# Mysticeti

## The consensus protocol

Alberto Sonnino

# The Mysticeti Consensus

## In 45 minutes

### In scope

- Consensus rule

### Out of scope

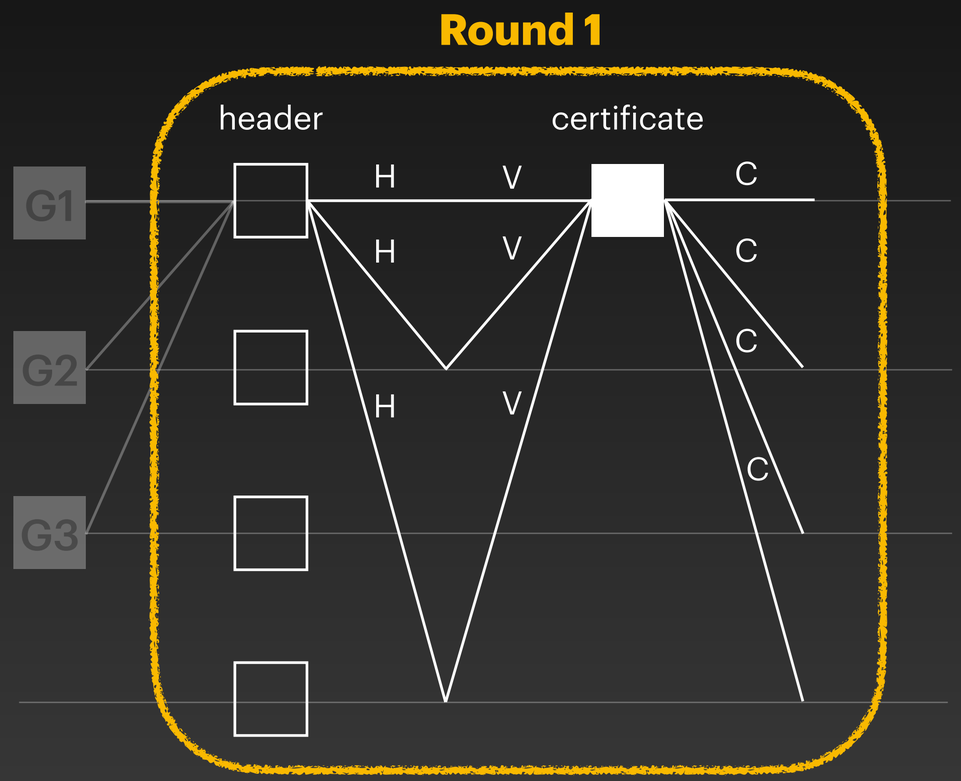
- System design
- Fast path

# All messages are in the DAG

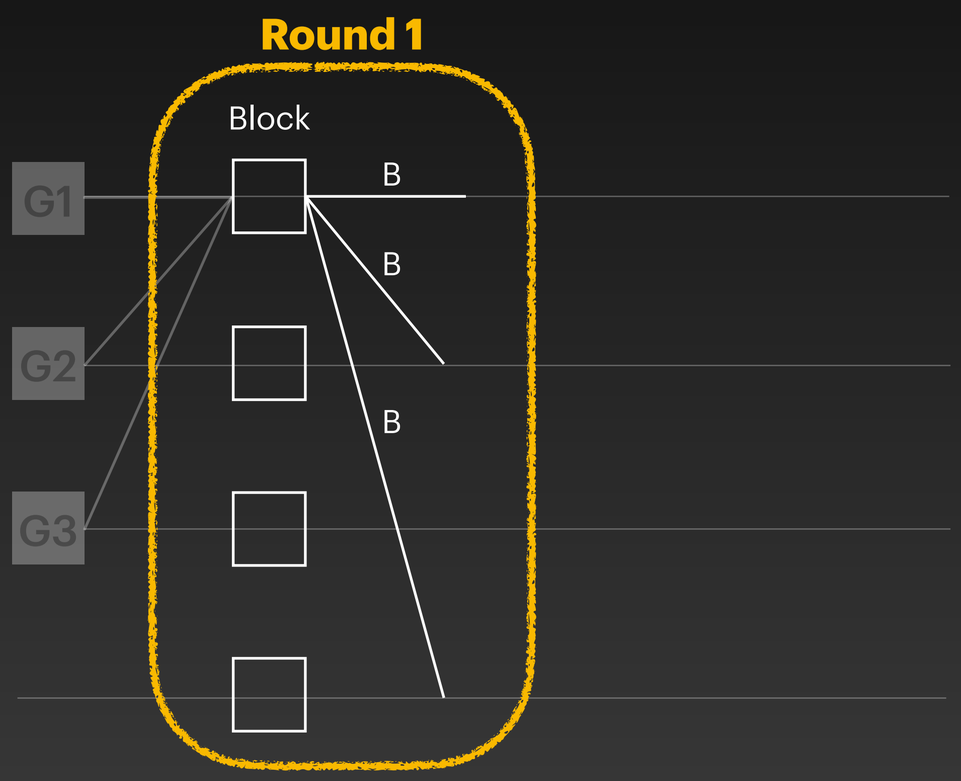
Few signatures & Earlier decisions

# The DAG

## Narwhal



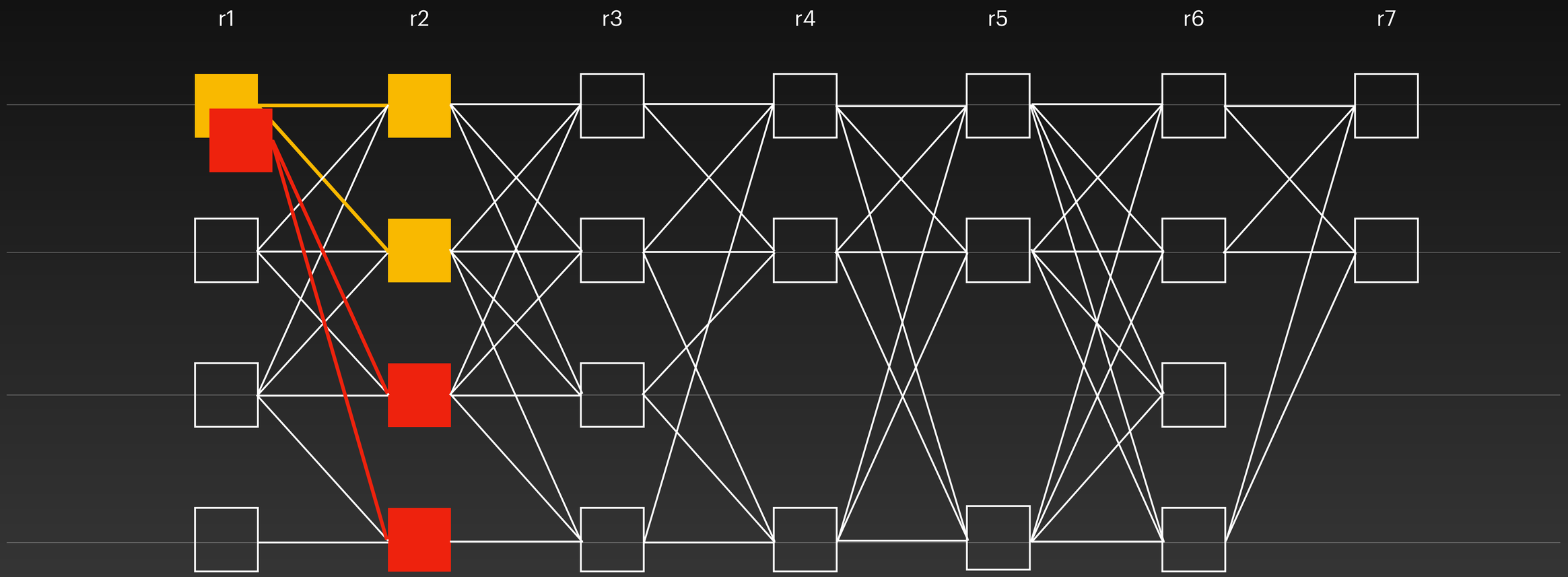

## Mysticeti



# Uncertified DAG... took you 3 years?

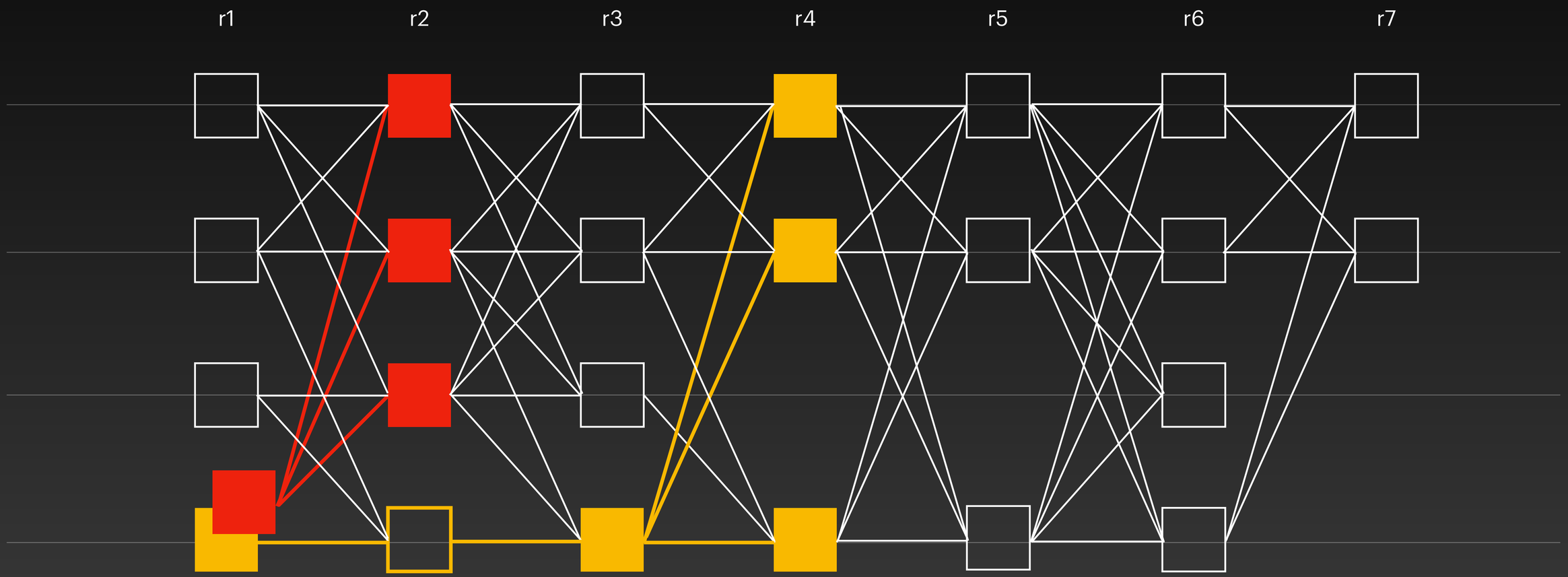
# The Mysticeti DAG

## Possible equivocations



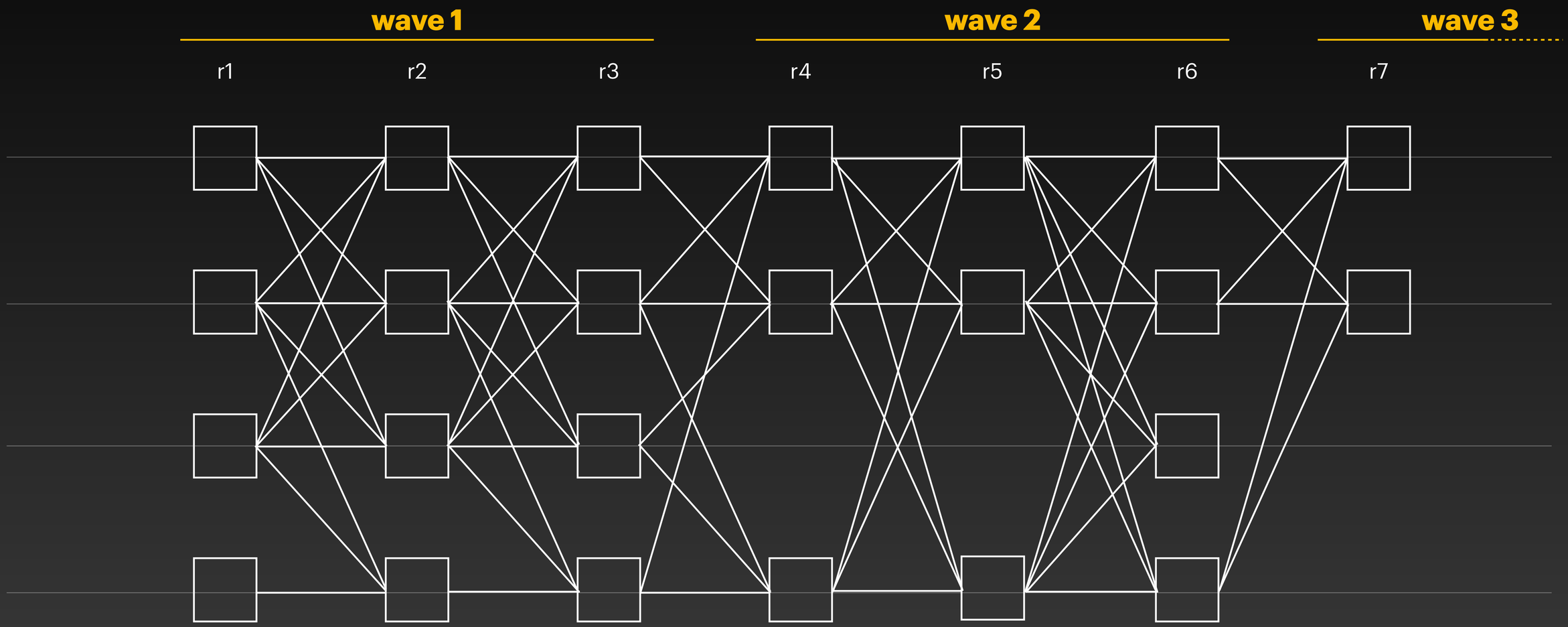
