2022 DESIGN AND VERIFICATION™ DVCON CONFERENCE AND EXHIBITION JAPAN

Fast Congestion Planning and Floorplan QoR Assessment

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Executive Summary

- Current process for evaluating floorplan QoR often takes days to weeks.

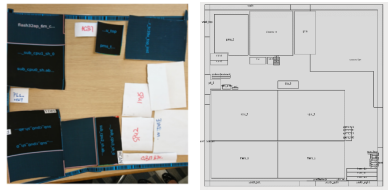
- Machine Learning can predict timing slack and congestion without running Place and Route in the ASIC flow.
  - Achieves 80% accuracy in experiments with real-world SoCs

- Armed with predictive insights, designers can iterate and fix potential problems quickly.
  - Major customers starting internal ML efforts

Challenge: Complex SOC Implementation

- Selecting the best floorplan requires days to weeks to run Place & Route.

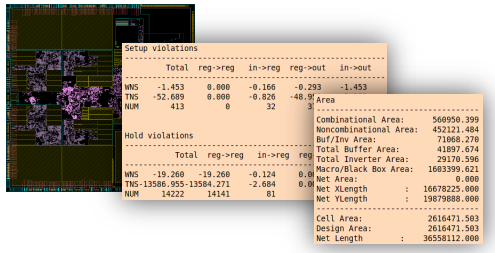
1. Create Floorplans



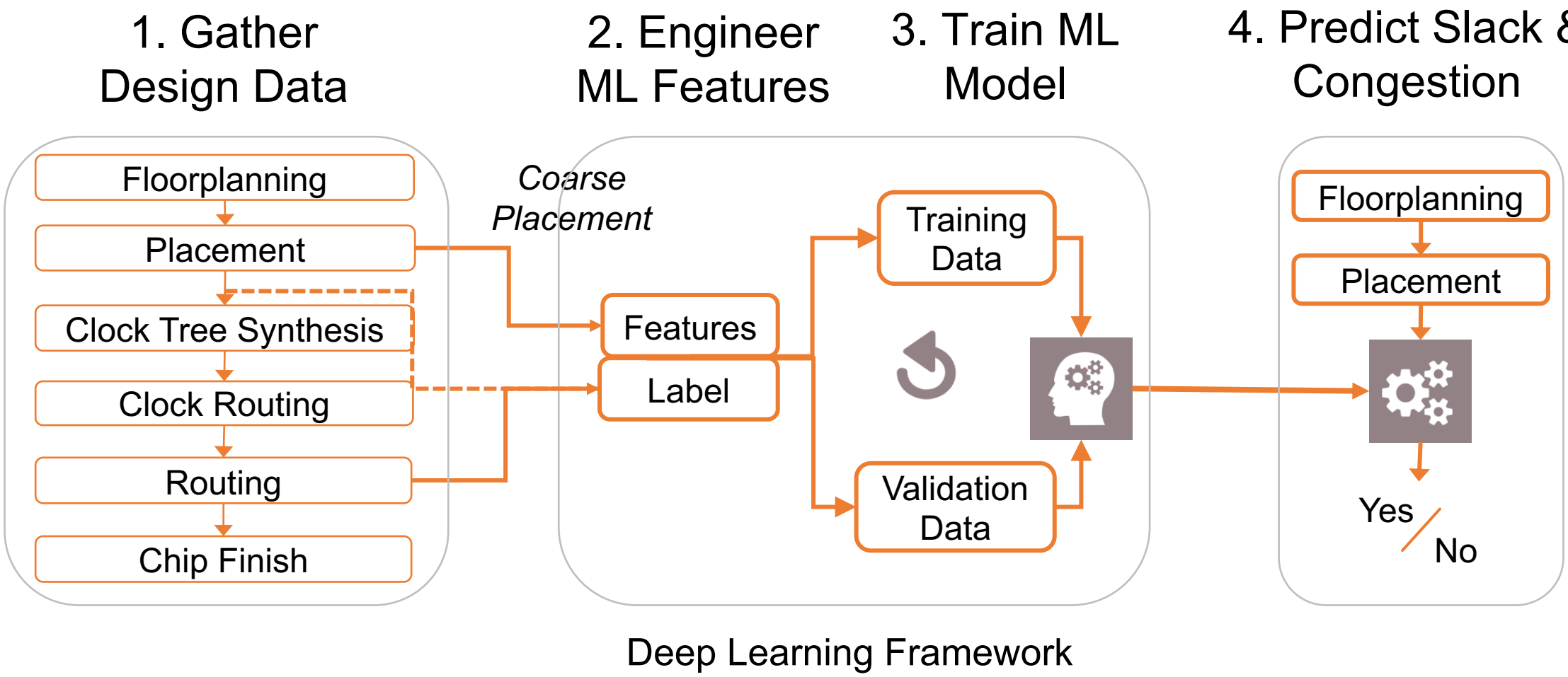
