LITHOGRAPHY HOTSPOT DETECTION USING DEEP-LEARNING

SUMEDHA
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RESEARCH PAPER

- Research Paper implemented is: “Lithography Hotspots Detection Using Deep Learning” by Vadim Borisov and Jurgen Scheible from Robert Bosch Center for Power Electronics, Reutlingen University, Reutlingen, Germany.

- It was published in 2018 15th International Conference on Synthesis, Modeling, Analysis and Simulation Methods and Applications to Circuit Design (SMACD) by IEEE

- Link: https://ieeexplore.ieee.org/document/8434561

DATASET USED

- Link: http://appsrv.cse.cuhk.edu.hk/~hyyang/files/iccad-official.tgz
- Dataset used is ICCAD benchmark dataset and data is unlabelled. It has five sub-datasets:
- ICCAD_1: It consists of 440 training images(100 with hotspot and 340 without hotspot) and 4907 testing images(227 with hotspot and 4680 without hotspot).
- ICCAD_2: It consists of 5401 training images(175 with hotspot and 5226 without hotspot) and testing images 41,798 (499 with hotspot and 41,299 without hotspot).
- ICCAD_3: It consists of training images 5,554 (with 910 hotspot and 4644 without hotspot) and testing images 48,143 (1809 with hotspot and 46334 without hotspot).
- ICCAD_4: It consists of training images 4549 (96 with hotspot and 4453 without hotspot) and 32069 testing images(178 with hotspot and 31891 without hotspot).
- ICCAD_5: It consists of training images 2744 (27 with hotspot and 2717 without hotspot) and testing images 19370 (42 with hotspot and 19328 without hotspot).

INTRODUCTION

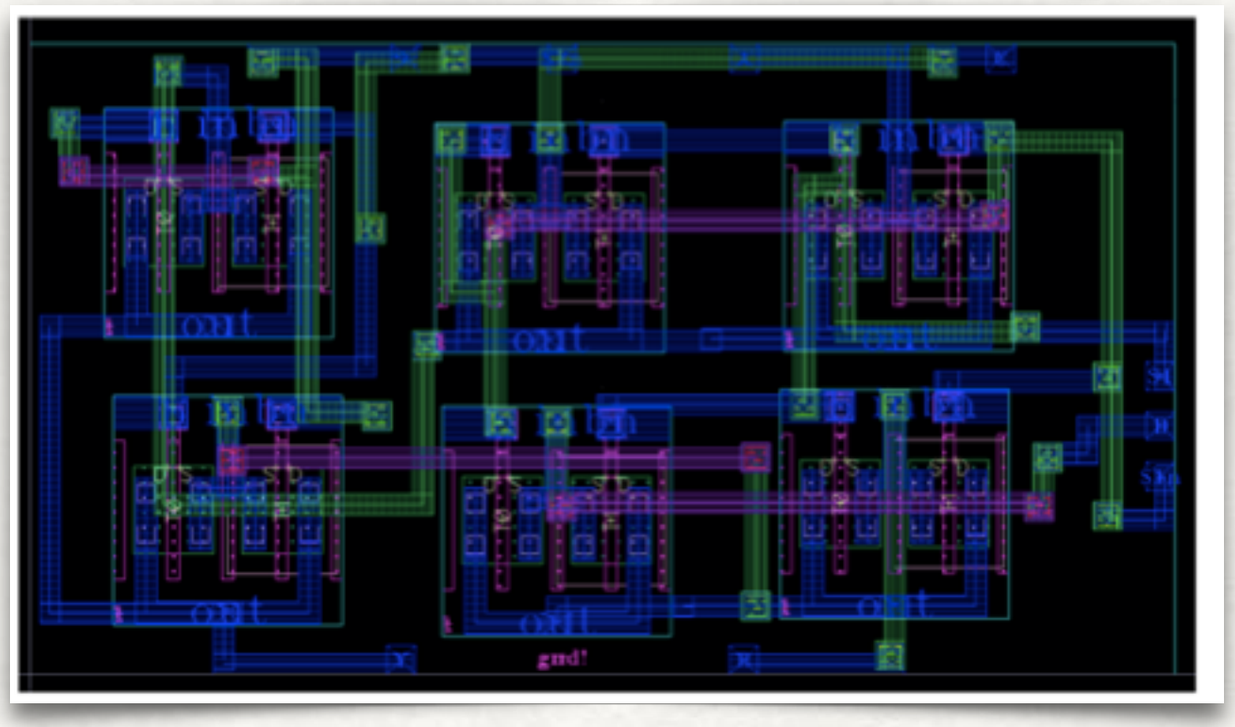
- Lithography: Lithography technique is used to pattern specific shapes of a thin layer on a rigid substrate for fabricating electrical devices.