# The Mysticeti DAG

## Possible equivocations (even with 2f+1 support)

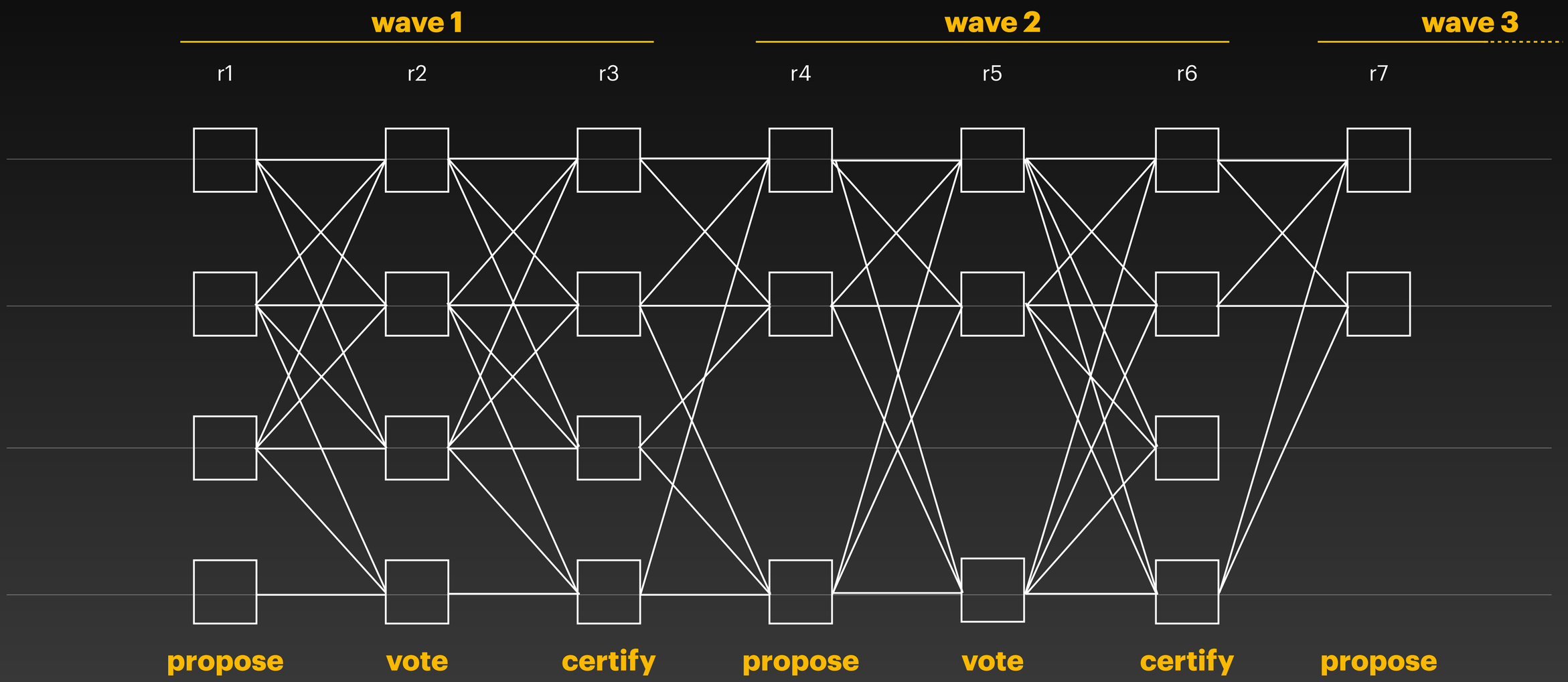


# Baseline Mysticeti

# The Mysticeti DAG



# The Mysticeti DAG



# Decision Rules

## Upon interpreting the dag...

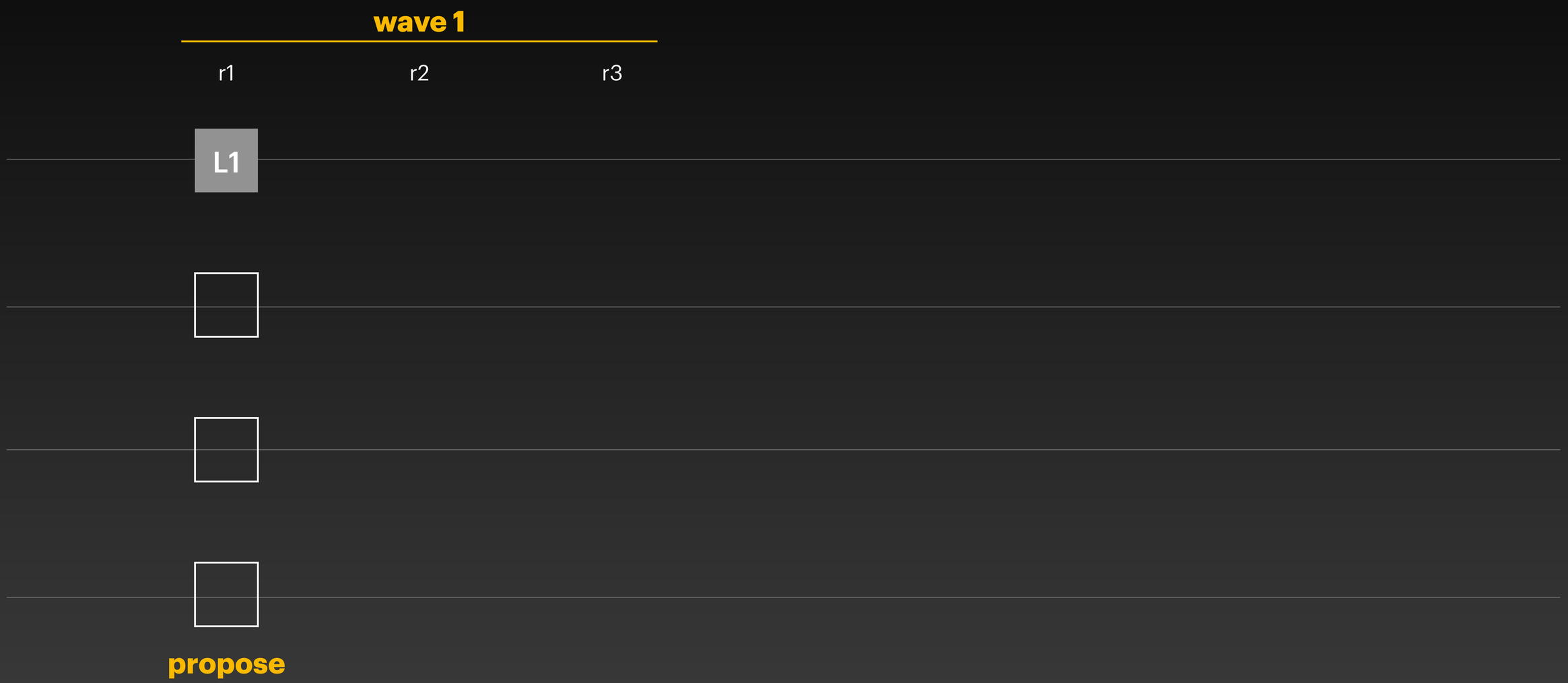
### Bullshark

- A leader is **Commit** or not
- Either directly or indirectly (recursion)

### Mysticeti

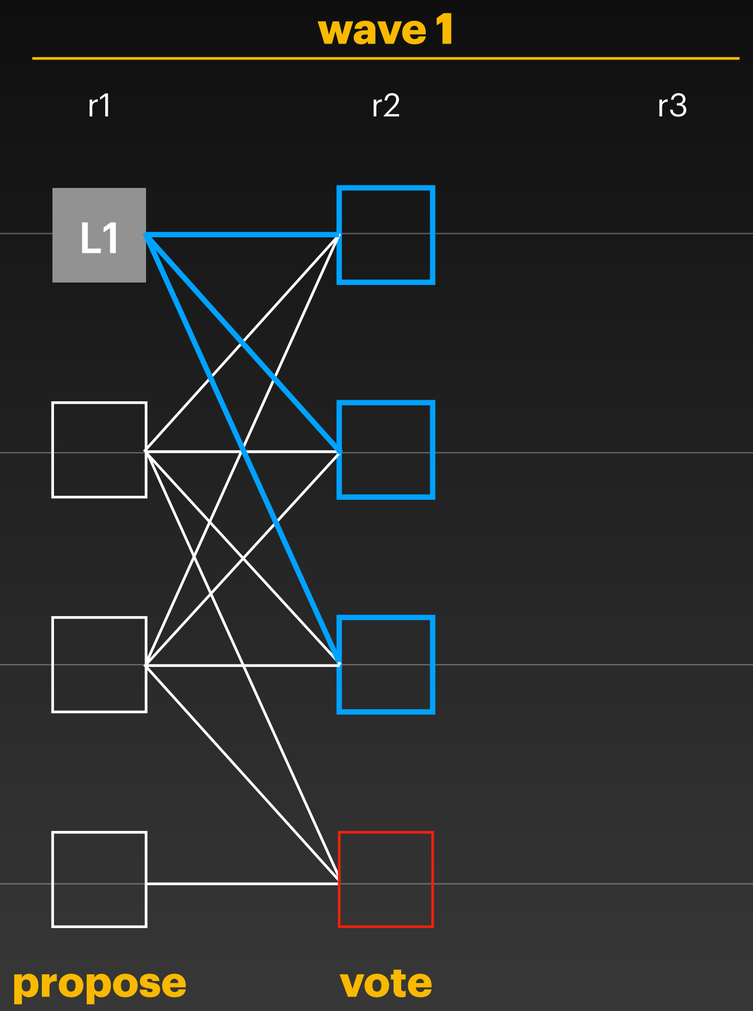
- A leader is **Commit**, **Skip**, or **Undecided**
- Either directly or indirectly (recursion)

