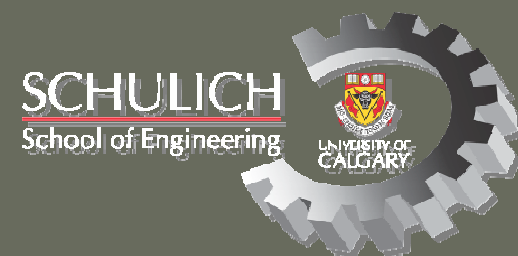

A Net-Reduction based Clustering Preprocessing Algorithm

Jianhua Li, **Laleh Behjat**
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ISPD April 12, 2006

A net reduction-based clustering preprocessing algorithm - ISPD 2006

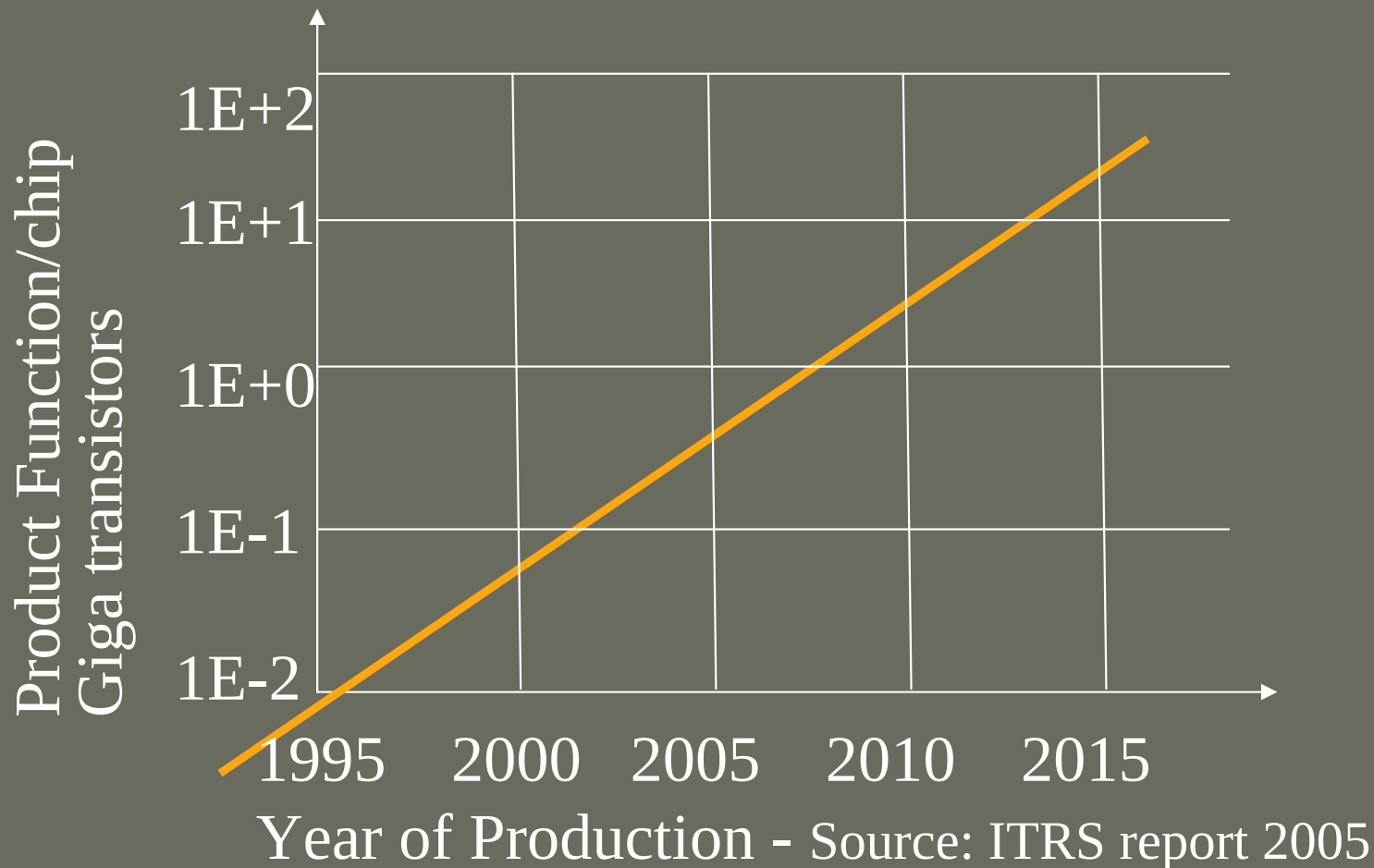


Outline

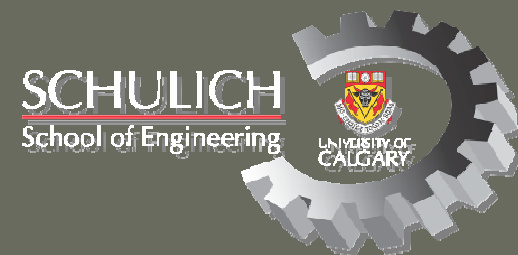
- Introduction
- Background and Motivation
- Net Cluster Algorithm
- Numerical Results
- Conclusions and Future Work

Introduction

Exponential growth in circuit sizes, Moore's Law

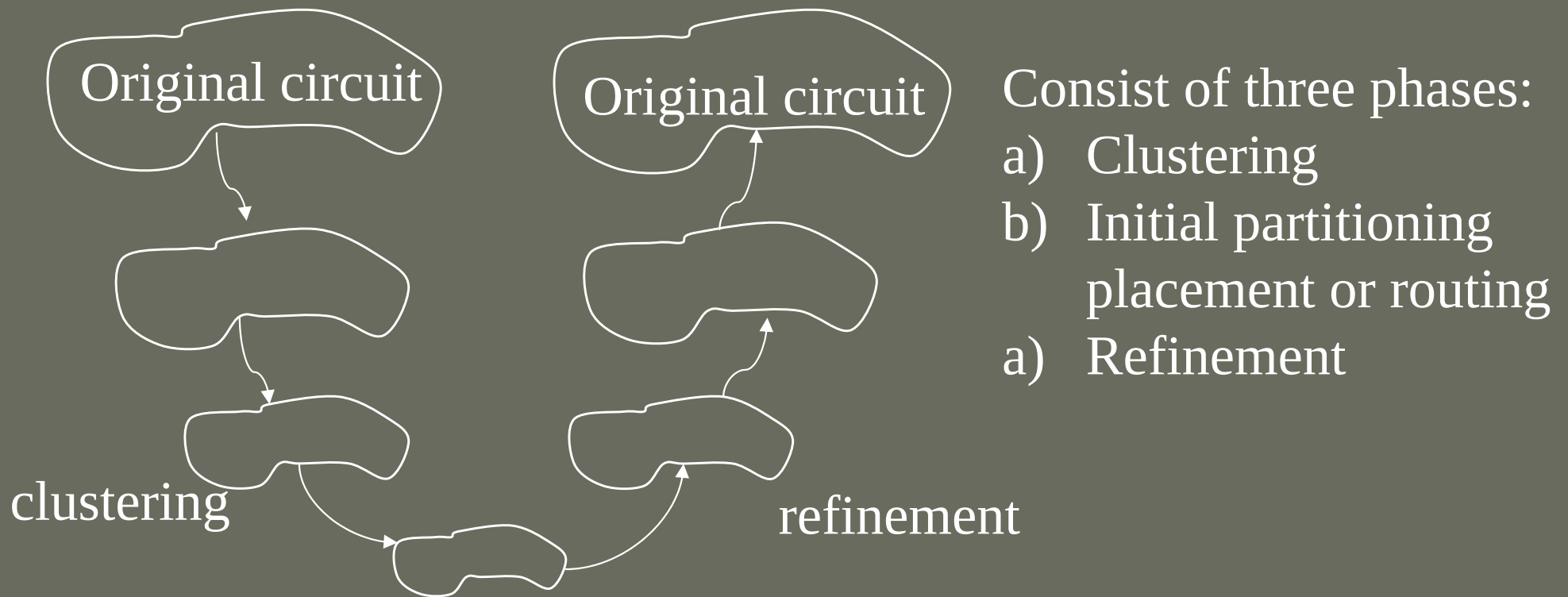


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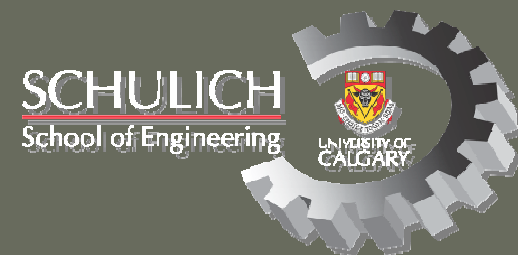
Introduction

Multi-level platforms have become the norm



partitioning, placement or routing

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-
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Background - Clustering algorithms

Numerous clustering algorithms:

- Edge coarsening (EC)
- First Choice (FC)
- Edge Separability (ESC)
- Fine Granularity (FG)
- Best-Choice

