviewed jou	ISIC2016	skip con., parallel m.s. conv.	-	92.42%	✗	-	✗	✗
101	Wang et al., Cascaded Context Enhancement for Automated Skin Lesion Segmentation	2020	non peer-reviewed	ISIC2016, *ISIC2017*, PH2	residual con., dilated conv., attention mod.	CE, Dice, DS	80.30%	✓	flipping, rotation, cropping	✗	✗
102	Wang et al., DONet: Dual Objective Networks for Skin Lesion Segmentation	2020	non peer-reviewed	*ISIC2018*, PH2	attention mod., skip con., parallel m.s. conv., recurr	Dice, Focal Tversky	80.60%	✗	rotation, flipping, cropping	✗	✗
103	Ribeiro et al., Less is more: Sample selection and label conditioning improve skin lesion segm	2020	peer-reviewed con	ISIC Archive, PH2, DermoFit	skip con., residual con., dilated conv.	Soft Jaccard, CE	-	✓	Gaussian noise, color jittering	✓	✓
104	Zhu et al., ASNet: An adaptive scale network for skin lesion segmentation in dermoscopy imag	2020	peer-reviewed con	ISIC2018	skip con., residual con., dilated conv., attention mod	CE, Dice	82.15%	✗	flipping	✗	✗
105	Gu et al., CA-Net: Comprehensive attention convolutional neural networks for explainable mec	2020	peer-reviewed jou	ISIC 2018	residual con., skip con., attention mod.	Dice	85.32%*	✗	cropping, flipping, rotation	✗	✓
106	Lei et al., Skin lesion segmentation via generative adversarial networks with dual discriminator	2020	peer-reviewed jou	*ISIC 2017*, ISIC 2018	skip con., dense con., dilated conv., GAN	CE, L1, ADV	77.10%	✓	flipping, rotation	✗	✗
107	Andrade et al., Data Augmentation Using Adversarial Image-to-Image Translation for the Segn	2020	peer-reviewed jou	*DermoFit*, SMARTSKINS	residual con., dilated conv., GAN	Dice	81.03%	✗	flipping, brightness, saturation, contrast, hue	✗	✗
108	Wu et al., Automated skin lesion segmentation via an adaptive dual attention module	2020	peer-reviewed jou	*ISIC 2017*, ISIC 2018	residual con., attention mod., multi-scale	CE, Dice	82.55%	✗	flipping, rotation, scaling, cropping, sharpeni	✗	✗
109	Arora et al., Automated skin lesion segmentation using attention-based deep convolutional ne	2021	peer-reviewed jou	ISIC 2018	skip con., attention mod.	Dice, Tversky, Focal Tversky	83.00%	✗	flipping	✓	✗
110	Jin et al., Cascade knowledge diffusion network for skin lesion diagnosis and segmentation	2021	peer-reviewed jou	*ISIC2017*, ISIC2018	skip con., residual con., attention mod.	Dice, Focal	80.00%	✗	flipping, rotation, affine trans., scaling, cropp	✗	✓
111	Hasan et al., Dermo-DOCTOR: A framework for concurrent skin lesion detection and recogniti	2021	peer-reviewed jou	ISIC 2016, *ISIC 2017*	skip con., residual con., separable conv.	Dice, CE	66.66%*	✗	flipping, rotation, shifting, zooming, intensity	✗	✗
112	Kosgiker et al., SegCaps: An efficient SegCaps network-based skin lesion segmentation in de	2021	peer-reviewed jou	*ISIC 2017*, PH2	-	MSE, CE	90.25%	✗	-	✗	✗
113	Bagheri et al., Skin lesion segmentation based on mask RCNN, Multi Atrous Full-CNN, and a	2021	peer-reviewed jou	ISIC2016, ISIC2017, *ISIC2018*, PH2, Derm	parallel m.s. conv., dilated conv.	Dice, CE	85.04%	✓	rotation, flipping, color jittering	✗	✗
114	Saini et al., B-SegNet: branched-SegMentor network for skin lesion segmentation	2021	peer-reviewed con	*ISIC2017*, ISIC2018, PH2	pyramid pooling, residual con., skip con., dilated co	Dice	85.00%	✓	rotation, shearing, color jittering	✗	✗