# Direct Commit

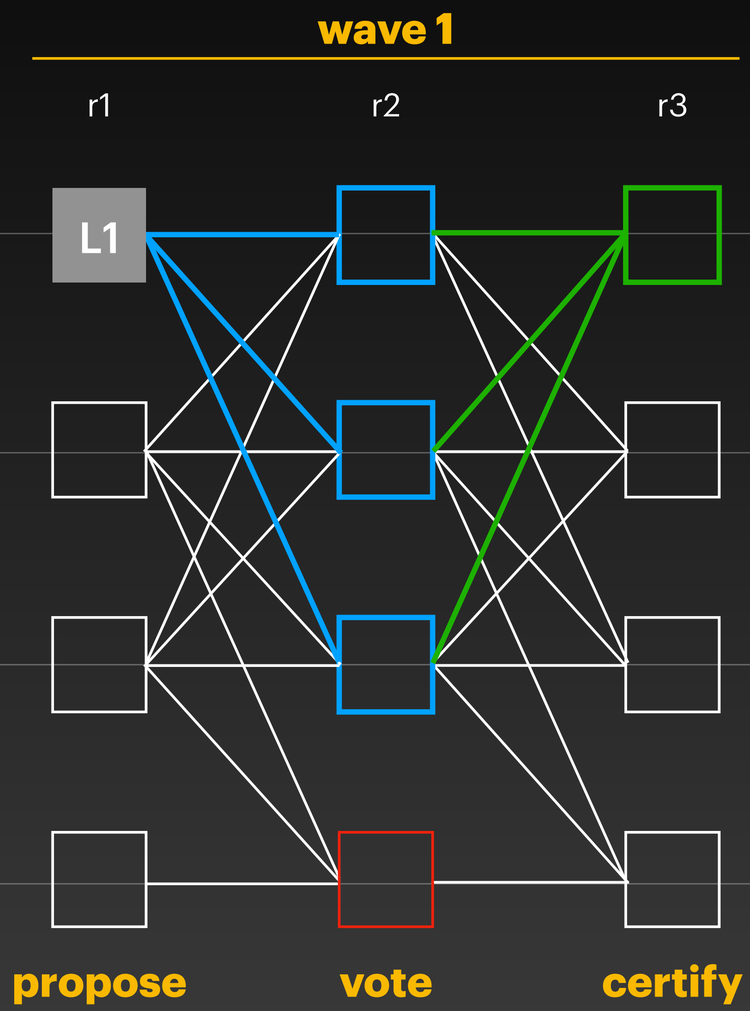


# Direct Commit

## 2f+1 votes

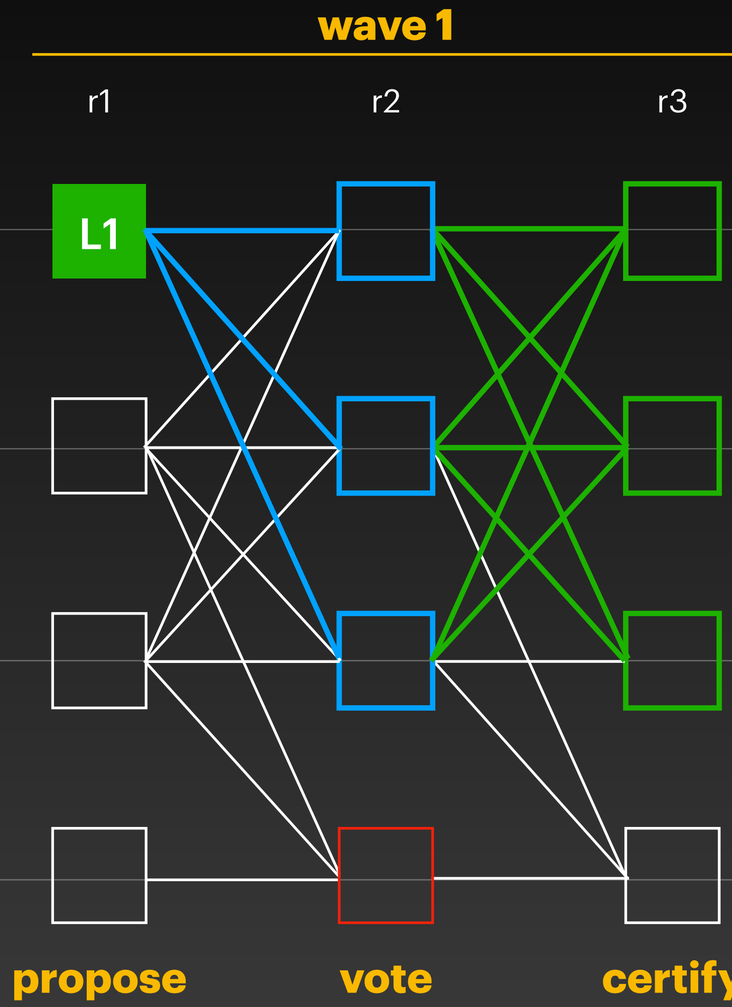


# Direct Commit



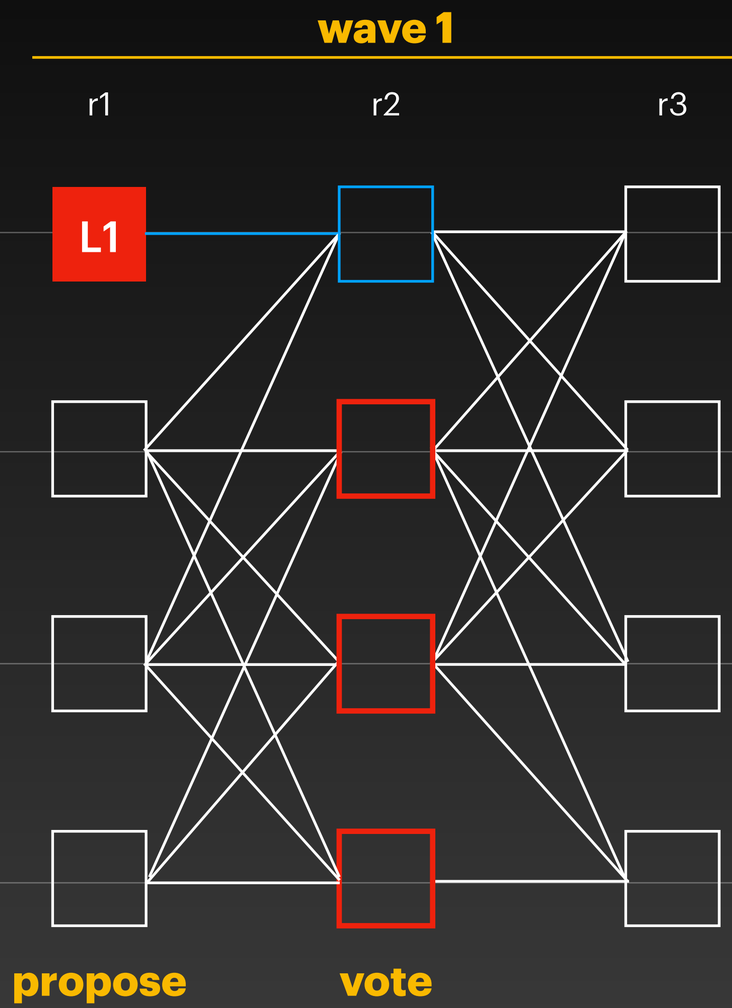