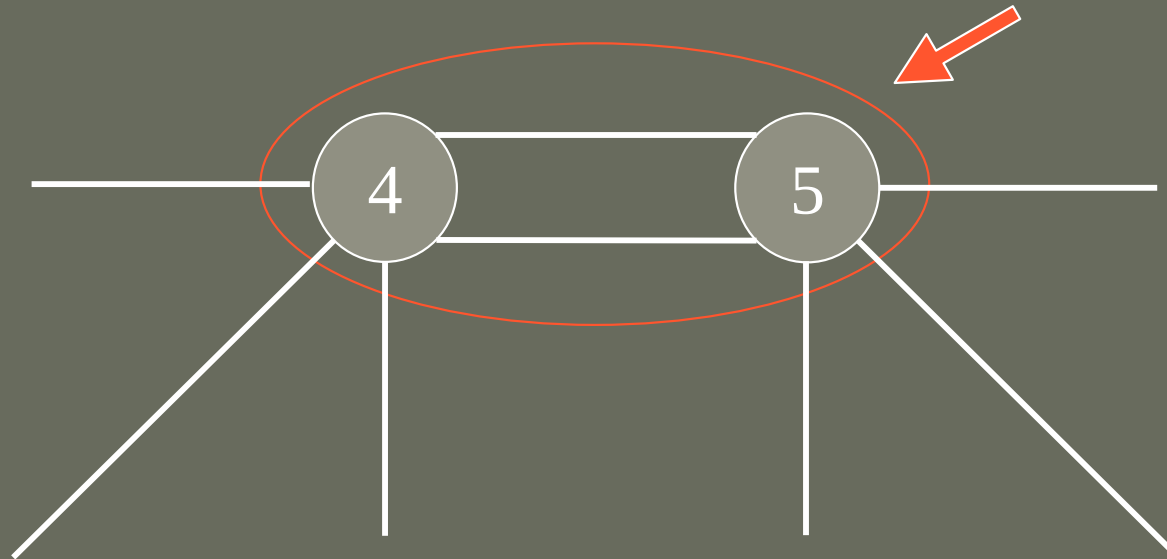
Background - Clustering algorithms

General Drawbacks:

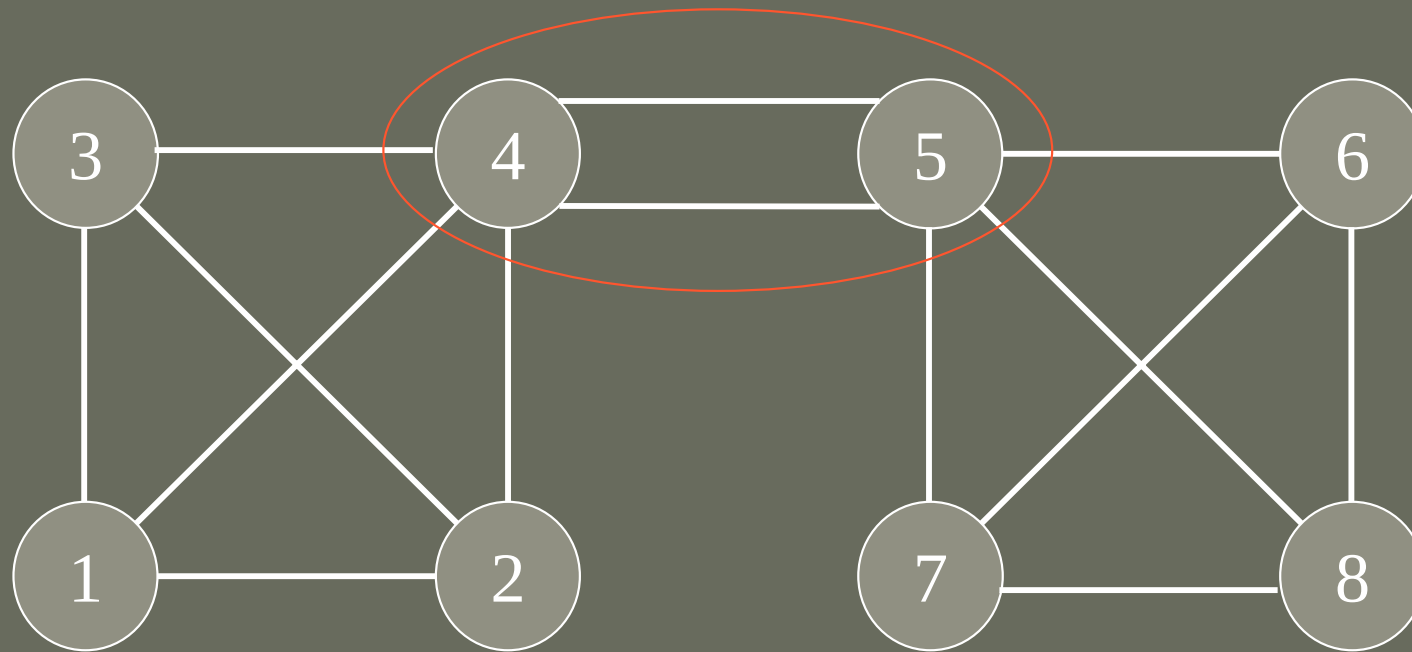
- Lack of global view
- Ignore natural cluster
- Limitations on number of cells in a cluster
- Edge based - need clique transformation

Background - Example

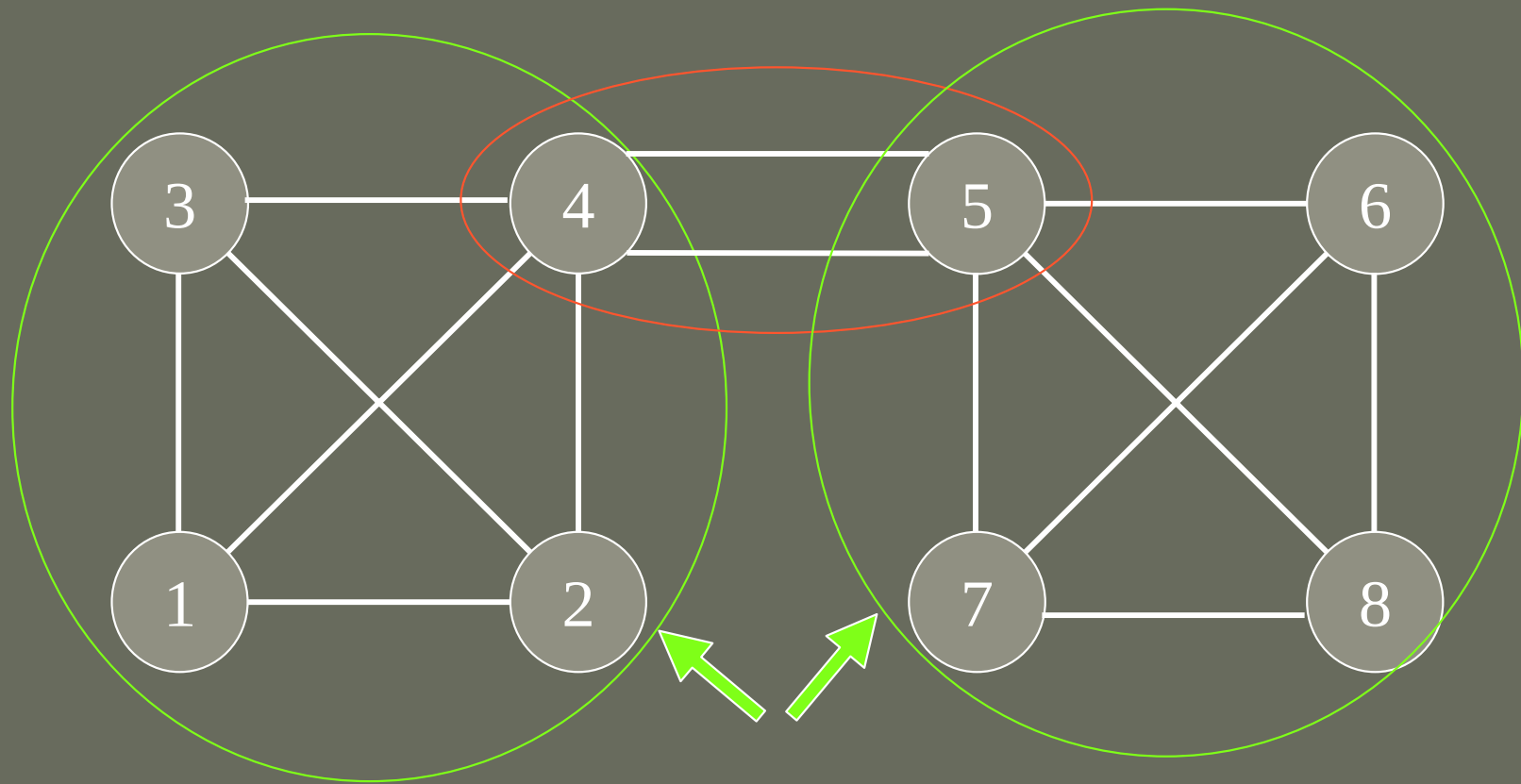
4 and 5 can be put together based on local connectivity