115	Tong et al., ASCU-Net: Attention Gate, Spatial and Channel Attention U-Net for Skin Lesion Se	2021	peer-reviewed jou	ISIC2016, ISIC2017, *PH2*	skip con., attention mod.	CE	84.20%	✓	flipping	✗	✗
116	Bagheri et al., Skin lesion segmentation from dermoscopic images by using Mask R-CNN, Ret	2021	peer-reviewed jou	*DermQuest*, ISIC2017, PH2	ensemble	CE, Focal	86.53%	✓	rotation, flipping, color jittering	✓	✗
117	Ren et al., Serial attention network for skin lesion segmentation	2021	peer-reviewed jou	ISIC2017	dense con., dilated conv., separable conv., attentior	Dice, CE	76.92%	✗	flipping, rotation	✗	✗
118	Liu et al., Skin lesion segmentation using deep learning with auxiliary task	2021	peer-reviewed jou	ISIC2017	residual con., dilated conv., pyramid pooling	WCE	79.46%	✗	flipping, cropping, rotation, image deformatic	✗	✗
119	Khan et al., PMED-Net: Pyramid Based Multi-Scale Encoder-Decoder Network for Medical Ima	2021	peer-reviewed jou	ISIC2018	skip con., image pyramid	Dice	85.10%	✗	-	✗	✓
120	Redekop and Chernyavskiy, Uncertainty-based method for improving poorly labeled segmenta	2021	peer-reviewed con	ISIC2017	-	-	68.77%*	✗	-	✗	✗
121	Kaul et al., Focusnet++: Attentive Aggregated Transformations For Efficient And Accurate Med	2021	peer-reviewed con	ISIC2018	skip con., residual con., attention mod.	CE, Tversky, adaptive, logarithmic	82.71%	✗	-	✗	✓
122	Abhishek and Hamarneh, Matthews correlation coefficient loss for deep convolutional network	2021	peer-reviewed con	*ISIC2017*, PH2, DermoFit	skip con.	MCC	75.18%	✗	flipping, rotation	✗	✓
123	Tang et al., Introducing frequency representation into convolution neural networks for medical	2021	peer-reviewed jou	ISIC2018	skip con.	CE	78.25%	✗	-	✗	✗
124	Xie et al., Semi-Supervised Skin Lesion Segmentation with Learning Model Confidence	2021	peer-reviewed con	ISIC2018	dilated conv., semi-supervised	CE, KL div.	82.37%	✗	scaling, rotation, elastic transformation	✗	✗
125	Poudel and Lee, Deep multi-scale attentional features for medical image segmentation	2021	peer-reviewed jou	ISIC2017	skip con., attention mod.	CE	87.44%	✗	scaling, flipping, rotation, Gaussian noise, m	✗	✗
126	Şahin et al., Robust optimization of SegNet hyperparameters for skin lesion segmentation	2021	peer-reviewed jou	ISIC2016, *ISIC 2017*	skip con., Gaussian process	-	74.51%	✗	resize, rotation, reflection	✓	✗
127	Sarker et al., SLSNet: Skin lesion segmentation using a lightweight generative adversarial net	2021	peer-reviewed jou	*ISIC 2017*, ISIC 2018	parallel m.s. conv., attention mod., GAN	L1, Jaccard	81.98%	✗	flipping, contrast, gamma reconstruction	✗	✗
128	Wang et al., Knowledge-aware Deep Framework for Collaborative Skin Lesion Segmentation a	2021	peer-reviewed jou	ISIC 2016, *ISIC 2017*	residual con., skip con., lesion-based pooling, featu	CE	82.40%	✗	flipping, scaling, cropping	✗	✗
129	Sachin et al., Performance Analysis of Deep Learning Models for Biomedical Image Segmenta	2021	book chapter	ISIC 2018	residual con., skip con.	-	75.96%	✗	flipping, scaling, color jittering	✗	✗
130	Wibowo et al., Lightweight encoder-decoder model for automatic skin lesion segmentation	2021	peer-reviewed jou	*ISIC 2017*, ISIC 2018, PH2	BConvLSTM, separable conv., residual con., skip co	Jaccard	80.25%	✗	distortion, blur, color jittering, contrast, gamn	✓	✓
131	Gudhe et al., Multi-level dilated residual network for biomedical image segmentation	2021	peer-reviewed jou	ISIC 2018	dilated conv., residual con., skip con.	CE	91.00%	✗	flipping, scaling, shearing, color jittering, Gau	✗	✓