# Direct Commit

## 2f+1 certificates



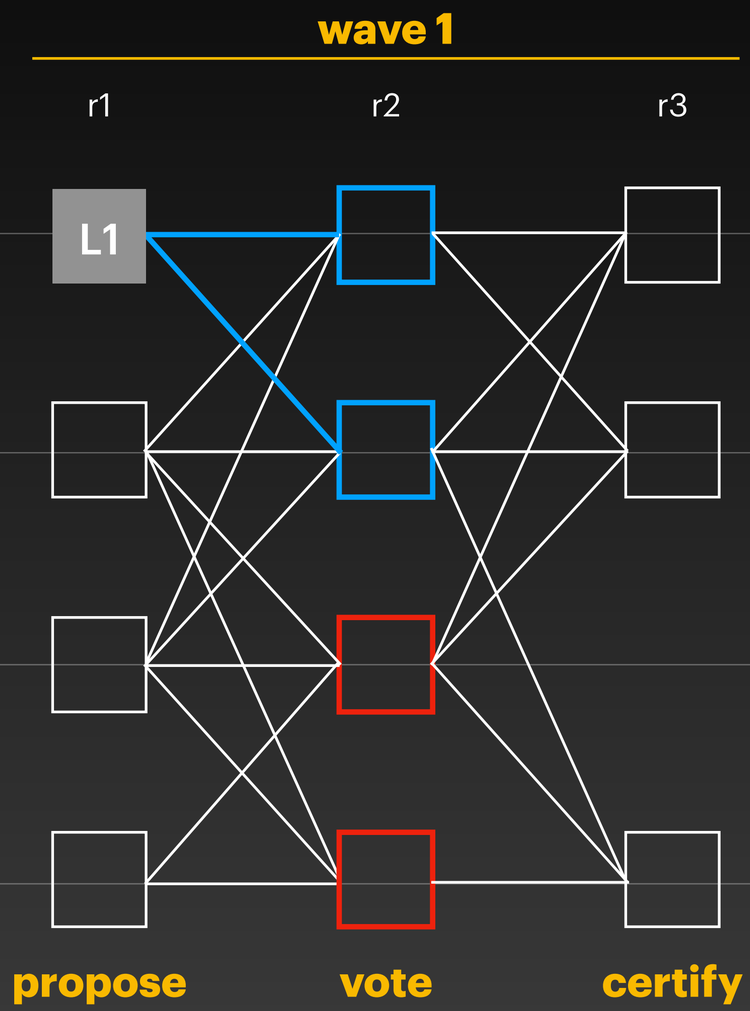
# Direct Skip

## 2f+1 blames



# Undecided

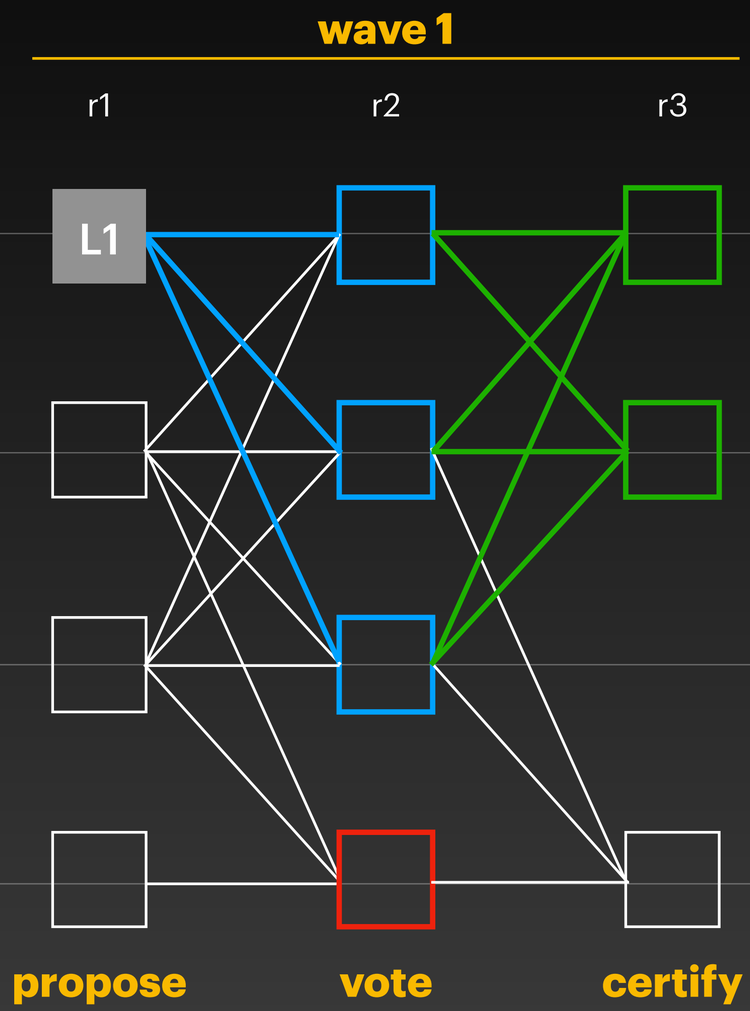
## <2f+1 blames and <2f+1 certificates



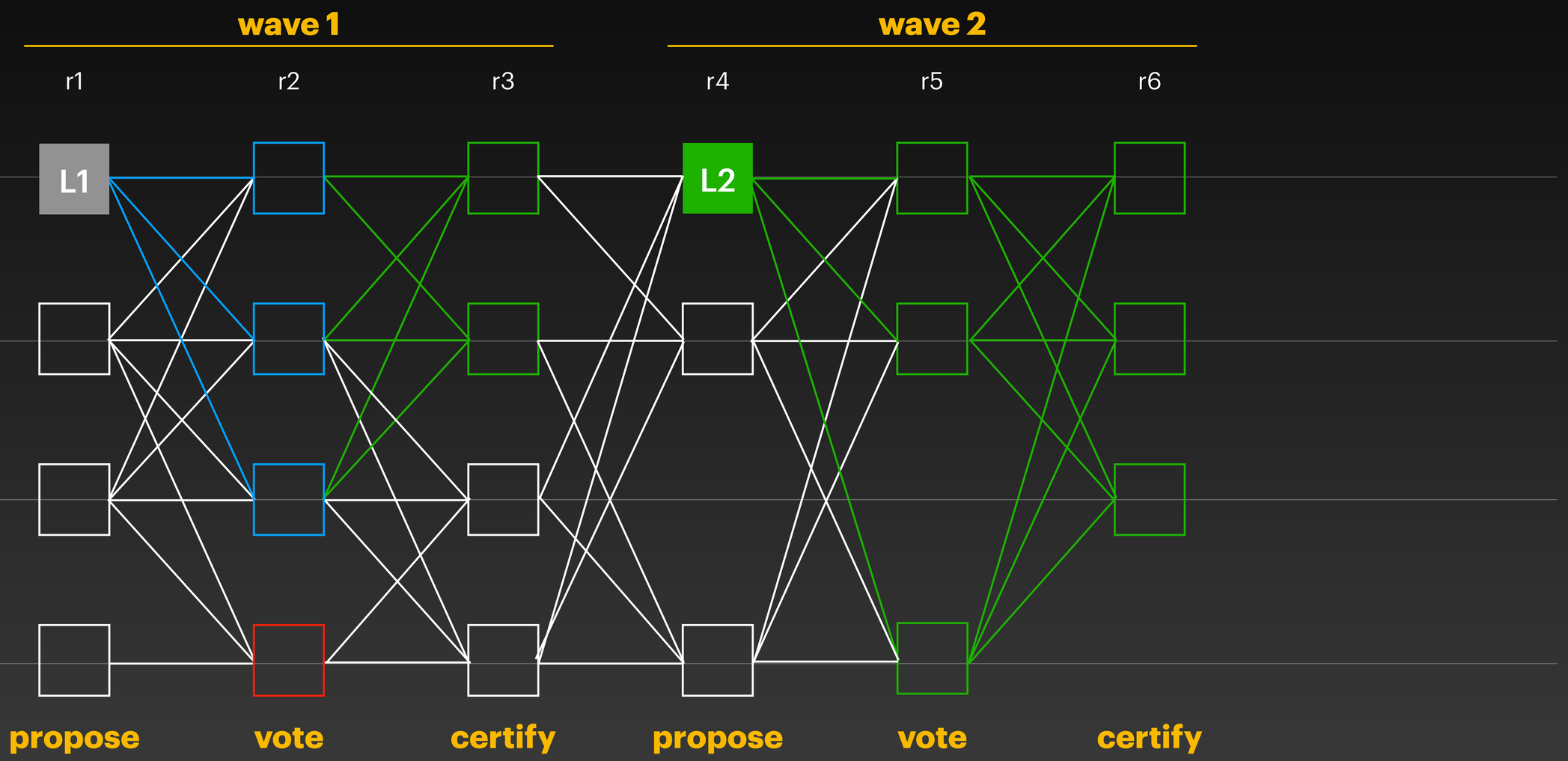

?