Background - Example



Background - Example



Eliminating natural clusters in the circuit

Background - motivations

- Capture the natural clusters in a circuit
- Focus on clustering nets versus cells
- Avoid using a clique model
- Remove hard limitations on the number of cells in a cluster

-
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Net Cluster - Outline

Input: flat netlist

Output: clustered netlist

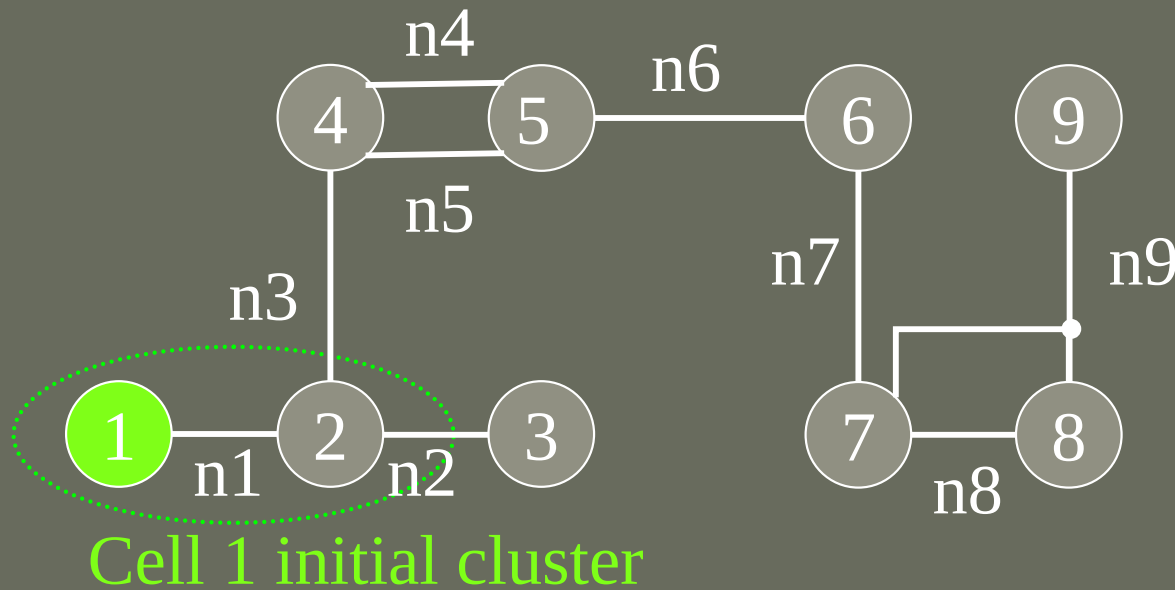
For all cells:

1. Initial Cluster Identification
2. Initial Cluster refinement
3. Score Calculation

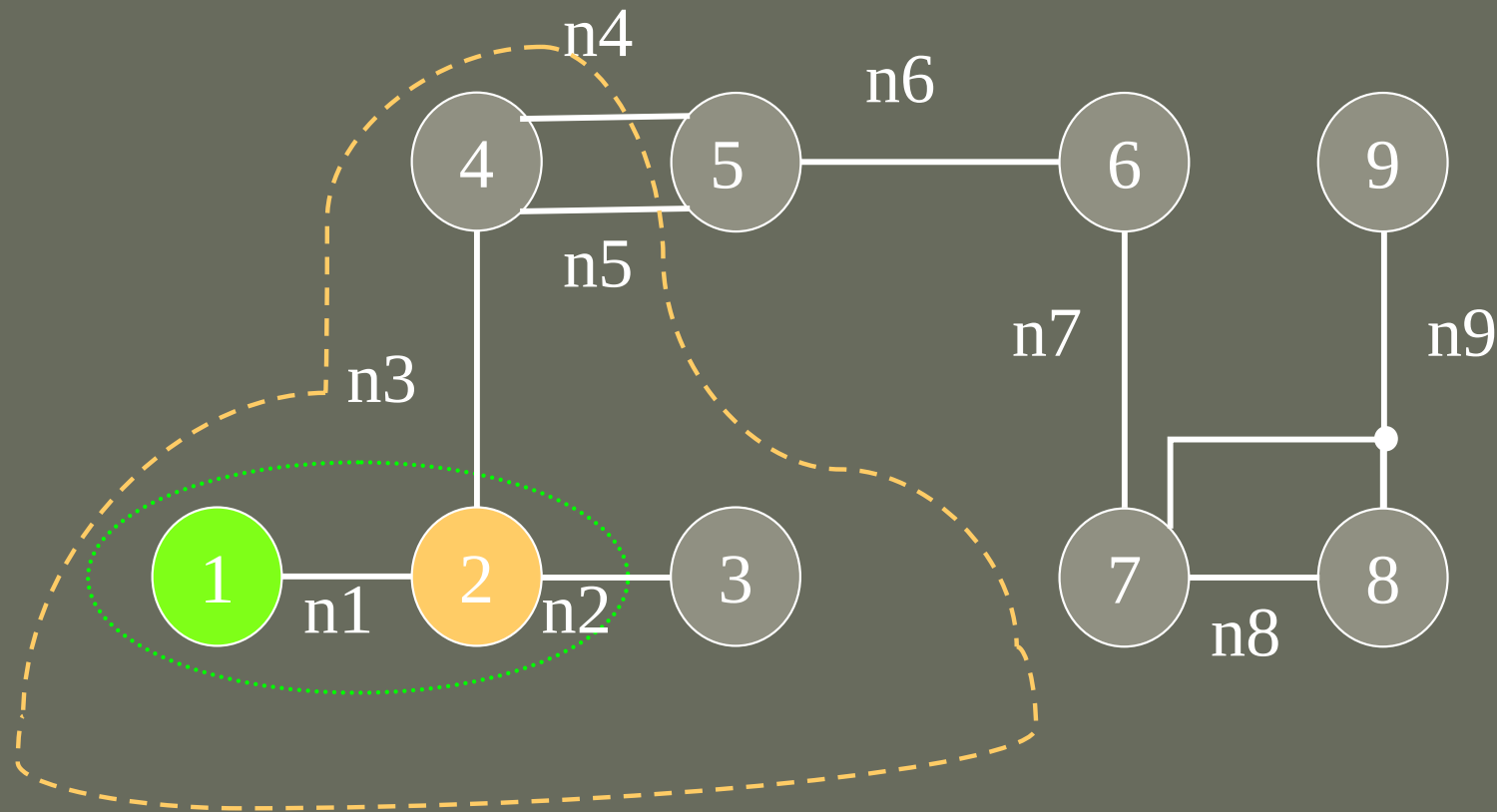
Form clusters based on score

Net Cluster - initial Cluster Identification

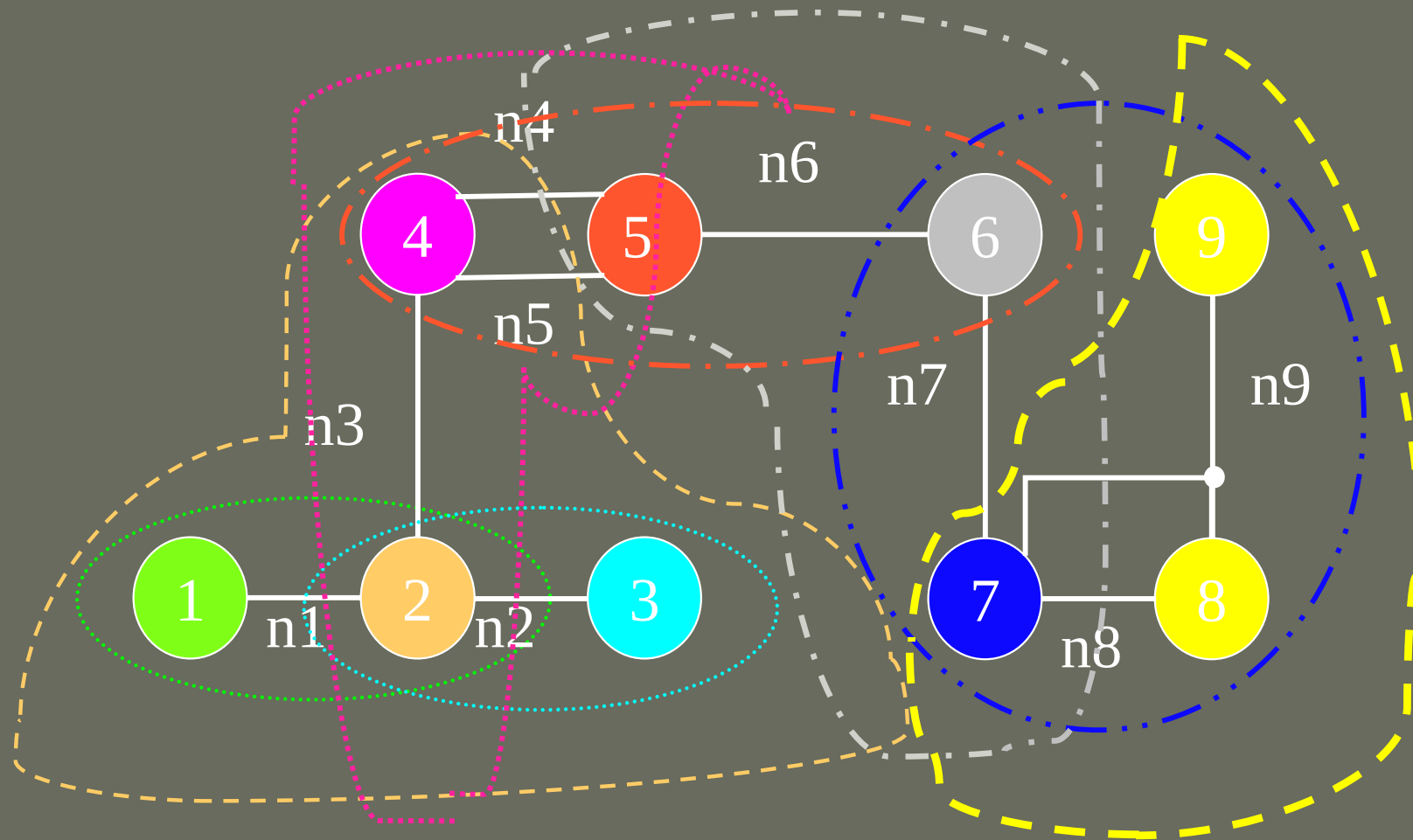
- Visit each cell as a seed cell
- Group seed cell with neighboring cells