- Lithography hotspot is a place where it is susceptible to have fatal pinching (open circuit) or bridging (short circuit) error due to poor printability of certain patterns in a design layout.

Lithography Hotspots

TECHNIQUES TO DETECT LITHOGRAPHY HOTSPOTS

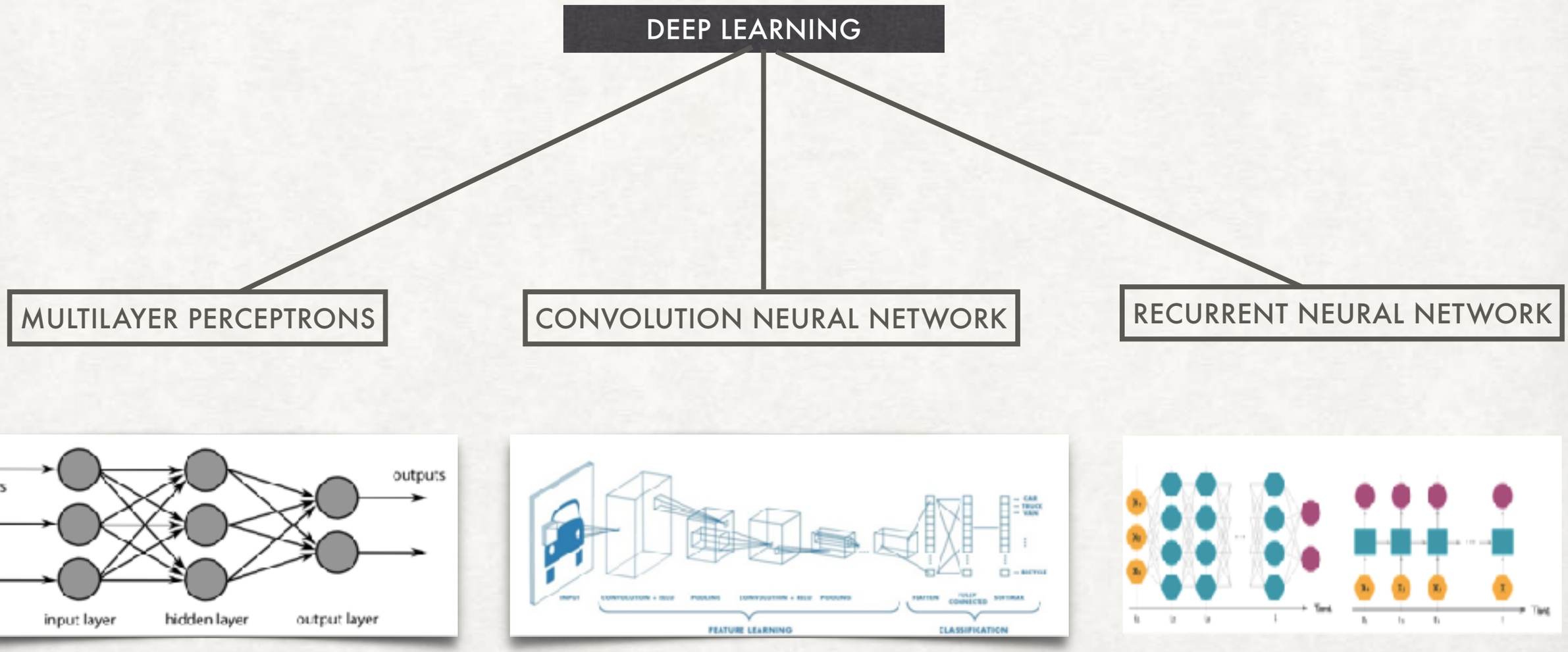
- Run lithography simulation on a layout using various simulation softwares like NCSU EDA, GenISys or wavelet transforms etc. : This method is too computationally expensive for full-chip design.