2. Explore Floorplans

- Goals: Meet performance & area targets
- Performed by highly experienced engineers

3. Pick the Best Floorplan



Solution: Predict Floorplan QoR without Place and Route

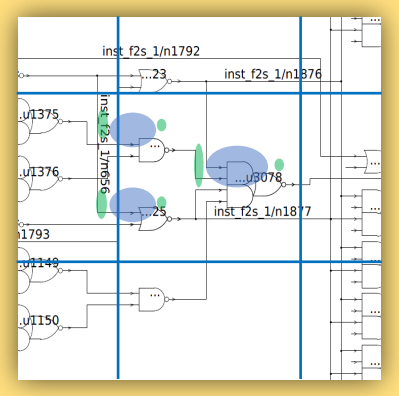


Feature Engineering

Design Representation
- Cut design into an XY grid

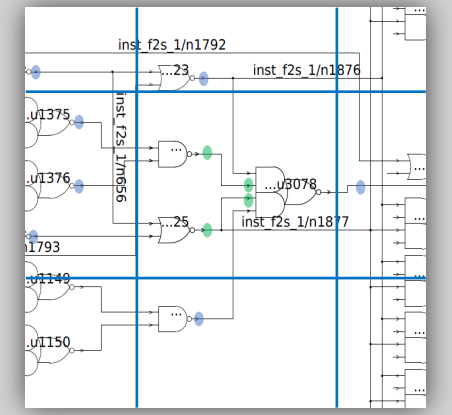
Cell Density
- Total cells per XY

Pin Density
- Total pins of standard cells per XY



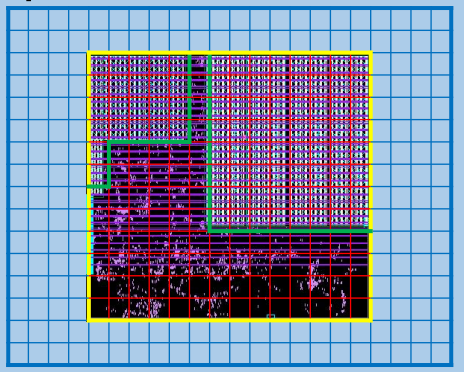
External Connectivity
- Total connections between cells within and cells outside an XY

Internal Connectivity
- Total connections between cells in an XY



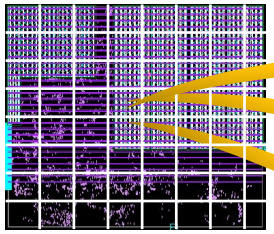
Macro Regions
- Differentiate between hard macro regions and standard cell regions

Occupied Regions
- Differentiate between occupied and unused floorplan area.