Net Cluster - initial Cluster Identification

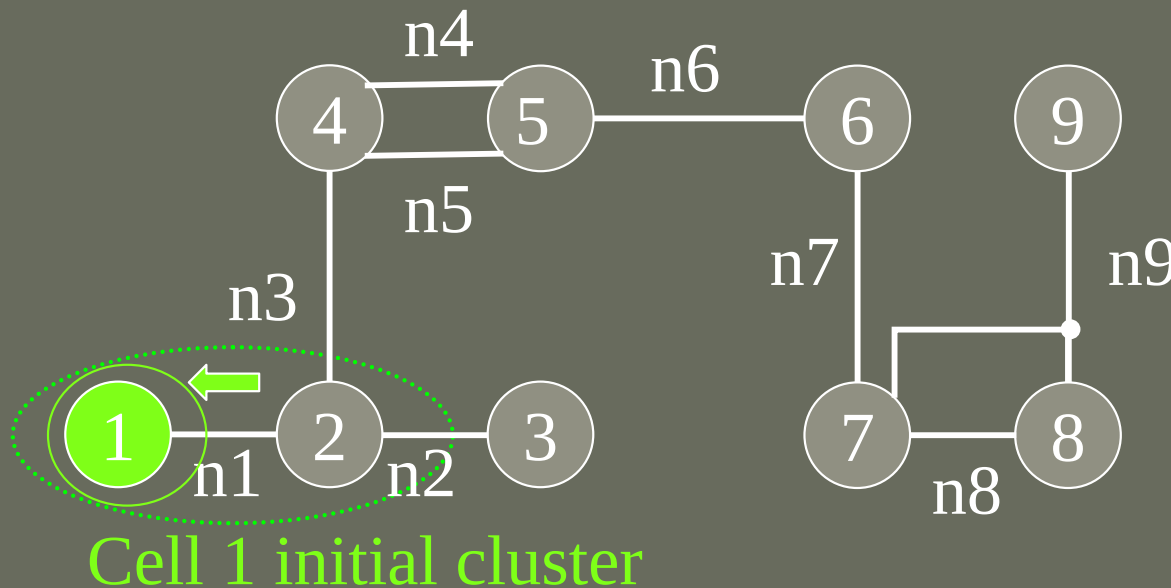


Net Cluster - initial Cluster Identification

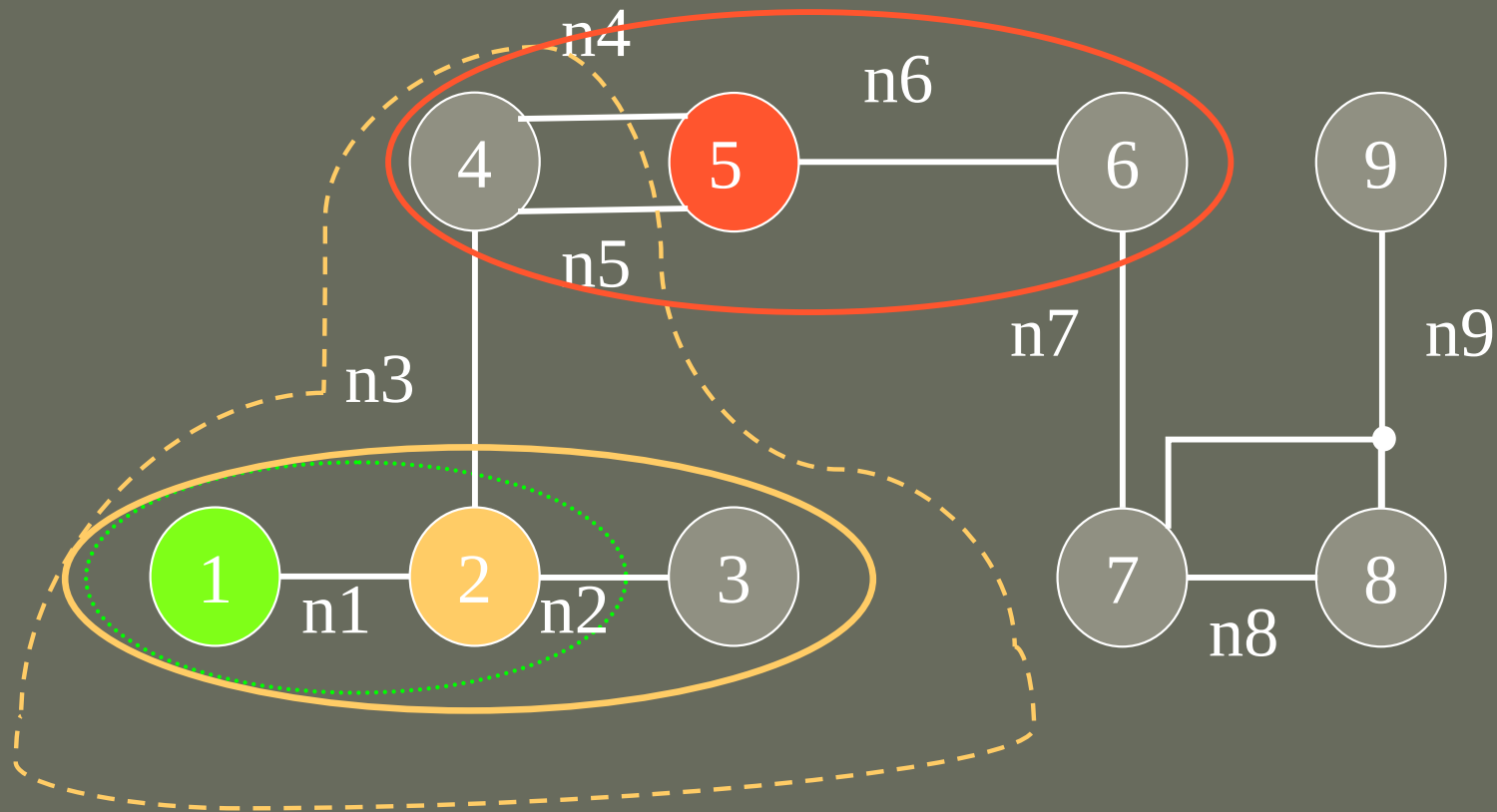


Net Cluster - Cluster refinement