# Undecided

## <2f+1 blames and <2f+1 certificates

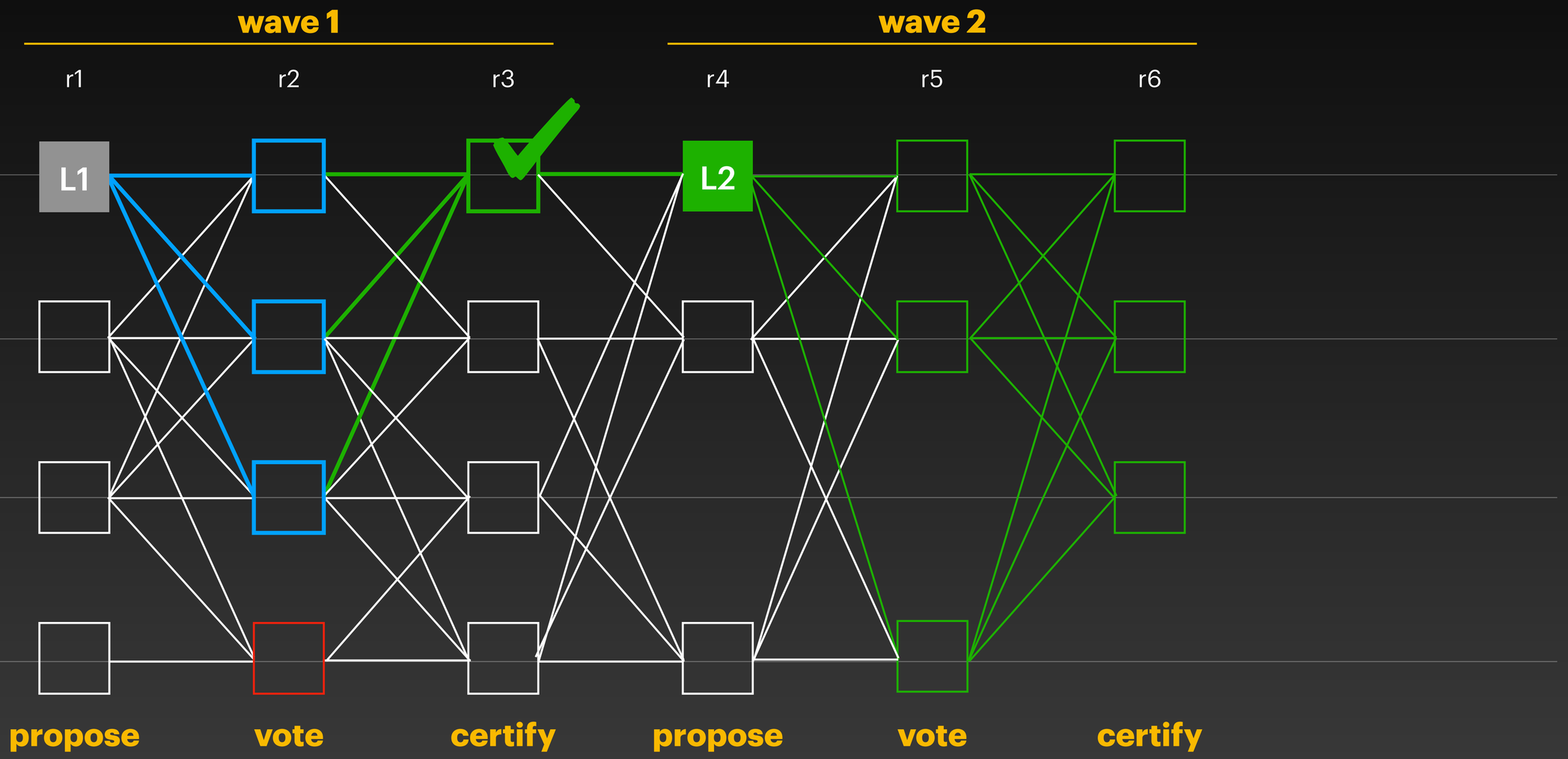


# Indirect Commit



# Indirect Commit

## Certified link to next commit