Train Machine Learning (ML) Model

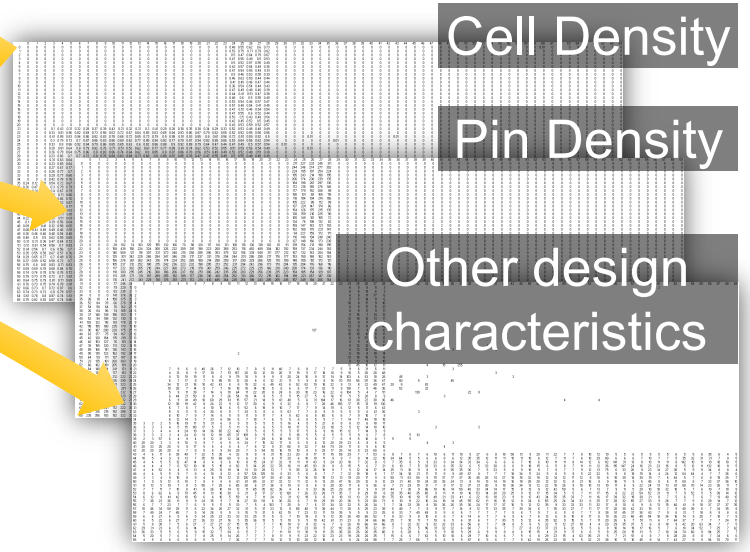
1. Create Floorplans



Design **E**xchange **F**ormat

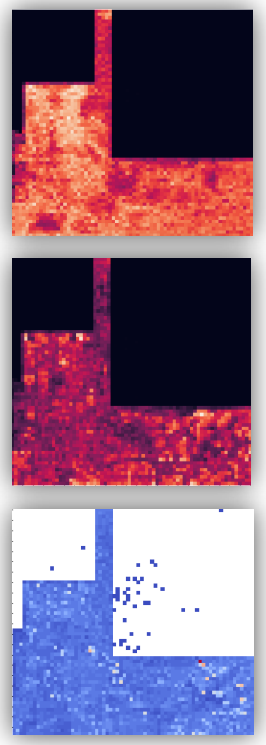
- *DEF output from coarse placement database of 9 SOC designs.*
- *Extract data from multiple floorplans*
- *Gather 1000 datapoints*

2. Derive Features

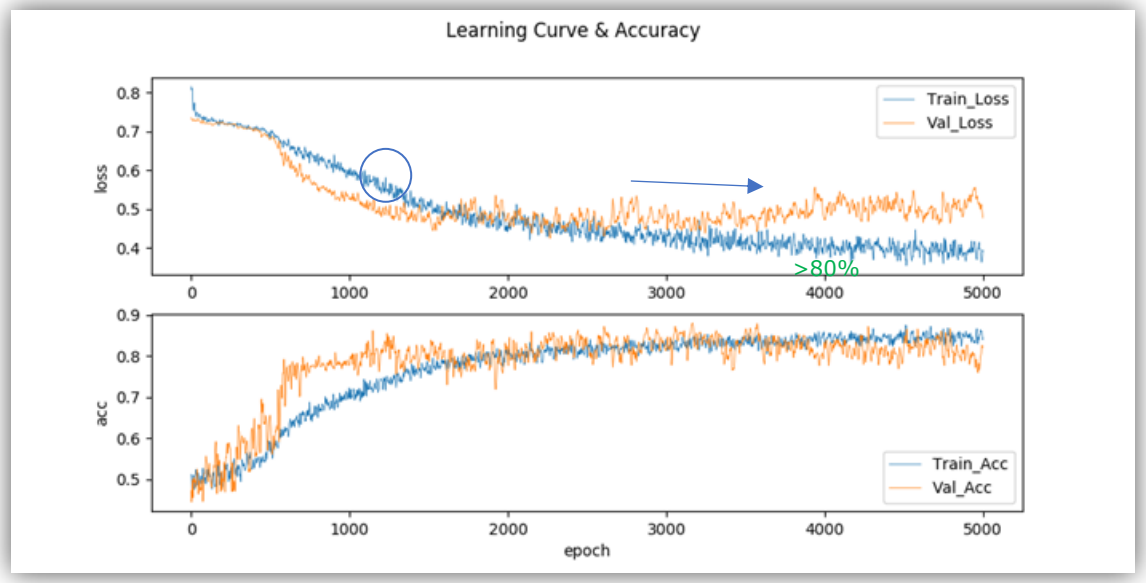


Formatted Training Data

3. Train on Deep Learning Network



Evaluate Trained ML Model



	Target	Achieved
Loss	~0.1	~0.4
Accuracy	80%	> 80%

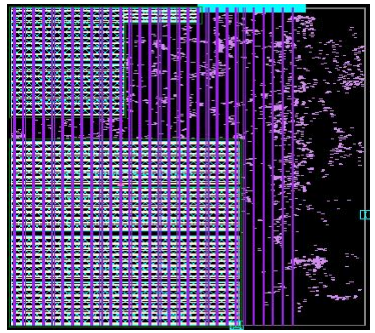
Table 1

- WNS prediction model can learn and achieves up to 80% predictive accuracy.
  - Features are adequate.
  - Number of data samples are sufficient.
- Areas for improvement:
  - More designs and more datapoints (> 1000) per design will improve model performance.
  - More iterations will reduce Training Loss.