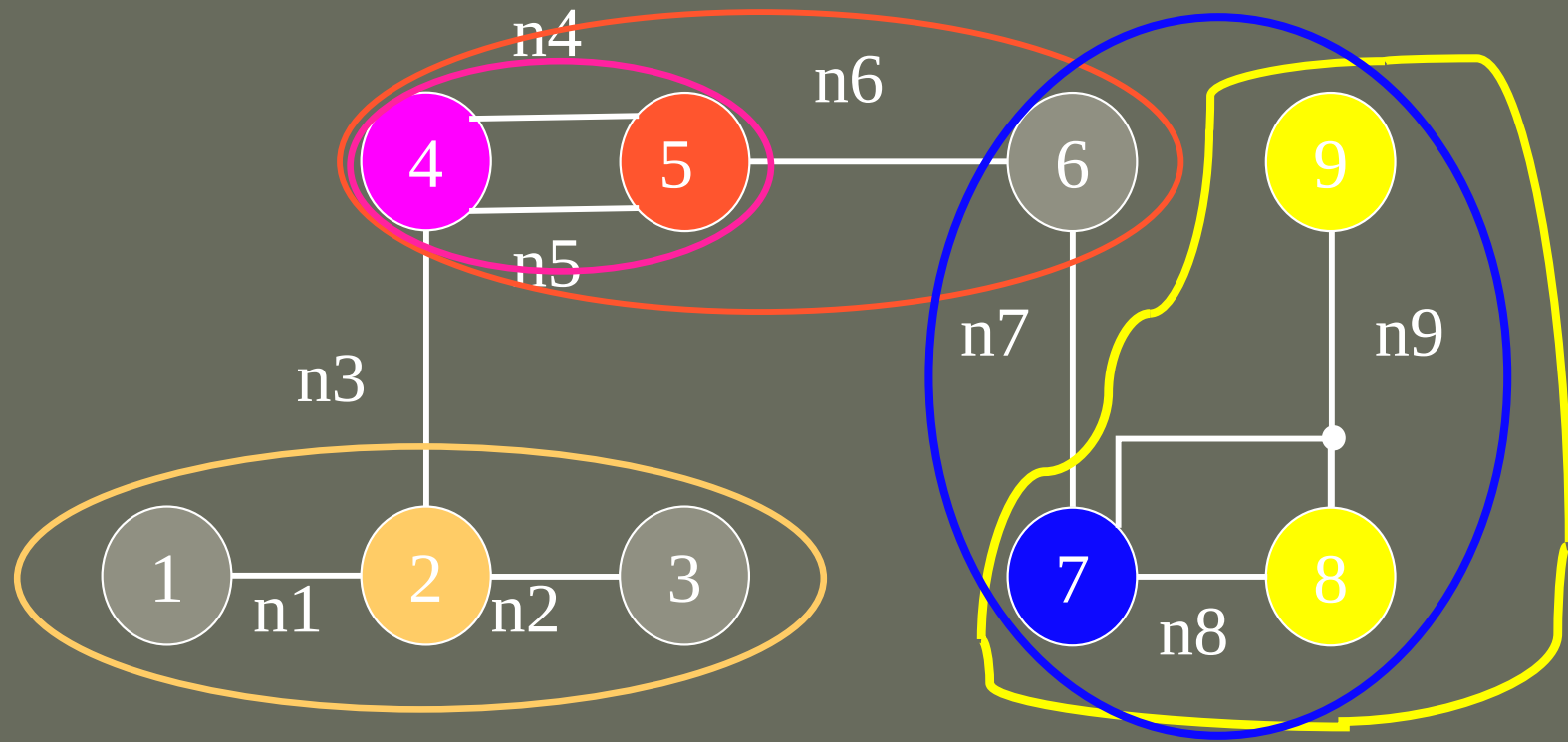
Use one-way FM to remove any cell with more connection to outside



Net Cluster - Cluster refinement

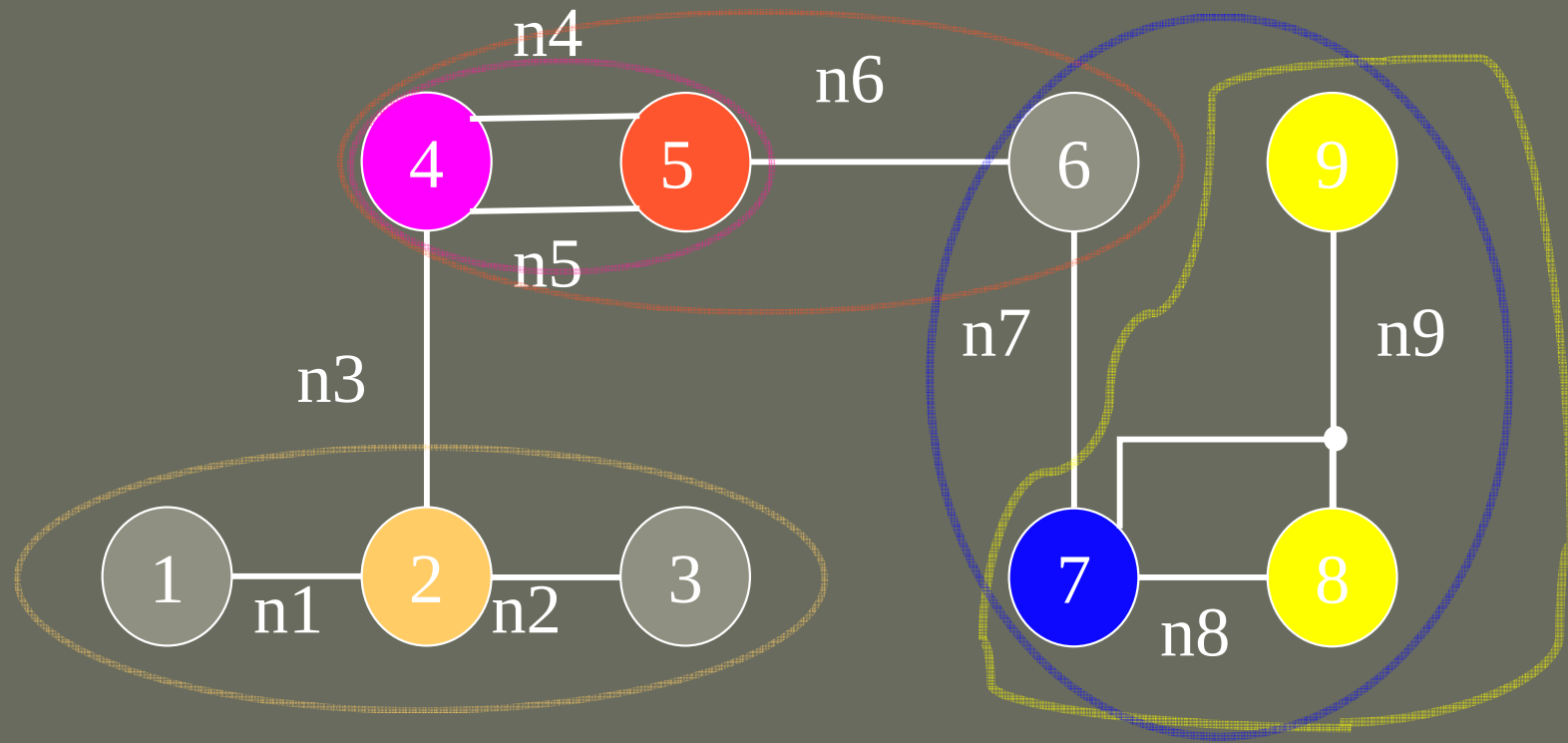


Net Cluster - Cluster refinement



Which clusters to choose?