- Therefore, techniques like deep learning techniques are being used as an alternative and practical hotspot detection method

DEEP LEARNING

- Deep Learning is a field concerned with algorithms inspired by the structure and function of the brain called artificial neural networks.

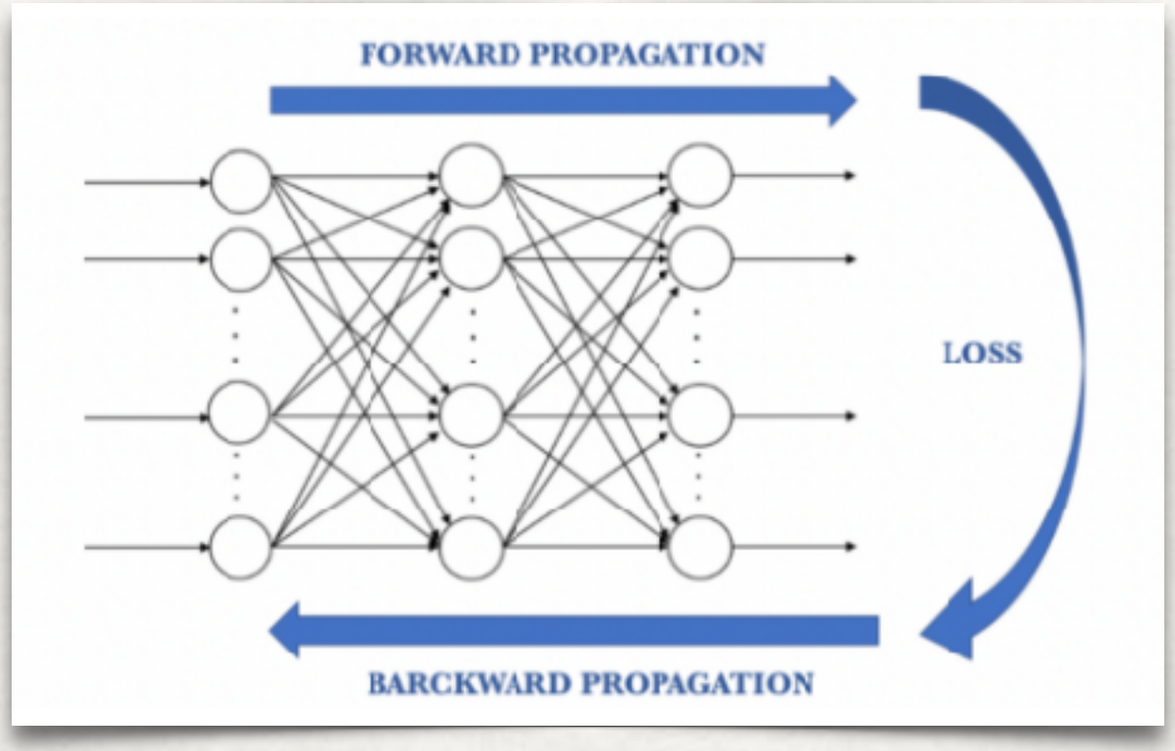


MULTILAYER PERCEPTRONS

- These are a network of interconnected artificial neurons (or nodes) where each neuron represents an information processing unit. These interconnected nodes pass information to each other mimicking the human brain.