Improve ML Model Output

Version 1: "Yes / No" prediction too broad to accurately reflect QoR.

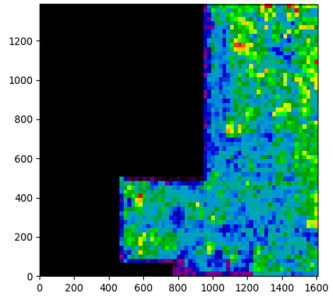
- Not precise enough for debugging.
- Hard to generalize across different SoC designs and/or process technologies.



Is TNS = -1000ns Good or Bad?

Version 2: Highlight timing or congestion per XY.

- Populate each XY with color-coded WNS or congestion value.
- Predicted colors form "heatmap" to show floorplan quality.

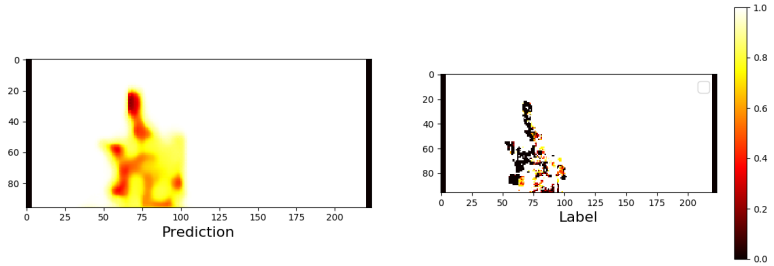


Point-to-Point WNS or Congestion Prediction

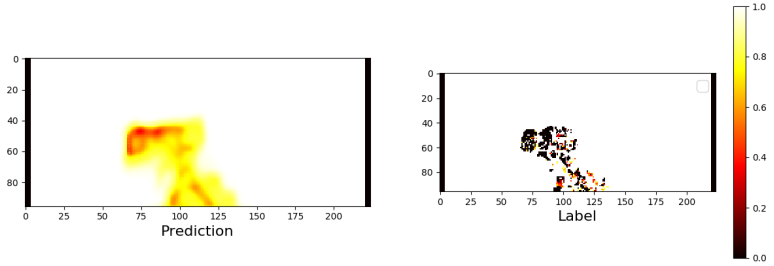
Output: Detailed Heatmap Predictions

Floorplans #1 to #4: Best floorplan (#3) has fewest colors - least congestion and smallest negative slack.

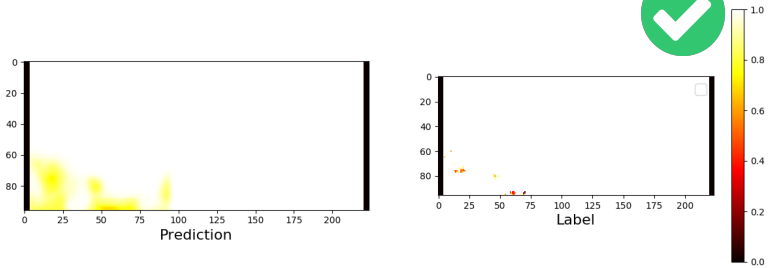
Floorplan 1: Predicted vs. Actual



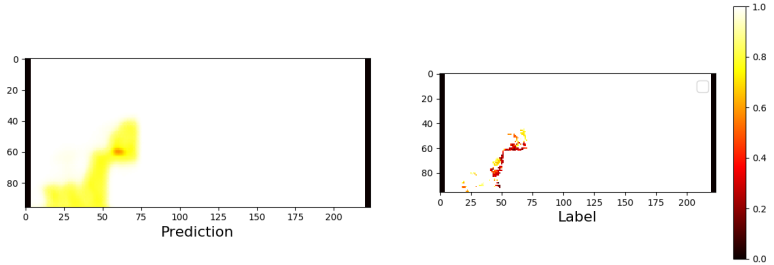
Floorplan 2: Predicted vs. Actual



Floorplan 3: Predicted vs. Actual



Floorplan 4: Predicted vs. Actual



Summary

- Machine Learning (ML) can predict timing slack and congestion without the need to run Place and Route.
  - Data from multiple designs used to train AI model.
  - Trained AI model shows 80% predictive accuracy.

- Customers can use this technology to:
  - iterate quickly with multiple floorplans
  - resolve problematic areas
  - save time and resources on running place and route.

Questions?