Net Cluster - Cluster refinement

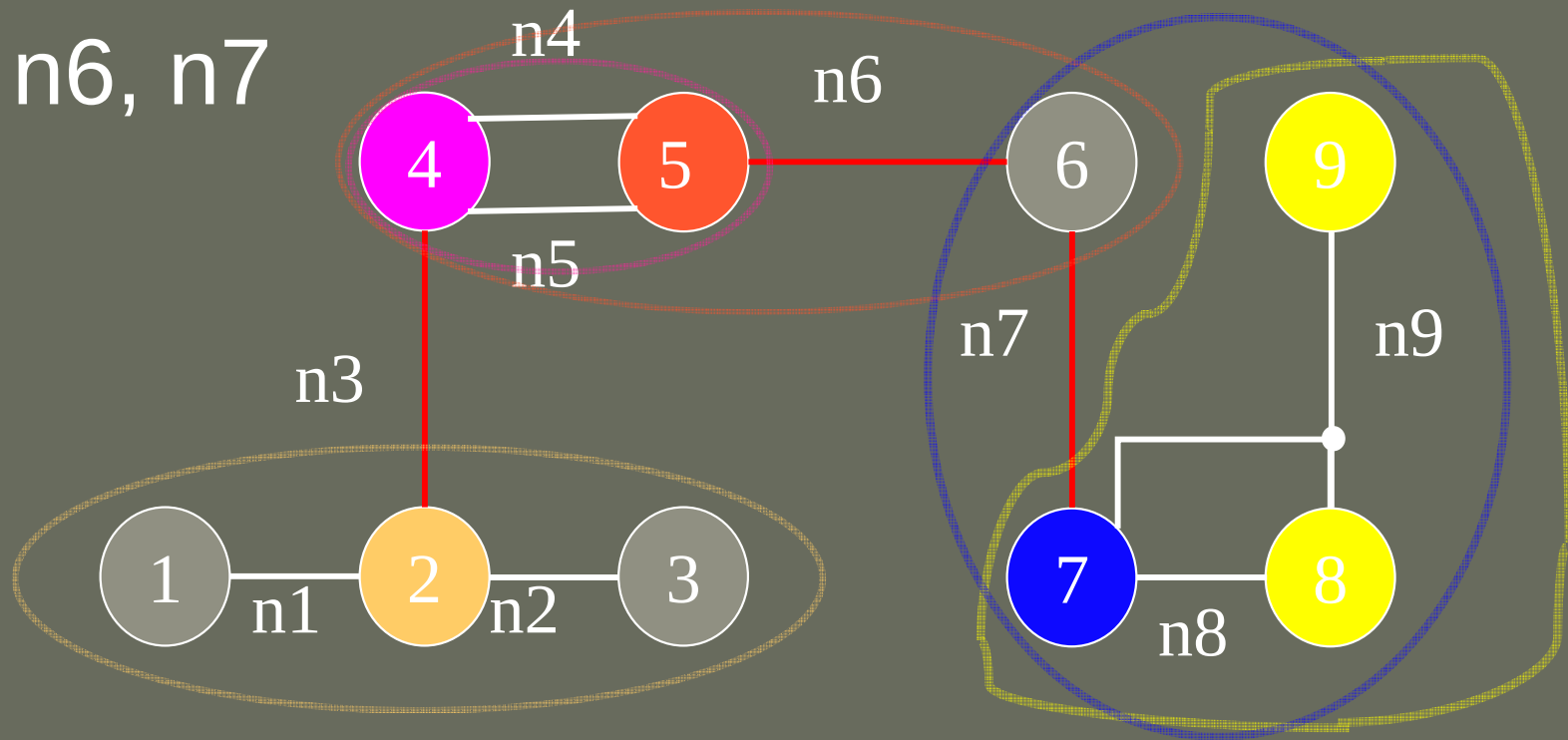


Let's forget about the clusters

Net Cluster - Score Calculation

Nets cut: _____

n3, n6, n7



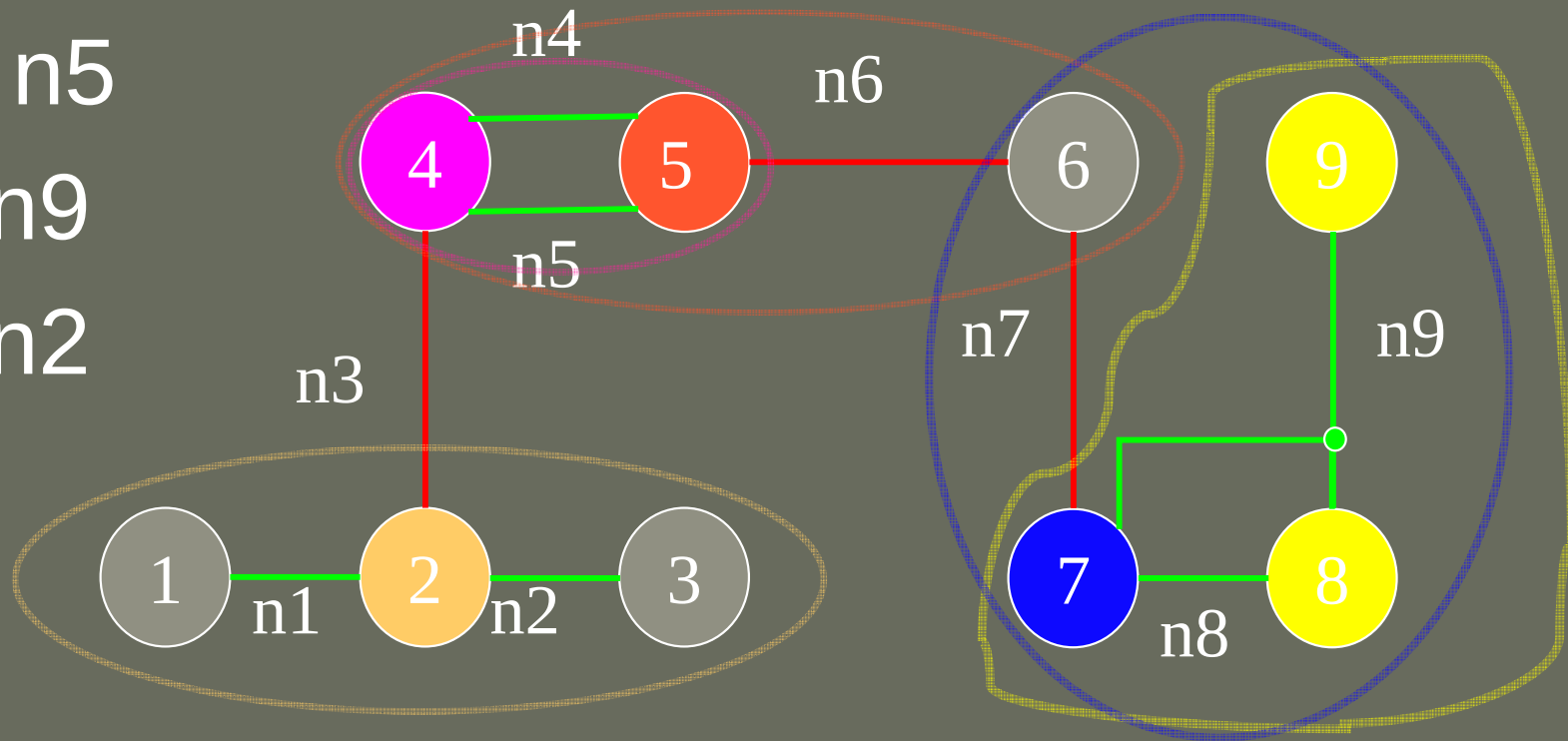
Net Cluster - Score Calculation

Nets only clustered: —

n4, n5

n8, n9

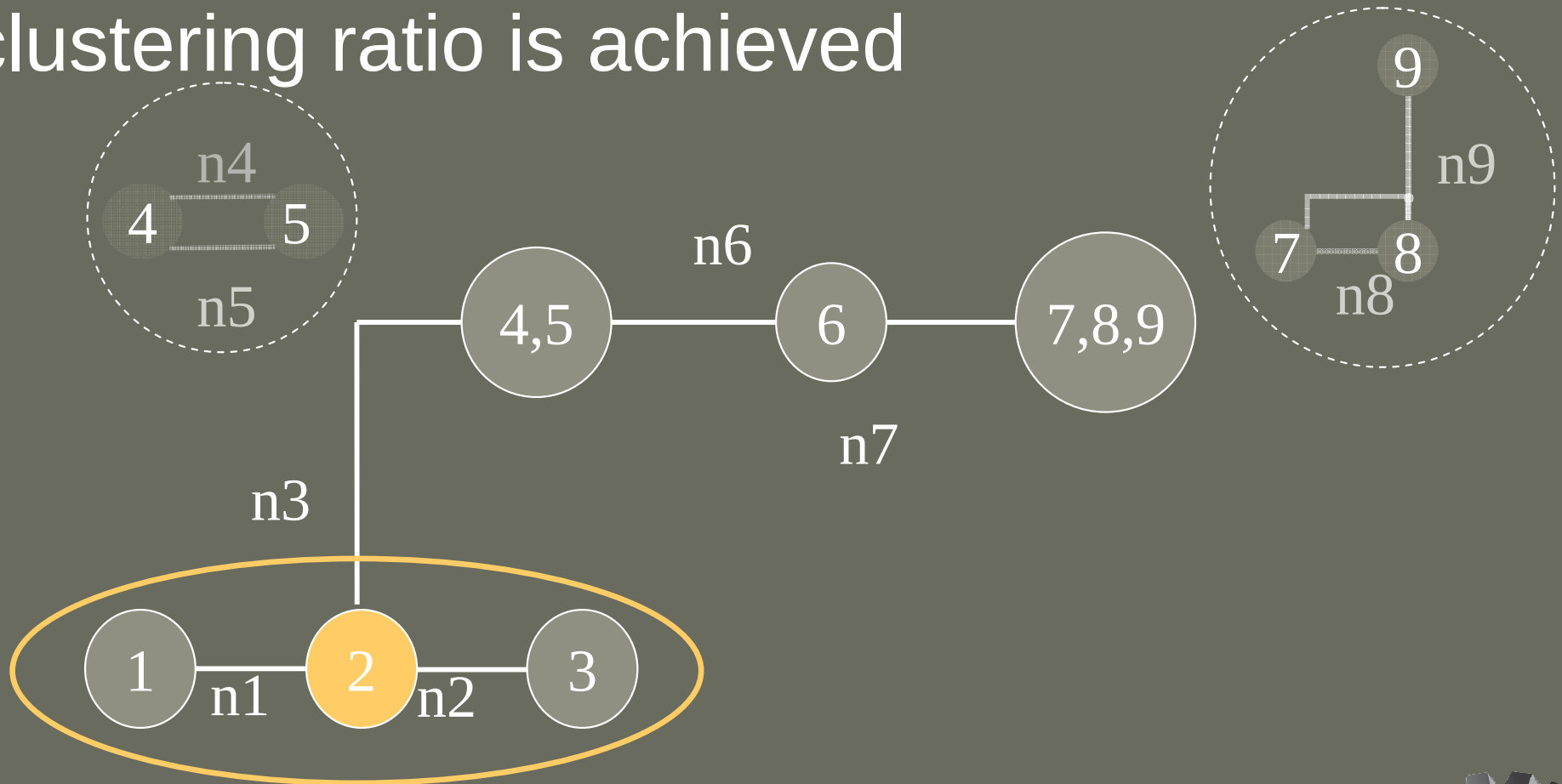
n1, n2





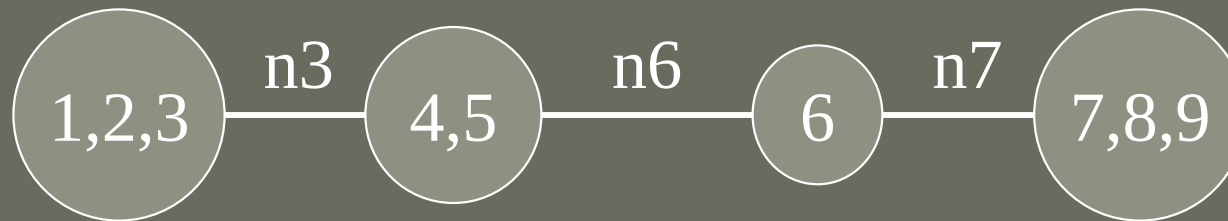
Net Cluster - Cluster Formation

Cluster nets based on their score till a clustering ratio is achieved



Net Cluster - Cluster Formation

Final Clustered circuit



Net Cluster - Discussion

Characteristics:

- Identify the natural clusters in a circuit
- Uses a simplified FM to refine clusters
- Assigns scores to nets
- Clusters nets versus cell

-
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Numerical Results

Tested as a preprocessing step for multilevel partitioning.