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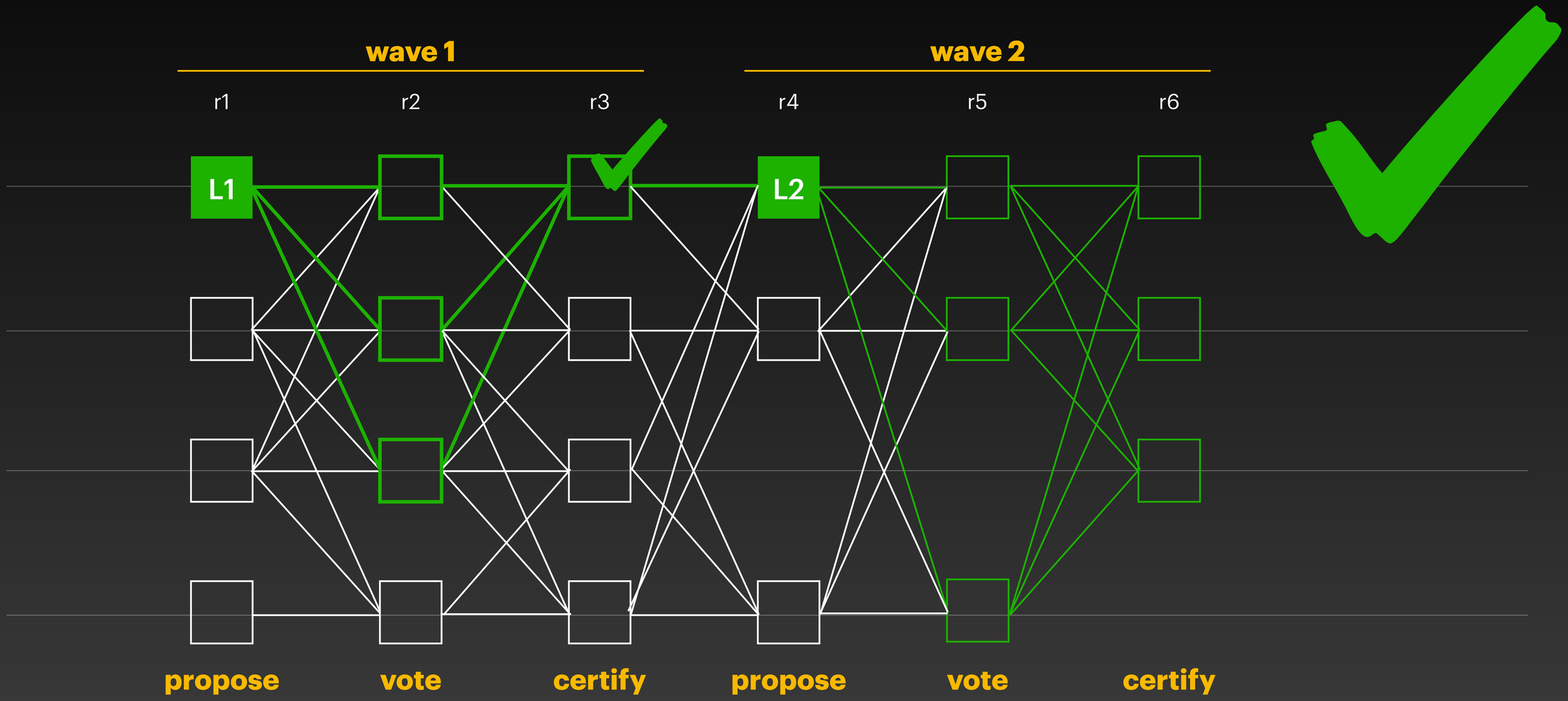
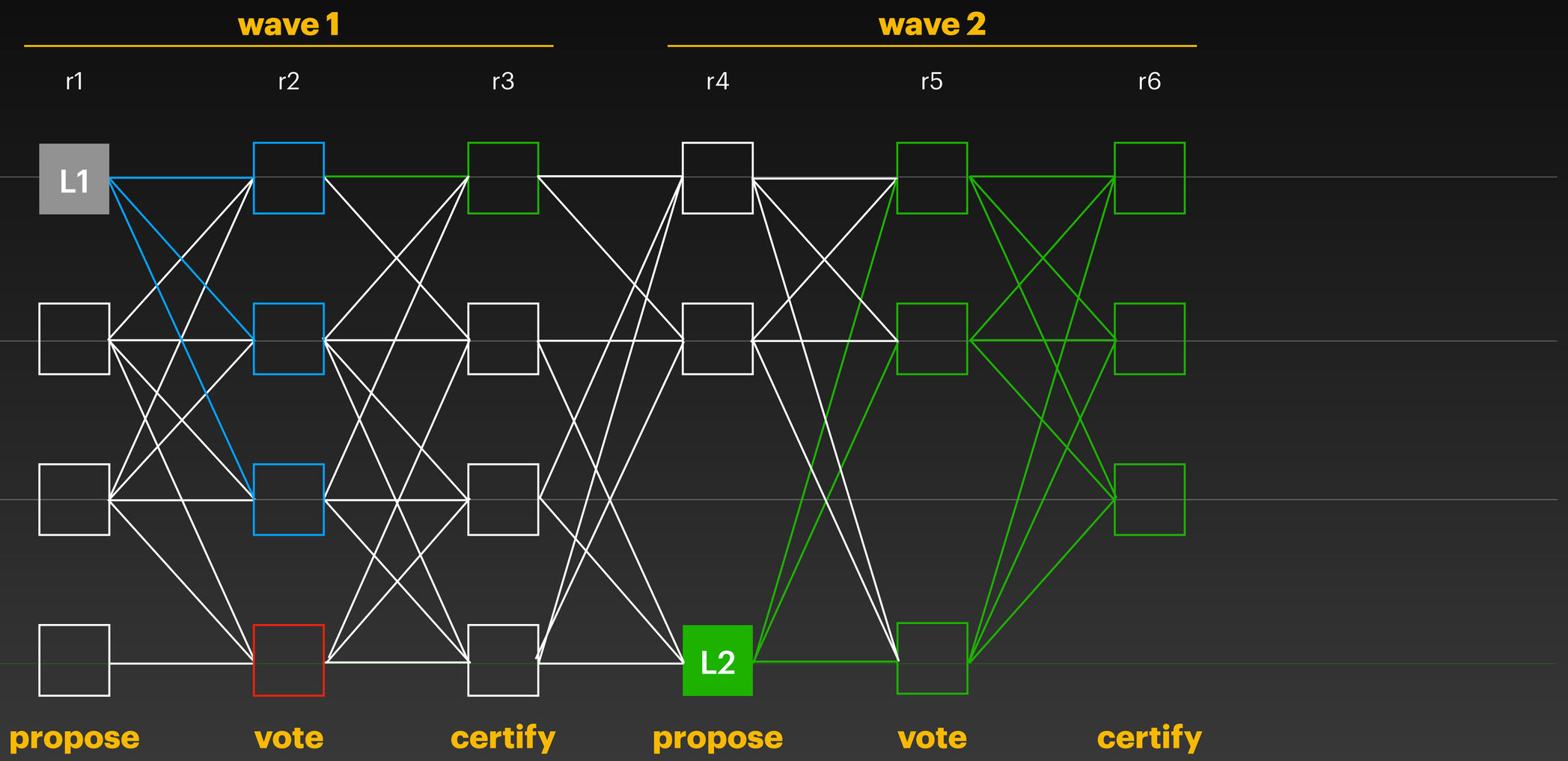
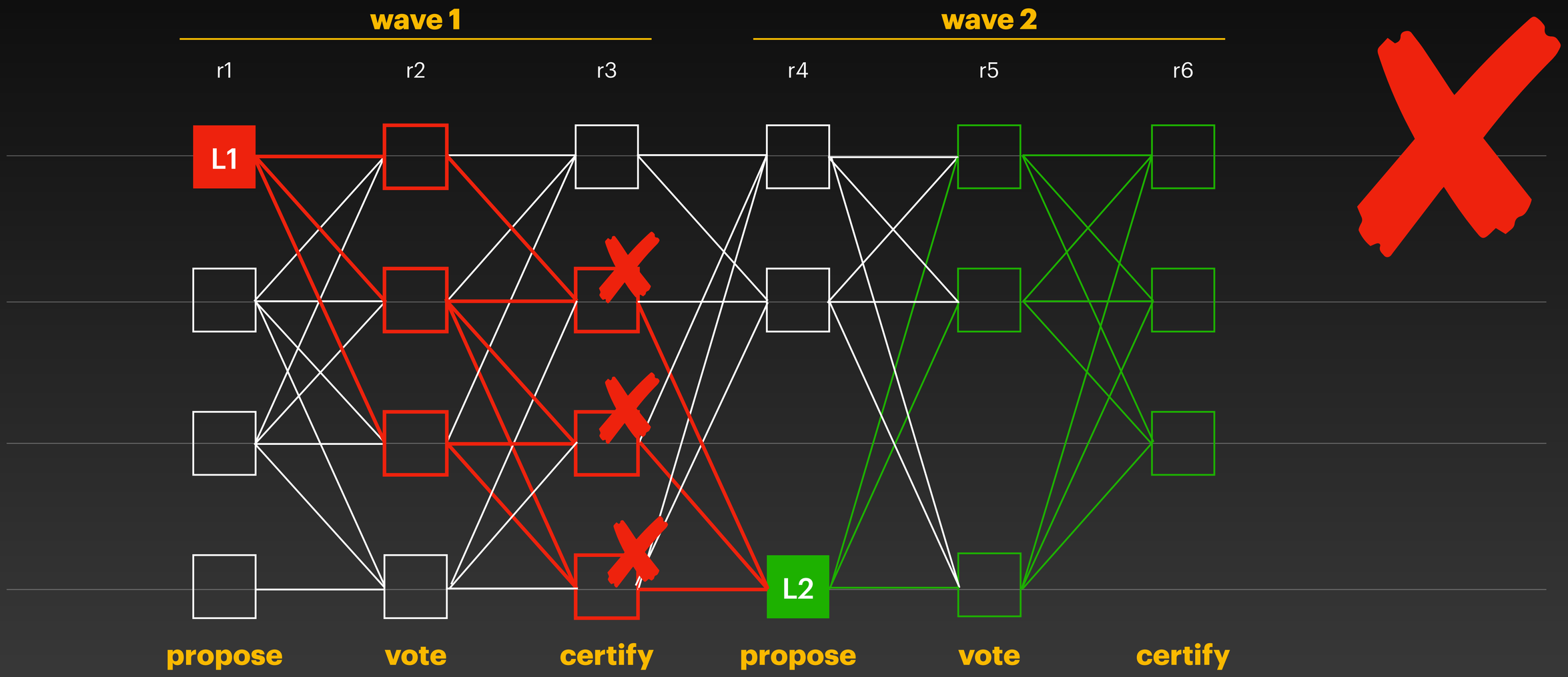