132	Khouloud et al., W-net and inception residual network for skin lesion segmentation and classifi	2021	peer-reviewed jou	ISIC 2016, *ISIC 2017*, ISIC 2018, PH2	feature pyramid, residual con., skip con., attention n	-	86.92%*	✗	-	✗	✗
133	Gu et al., kCBAC-Net: Deeply Supervised Complete Bipartite Networks with Asymmetric Conv	2021	peer-reviewed con	ISIC 2017	asymmetric conv., skip con.	DS	79.40%	✗	cropping, flipping, rotation	✗	✗
134	Zhao et al., Segmentation of dermoscopy images based on deformable 3D convolution and Re	2021	peer-reviewed jou	ISIC 2018	pyramid pooling, attention mod., residual con., skip	CE, Dice	86.84%	✗	cropping	✗	✗
135	Tang et al., AFLN-DGCL: Adaptive Feature Learning Network with Difficulty-Guided Curriculun	2021	peer-reviewed jou	ISIC 2016, *ISIC 2017*, ISIC 2018	attention mod., residual con., skip con., ensemble, p	Focal	80.70%	✗	copying	✗	✗
136	Zunair and Hamza, Sharp U-Net: Depthwise convolutional network for biomedical image segm	2021	peer-reviewed jou	ISIC 2018	sharpening kernel, residual con.	CE	79.78%	✗	-	✗	✓
137	Li et al., Superpixel-Guided Iterative Learning from Noisy Labels for Medical Image Segmenta	2021	peer-reviewed con	ISIC 2017	skip con.	CE, KL div.	71.12%*	✗	-	✗	✓
138	Zhang et al., Self-supervised Correction Learning for Semi-supervised Biomedical Image Segı	2021	peer-reviewed con	ISIC 2016	skip con., residual con., feature fusion, semi-superv	CE, Dice	80.49%	✗	flipping, rotation, zooming, cropping	✗	✓
139	Xu et al., DC-Net: Dual context network for 2D medical image segmentation	2021	peer-reviewed con	ISIC 2018	Transformer, multi-scale	Dice	89.60%	✗	flipping, rotation	✗	✗
140	Ahn et al., A spatial guided self-supervised clustering network for medical image segmentation	2021	peer-reviewed con	PH2	self-supervised, clustering	CE, Spatial loss, Consistency loss	71.53%*	✗	-	✗	✓
141	Zhang et al., TransFuse: Fusing Transformers and CNNs for medical image segmentation	2021	peer-reviewed con	ISIC 2017	skip con., feature fusion, Transformer	CE, Jaccard	79.50%	✗	rotation, flipping, color jittering	✗	✓

Mirikharaji et al., "A Survey on Deep Learning for Skin Lesion Segmentation", 2023				Highlight: Multiple datasets evaluated		Highlight: Multiple losses used	Highlight: Converted from reported Dice	Highlight: Performs CDE		Highlight: Uses post-processing	Highlight: Code released
Index	Paper Title	Year	Venue	Datasets	Architectural Modules	Loss Function	Performance (Jaccard)	Cross-data Evaluation	Augmentation	Post-processing	Code Provided
142	Ji et al., Multi-compound Transformer for accurate biomedical image segmentation	2021	peer-reviewed con	ISIC 2018	skip con., multi-scale, Transformer	CE, Dice	82.4%*	✗	flipping	✗	✓
143	Wang et al., Boundary-aware Transformers for skin lesion segmentation	2021	peer-reviewed con	ISIC 2016, **"ISIC 2018"**, PH2	multi-scale, Transformer	CE, Dice	84.3%*	✓	flipping, scaling	✗	✓
144	Yang et al., Deep Hybrid Convolutional Neural Network for Segmentation of Melanoma Skin Le	2021	peer-reviewed jou	**"ISIC 2018"**, PH2	skip con., multi-scale, feature fusion	CE, Dice	94.00%	✗	rotation, flipping, cropping, HSC, manipulatic	✗	✗
145	Tao et al., Attention-guided network with densely connected convolution for skin lesion segmer	2021	peer-reviewed jou	**"ISIC 2017"**, PH2	skip con., dense con., attention mod., multi-scale	-	78.85%	✗	rotation	✗	✗