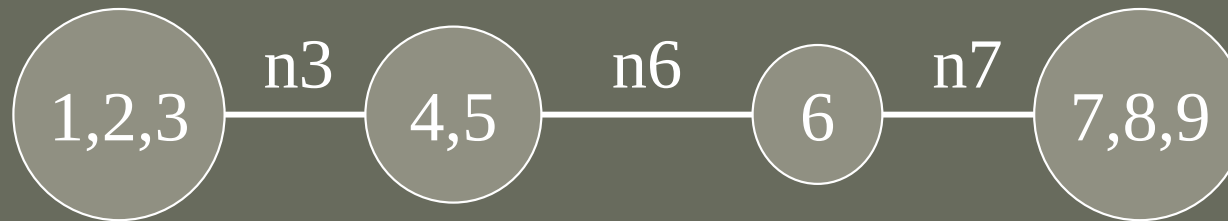
Why Partitioning:

- Easy implementation
- Less parameters affecting the results

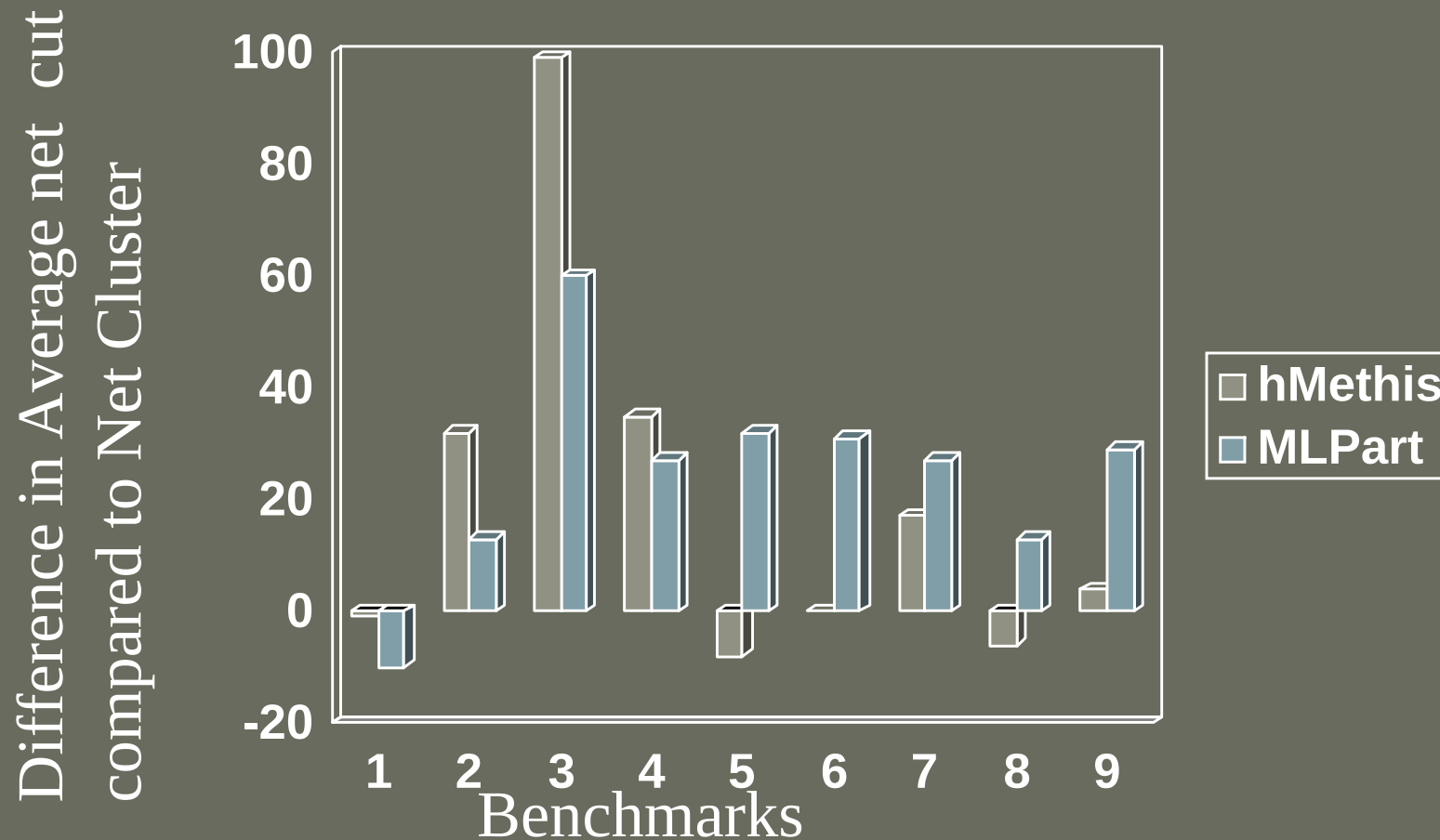
Numerical Results

Preprocessing:

- The number of natural clusters decreases dramatically after first few levels



Numerical Results - net cuts (1)



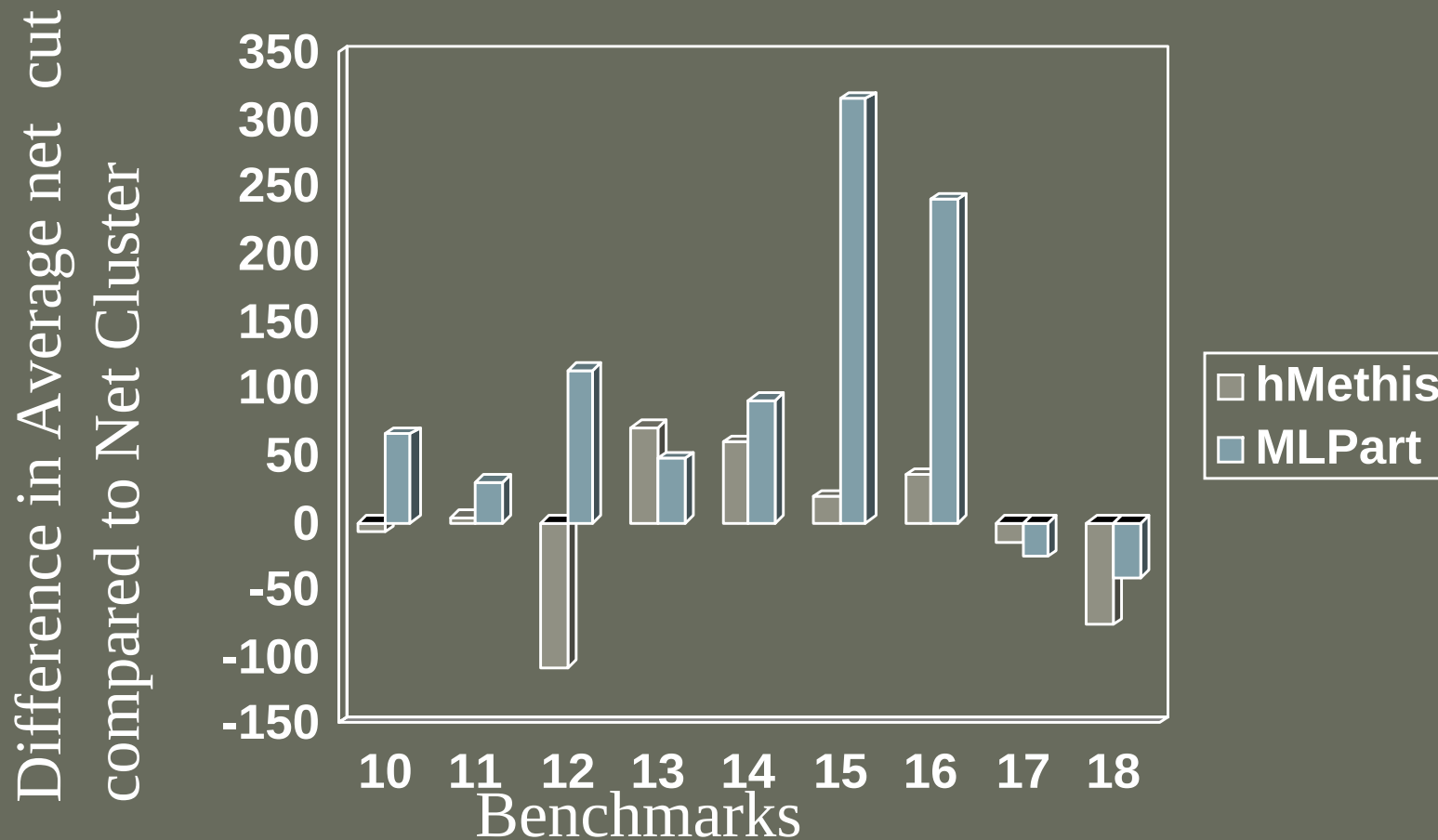
Net cut comparison for ISPD 98 benchmarks