# Indirect Skip



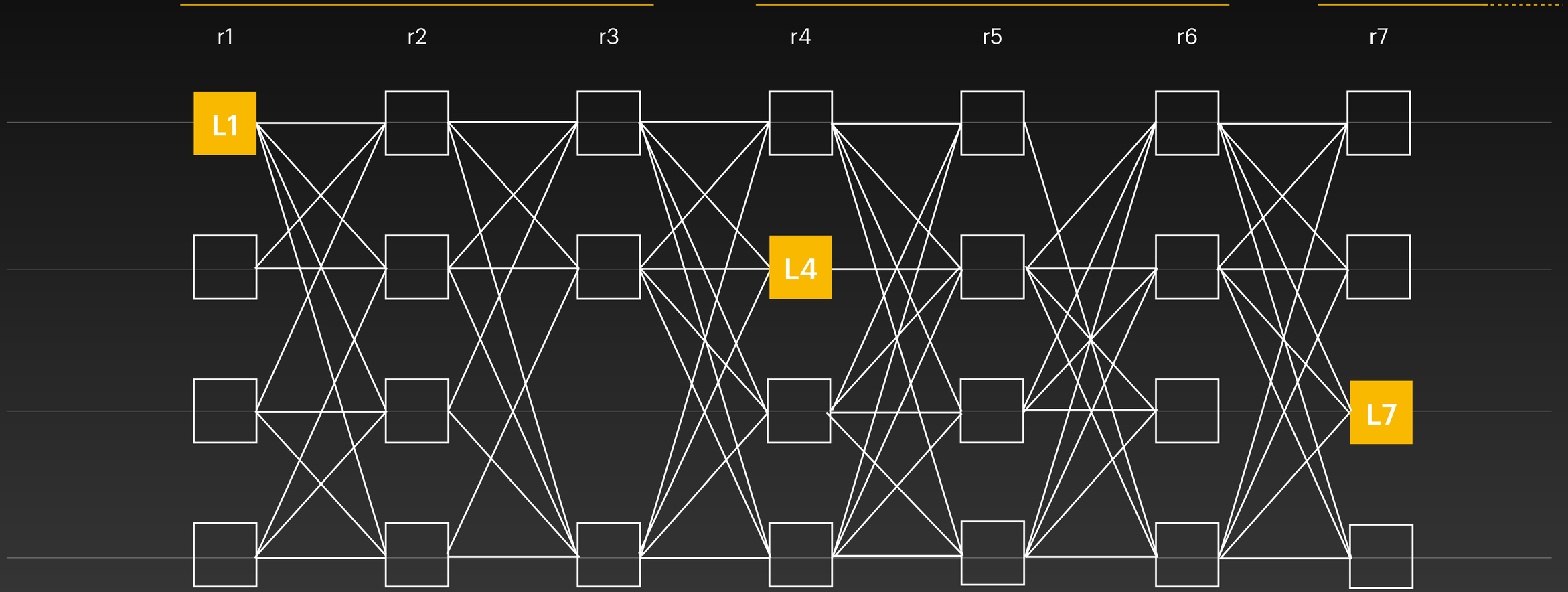
# Indirect Skip

## No certified link to next commit

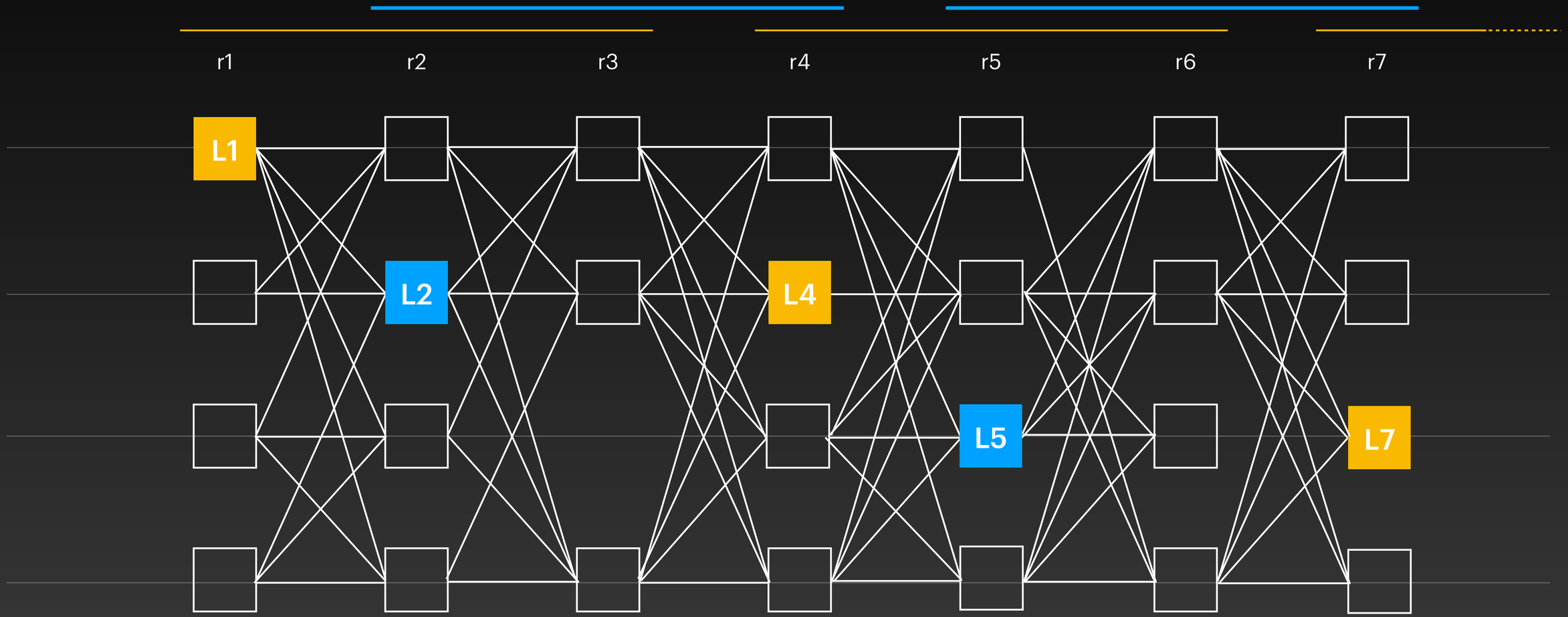


# Universal Mysticeti Committer

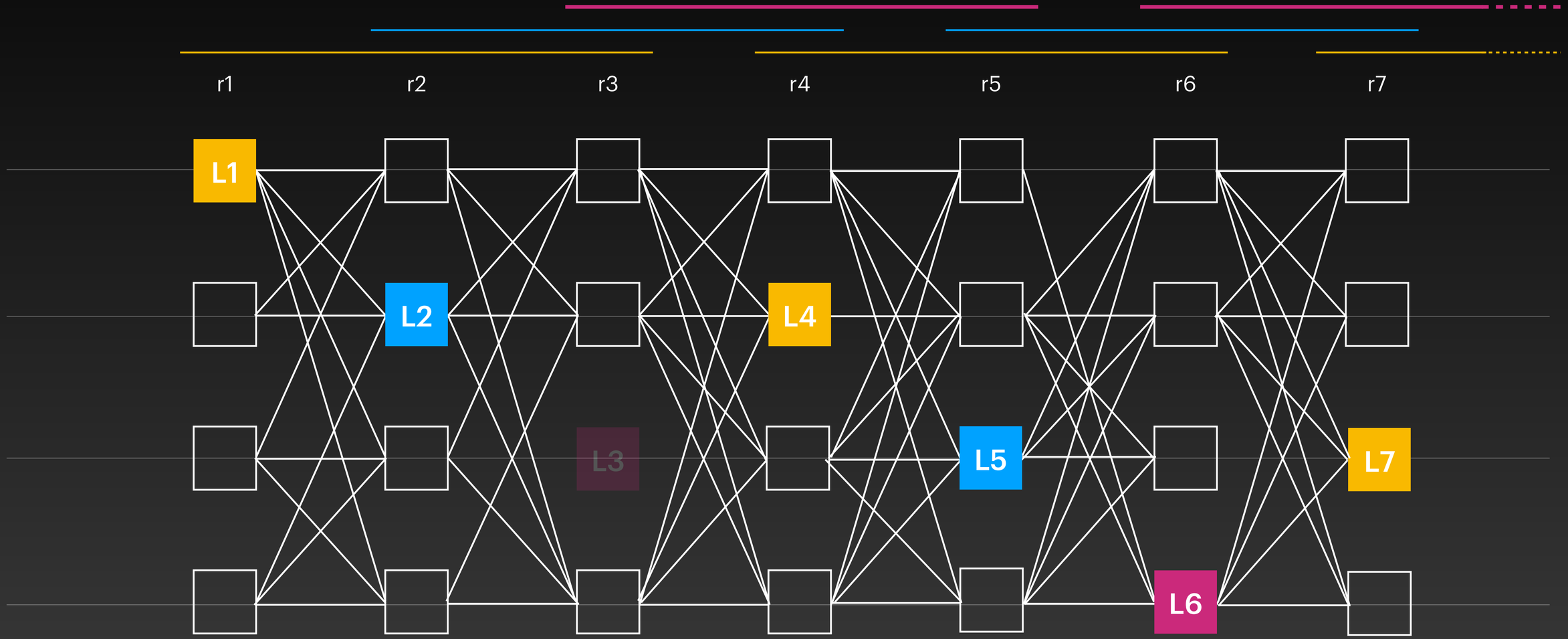
# Pipelined Mysticeti



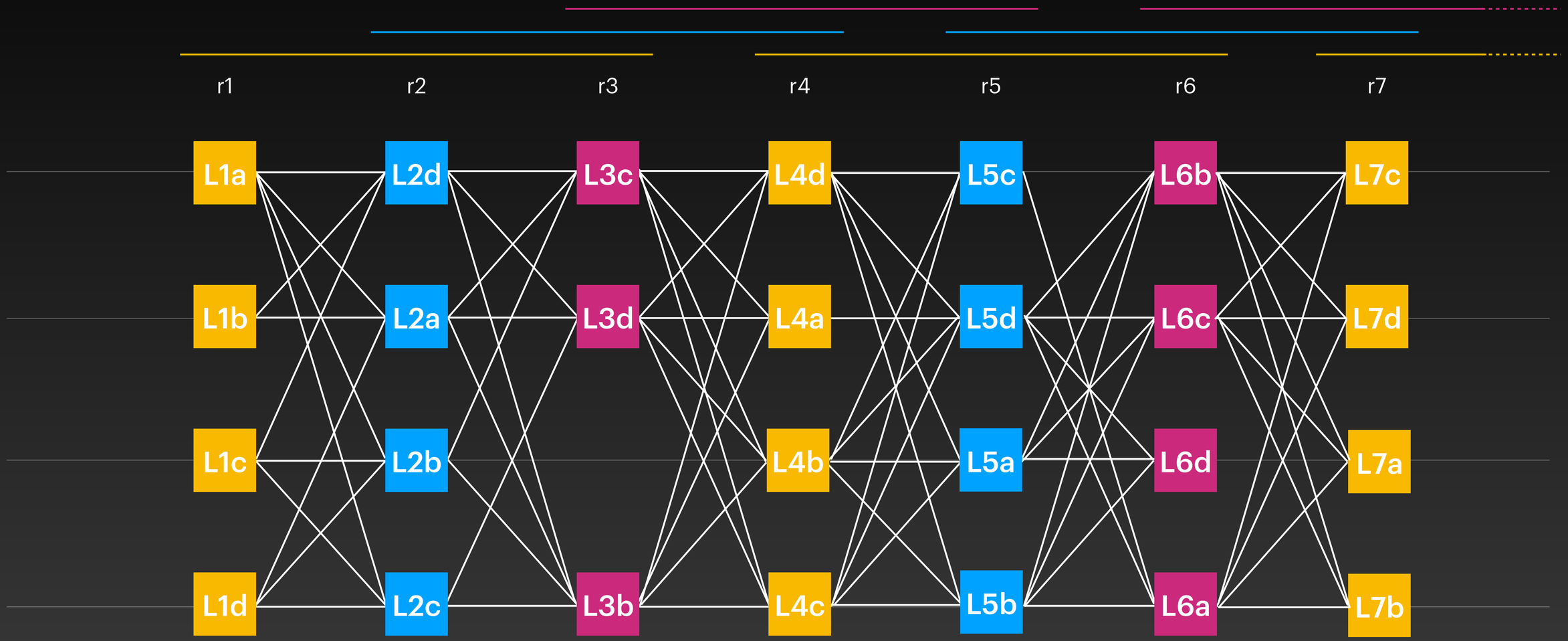
# Pipelined Mysticeti



# Pipelined Mysticeti



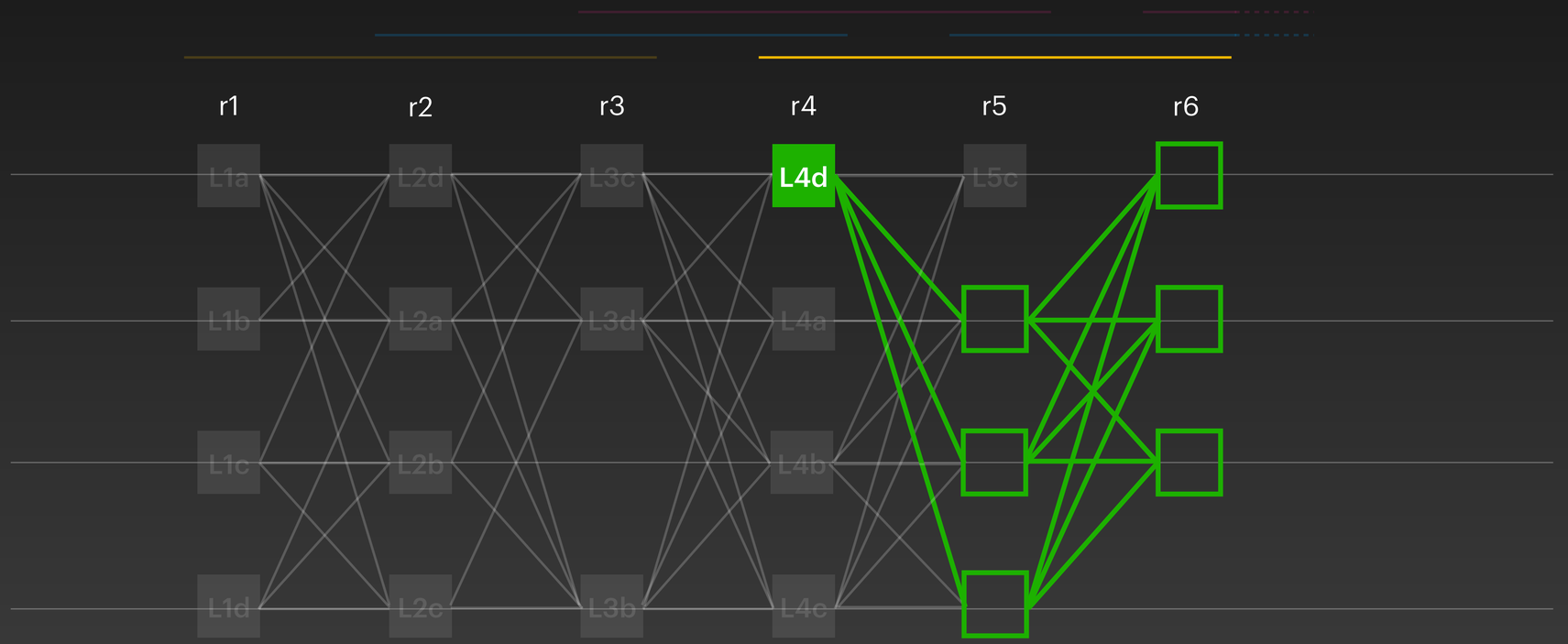