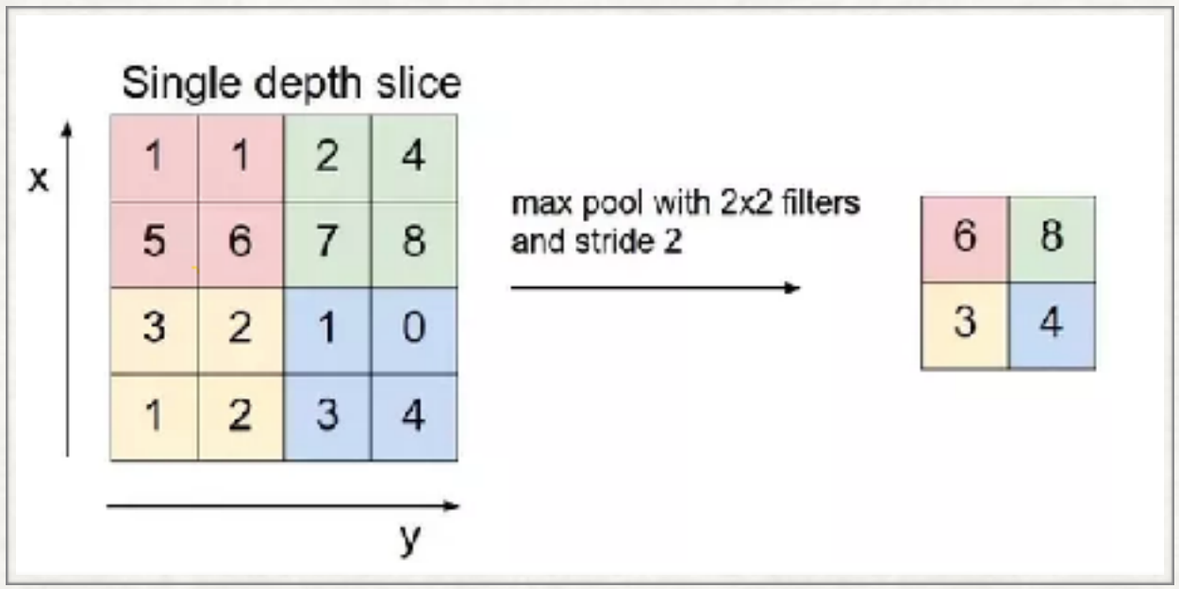
- Several Neural Network layers are connected in feedforward style to pass information to each other. The loss is back propagated to adjust the weights and make the model more accurate.

- Activation function decides whether a neuron should be activated or not by calculating the weighted sum and further adding bias to it. The motive is to introduce non-linearity into the output of a neuron.



CONVOLUTION NEURAL NETWORK (CNN)

- CNN are specifically used to do image recognition, image classification etc.
- Unlike neural networks, where the input is a vector, here the input is a 3-channeled image
- Convolution layer: We take a n*m filter (kernel) and slide it over the complete image and along the way take the dot product between the filter and chunks of the input image. We can add as many convolutional layers until satisfactory results are obtained
- Pooling Layer: It reduces the number of parameters when the images are too large.Max pooling takes the largest element from the rectified feature map



HYPER-PARAMETERS USED

RESEARCH PAPER IS IMPLEMENTED USING BOTH CNN AND MULTI-LAYER PERCEPTRONS

Epochs used <= 20

Layers	Hyper-parameters
Multilayer Perceptron	Layers = 8, Batch Size = 64, Image Shape = 224,224
CNN	Filters = 12, Kernel size = (3,3)
MaxPooling	pooling window = (2,2)
Activation	type = RELU

OUTPUT COMPARISON

Dataset Used	Accuracy(Research Paper)	Accuracy(Implementation using ANN)	Accuracy(Implementation using CNN)
ICCAD_1	100	79	89.73
ICCAD_2	99.8	96.68	96.81
ICCAD_3	99.9	97.32	83.63
ICCAD_4	99.8	95.8	97.9
ICCAD_5	95.12	95.77	99.05

CONCLUSION

- In almost all the cases CNN gives better accuracy than Multi Layer Perceptron Networks
- An architecture for lithography hotspot detection using CNN and Multi Layer Neural Networks has been built. Compared to other methods, the proposed model has the following advantages:
- The proposed model has a relatively small number of learning parameters and epochs compared to the other DL approaches. Therefore, it needs less computation time for learning and prediction.
- Because of the simplistic nature of DL methods, the proposed approach can be quickly added to any EDA software.

FUTURE SCOPE

- In order to increase the performance, reduce runtime, get a more stable, faster, and more accurate results a number of other methods are being developed where deep convolutional neural networks are built along with other Machine Learning algorithms such as data augmentation, DBSCAN clustering, modified batch normalization, and fast scanning methods

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