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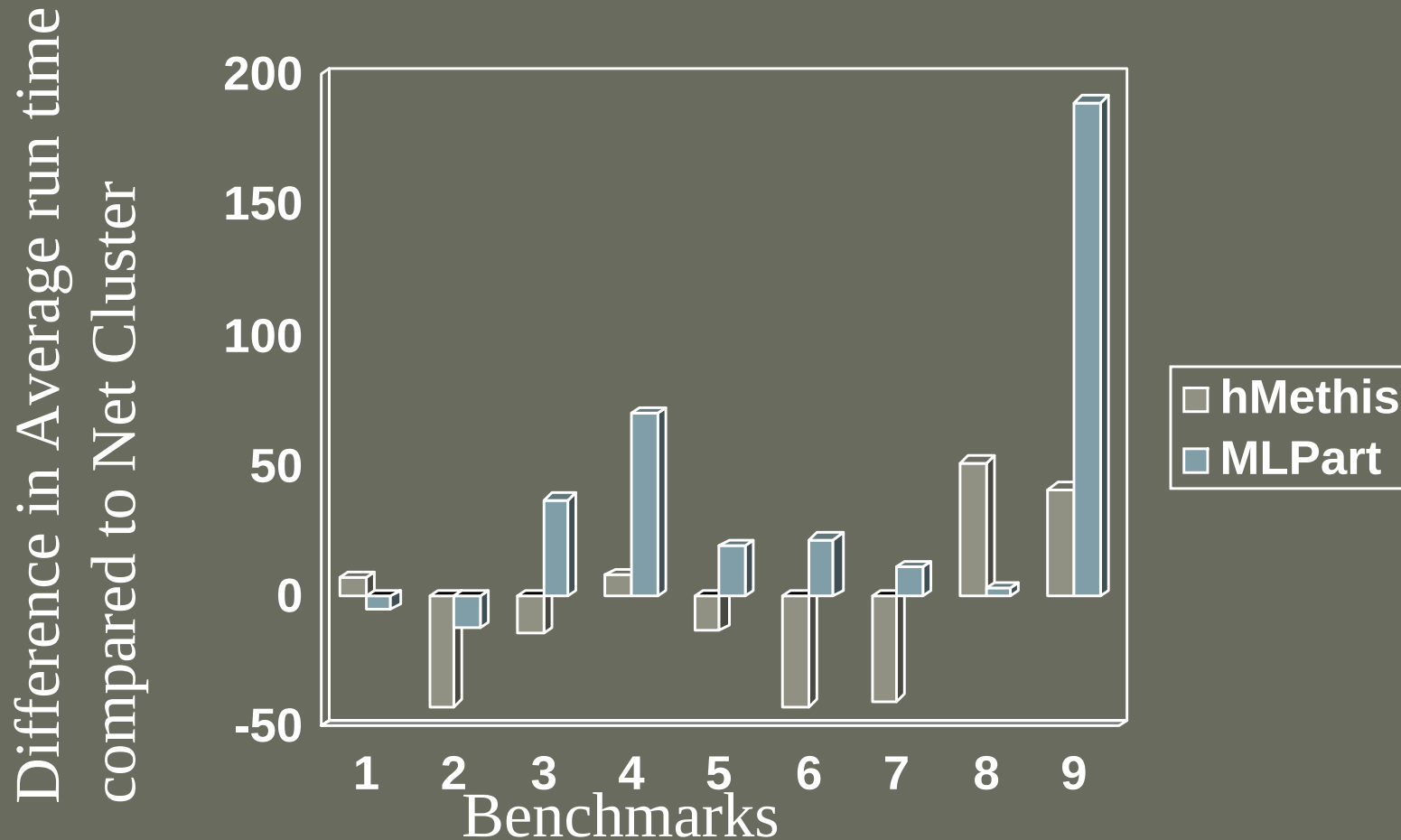


Numerical Results - net cuts (2)



Net cut comparison for ISPD 98 benchmarks

Numerical Results - run times (1)



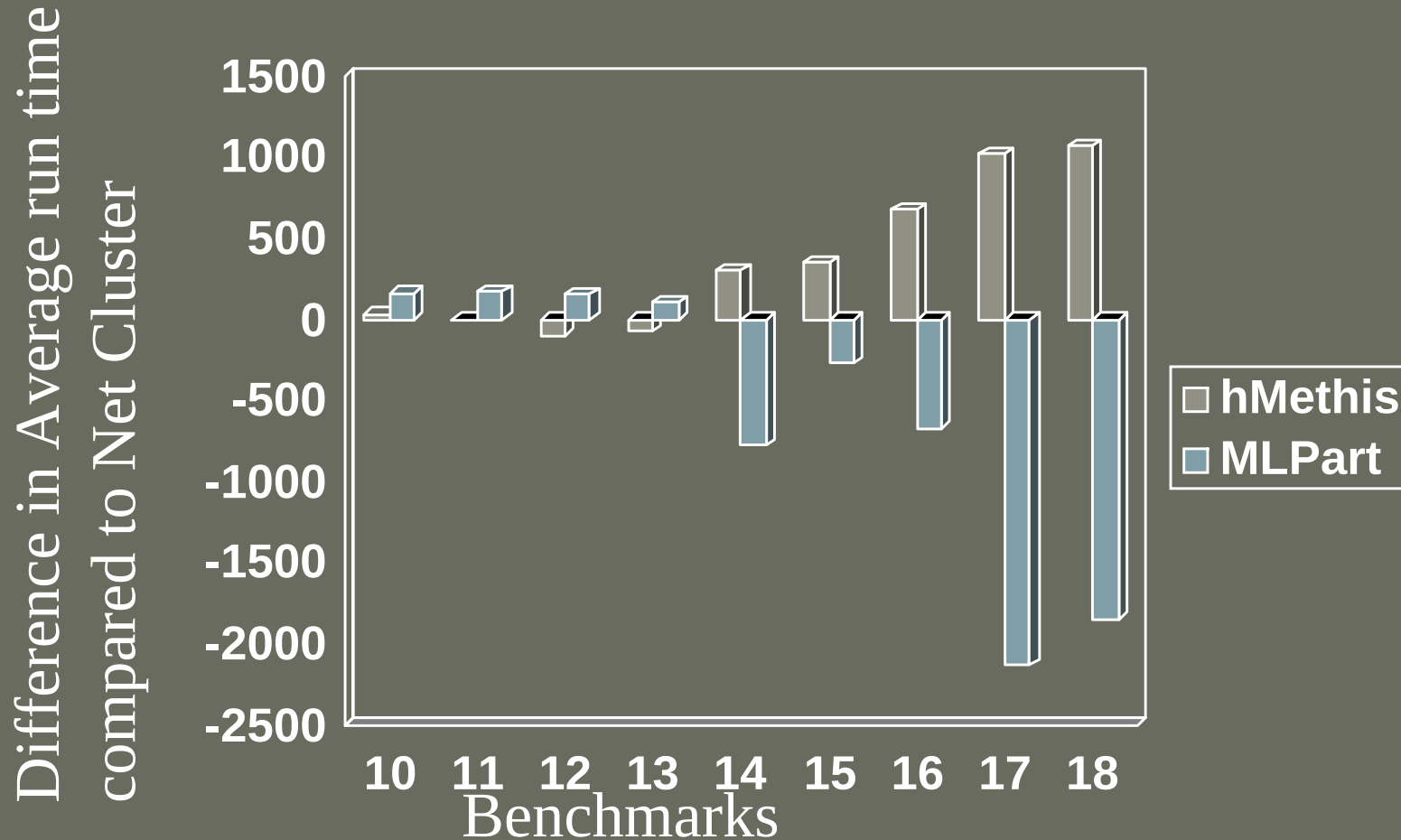
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Numerical Results - run times (2)



Net cut comparison for ISPD 98 benchmarks

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Conclusions and Future Work

- Developed a deterministic clustering algorithm
- Is capable of finding the natural clusters
- Focuses on clustering nets versus cells

Future Work

- Techniques for developing initial clusters in the lower levels
- Application to placement

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