146	Kim and Lee, A Simple Generic Method for Effective Boundary Extraction in Medical Image Se	2021	peer-reviewed jou	**"ISIC 2016"**, PH2	residual con., skip con.	boundary aware loss	84.33%*	✗	-	✗	✗
147	Dai et al., Ms RED: A novel multi-scale residual encoding and decoding network for skin lesion	2022	peer-reviewed jou	**"ISIC2018"**, PH2	residual con., skip con., dilated conv., image pyrami	CE, Dice, SoftDice	83.45%	✓	cropping, flipping, rotation	✗	✗
148	Bi et al., Hyper-fusion network for semi-automatic segmentation of skin lesions	2022	peer-reviewed jou	ISIC2016, **"ISIC2017"**, PH2	residual con., skip con., attention mod., feature fusi	CE	83.70%	✓	cropping, flipping	✗	✗
149	Lin et al., ConTrans: Improving Transformer with Convolutional Attention for Medical Image Se	2022	peer-reviewed con	**"ISIC 2017"**, ISIC 2018	attention mod., Transformer	CE, Jaccard, DS	77.81%*	✗	flipping, rotation	✗	✗
150	Wu et al., SeATrans: Learning Segmentation-Assisted Diagnosis Model via Transformer	2022	peer-reviewed con	PH2	skip con., Transformer, multi-scale	CE	70.0%*	✗	-	✗	✗
151	Valanarasu and Patel, UNeXt: MLP-based Rapid Medical Image Segmentation Network	2022	peer-reviewed con	ISIC 2018	skip con.	CE, Dice	81.70%	✗	-	✗	✓
152	Basak et al., MFSNet: A multi focus segmentation network for skin lesion segmentation	2022	peer-reviewed jou	**"ISIC 2017"**, PH2, HAM10000	residual con., multi-scale, attention mod.	CE, Jaccard, DS	97.40%	✗	-	✗	✓
153	Wu et al., FAT-Net: Feature adaptive Transformers for automated skin lesion segmentation	2022	peer-reviewed jou	ISIC 2016, **"ISIC 2017"**, ISIC 2018, PH2	skip con., residual con., attention mod., Transforme	CE, Dice	76.53%	✗	flipping, rotation, brightness change, contras	✗	✓
154	Liu et al., NCRNet: Neighborhood Context Refinement Network for skin lesion segmentation	2022	peer-reviewed jou	ISIC 2017	skip con., residual con., dilated conv., attention mod	CE, Dice	78.62%	✗	flipping, rotation	✗	✗
155	Wang et al., O-Net: a novel framework with deep fusion of CNN and Transformer for simultane	2022	peer-reviewed jou	ISIC 2017	skip con., residual con., Transformer	-	84.52%	✗	flipping, rotation	✗	✓
156	Zhang et al., Feature Fusion for Segmentation and Classification of Skin Lesions	2022	peer-reviewed con	ISIC 2017	skip con., feature fusion	Dice, Focal	74.54%	✗	flipping	✗	✗
157	Wang et al., Superpixel Inpainting For Self-Supervised Skin Lesion Segmentation from Dermo	2022	peer-reviewed con	**"ISIC 2017"**, PH2	skip con., residual con., self-supervised	Dice	76.50%	✓	rotation, flipping, color jittering	✗	✗
158	Dong et al., TC-Net: Dual coding network of Transformer and CNN for skin lesion segmentatio	2022	peer-reviewed jou	ISIC 2016, **"ISIC 2017"**, ISIC 2018	residual con., skip con., Transformer, feature fusion	CE, Dice	74.55%	✗	-	✗	✗
159	Chen et al., Skin Lesion Segmentation Using Recurrent Attentional Convolutional Networks	2022	peer-reviewed jou	**"ISIC 2017"**, PH2	skip con., attention mod., recurrent net.	CE	80.36%	✓	flipping, rotation, affine trans., masking, mes	✗	✗
160	Kaur et al., Automatic lesion segmentation using atrous convolutional deep neural networks in	2022	peer-reviewed jou	ISIC 2016, **"ISIC 2017"**, ISIC 2018, PH2	dilated conv.	CE	81.70%	✓	scaling, rotation, translation	✗	✗
161	Badshah and Ahmad, ResBCU-Net: Deep learning approach for segmentation of skin images	2022	peer-reviewed jou	ISIC 2018	residual con., BConvLSTM	-	94.50%	✗	-	✗	✗
