than whole-image classification, which predicts a single label for the entire image. Instance segmentation extends the scope of semantic segmentation by detecting and delineating each object of interest in the image (e.g., individual people).

Numerous image segmentation algorithms have been developed in the literature, from the earliest methods, such as thresholding [4], histogram-based bundling, region-growing [5], k-means clustering [6], watershed methods [7], to more advanced algorithms such as active contours [8], graph cuts [9], conditional and Markov random fields [10], and sparsity-based [11], [12] methods. In recent years, however, deep learning (DL) models have yielded a new performance improvements, often achieving the highest accuracy rates on popular benchmarks (e.g., Fig. 1). This has caused a paradigm shift in the field.

This survey, a revised version of [14], covers the recent literature in deep-learning-based image segmentation, including more than 100 such segmentation methods proposed to date. It provides a comprehensive review with insights into different aspects of these methods, including the training data, the choice of network architectures, loss functions, training strategies, and their key contributions. The target literature is organized into the following categories:

1) Fully convolutional networks
2) Convolutional models with graphical models
3) Encoder-decoder based models
4) Multiscale and pyramid network based models
5) R-CNN based models (for instance segmentation)
6) Dilated convolutional models and DeepLab family
7) Recurrent neural network based models

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