162	Alam et al., S2C-DeLeNet: A parameter transfer based segmentation-classification integration	2022	peer-reviewed jou	HAM10000	residual con., separable conv.	Dice	91.10%	✗	-	✗	✓
163	Yu et al., mCA-Net: modified comprehensive attention convolutional neural network for skin le	2022	peer-reviewed jou	ISIC 2018	skip con., attention mod., multi-scale	-	87.89%	✗	-	✗	✗
164	Jiang et al., SEACU-Net: Attentive ConvLSTM U-Net with squeeze-and-excitation layer for ski	2022	peer-reviewed jou	**"ISIC 2017"**, ISIC 2018	skip con., attention mod., ConvLSTM	CE, Jaccard	80.50%	✗	-	✗	✗
165	Ramadan et al., Color-invariant skin lesion semantic segmentation based on modified U-Net d	2022	peer-reviewed jou	ISIC 2018	skip con., attention mod.	CE, Dice, sens.-spec. loss	91.40%	✗	-	✗	✗
166	Zhang et al., Dynamic prototypical feature representation learning framework for semi-supervi	2022	peer-reviewed jou	**"ISIC 2017"**, ISIC 2018	skip con., dense con., semi-supervised	CE, contrastive loss	73.89%	✗	scaling, flipping, color distortion	✗	✗
167	Tran and Pham, Fully convolutional neural network with attention gate and fuzzy active contou	2022	peer-reviewed jou	**"ISIC 2017"**, PH2	skip con., attention mod.	Focal Tversky, fuzzy loss	79.20%	✗	rotation, zooming, flipping	✗	✗
168	Wang and Wang, Skin lesion segmentation with attention-based SC-Conv U-Net and feature r	2022	peer-reviewed jou	ISIC 2017	skip con., residual con., attention mod.	CE, Jaccard	78.28%	✗	rotation, zooming, resizing, shifting	✗	✗
169	Zhao et al., Self-supervised Assisted Active Learning for Skin Lesion Segmentation	2022	peer-reviewed con	ISIC 2017	skip con., self-supervised	CE, Dice	67.08%*	✗	-	✗	✗
170	Wang et al., Cross-Domain Few-Shot Learning for Rare-Disease Skin Lesion Segmentation	2022	peer-reviewed con	PH2	few shot, mask avg. pooling	Dice	86.97%*	✗	-	✗	✗
171	Wang et al., CTCNet: A Bi-directional Cascaded Segmentation Network Combining Transforms	2022	peer-reviewed con	**"ISIC 2017"**, ISIC 2018	residual con., dilated conv., multi-scale, feature fusi	CE, Jaccard	78.76%	✗	-	✗	✗
172	Liu et al., Skin Lesion Segmentation via Intensive Atrous Spatial Transformer	2022	peer-reviewed con	**"ISIC 2017"**, ISIC 2018	skip con., dilated conv., multi-scale, pyramid pooling	CE	80.19%	✗	-	✗	✗
173	Gu et al., DE-Net: A deep edge network with boundary information for automatic skin lesion se	2022	peer-reviewed jou	ISIC 2017	skip con., global adaptive, pooling	CE, L2	80.53%	✗	scaling, rotation, flipping	✗	✗
174	Khan et al., Ensemble learning of deep learning and traditional machine learning approaches f	2022	peer-reviewed jou	**"ISIC 2017"**, PH2	residual con., attention mod., ensemble	CE	79.20%	✗	-	✗	✗
175	Alahmadi and Alghamdi, Semi-Supervised Skin Lesion Segmentation With Coupling CNN and	2022	peer-reviewed jou	**"ISIC 2017"**, ISIC 2018, PH2	skip con., feature fusion, semi-supervised, Transfor	CE, Dice, L2	82.78%*	✗	-	✗	✗
176	Li et al., MHAU-Net: Skin Lesion Segmentation Based on Multi-Scale Hybrid Residual Attentio	2022	peer-reviewed jou	ISIC 2018	skip con., residual con., dilated conv., attention mod	CE, Dice	88.92%	✗	flipping, rotation	✗	✗
177	Kaur et al., Skin lesion segmentation using an improved framework of encoder-decoder based	2022	peer-reviewed jou	ISIC 2016, **"ISIC 2017"**, ISIC 2018, PH2	-	Tversky	77.80%	✓	rotation, scaling	✗	✗