# Pipelined Multi-Leader Mysticeti



# Direct Decision Rule

On each leader starting from highest round:

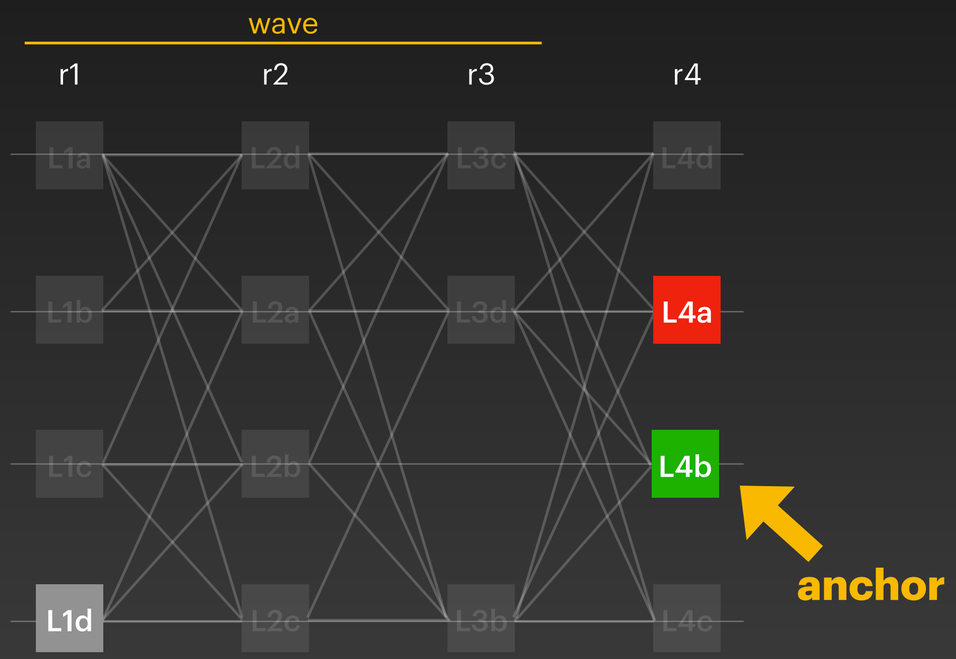
- **Skip** if 2f+1 blames
- **Commit** if 2f+1 certificates
- **Undecided** otherwise



# Indirect Decision Rule

## 1. Find Anchor

- First block with round > r+2 that is **Commit** or **Undecided**



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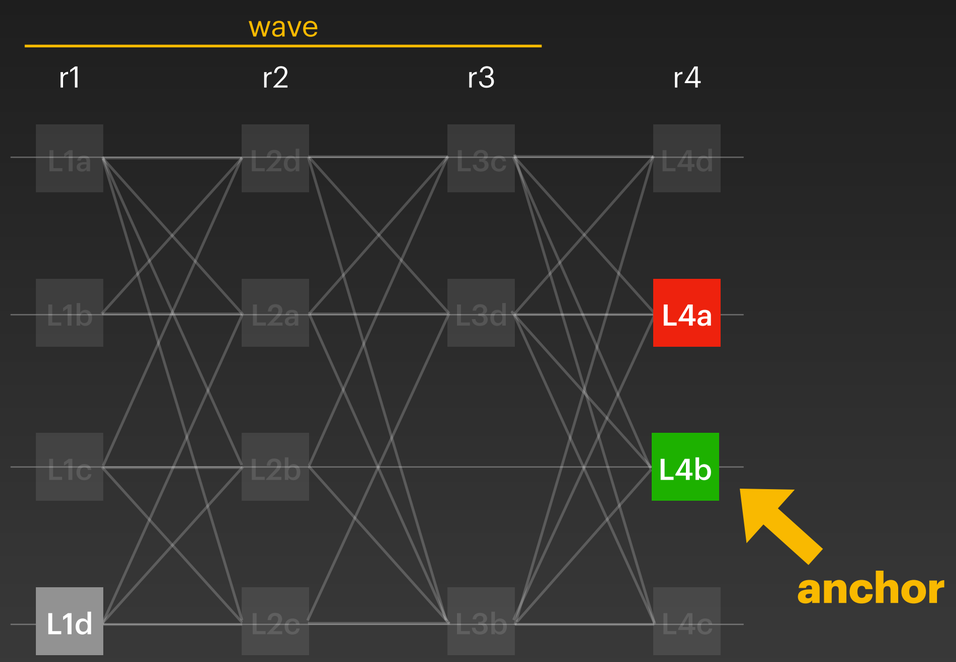
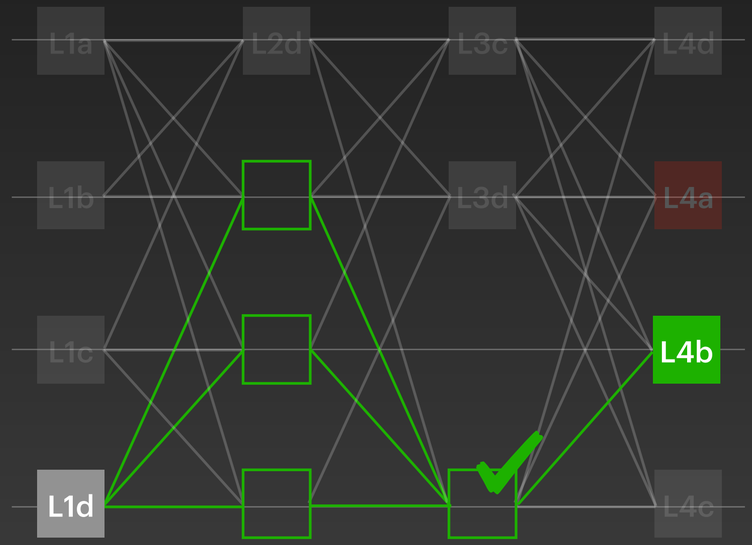


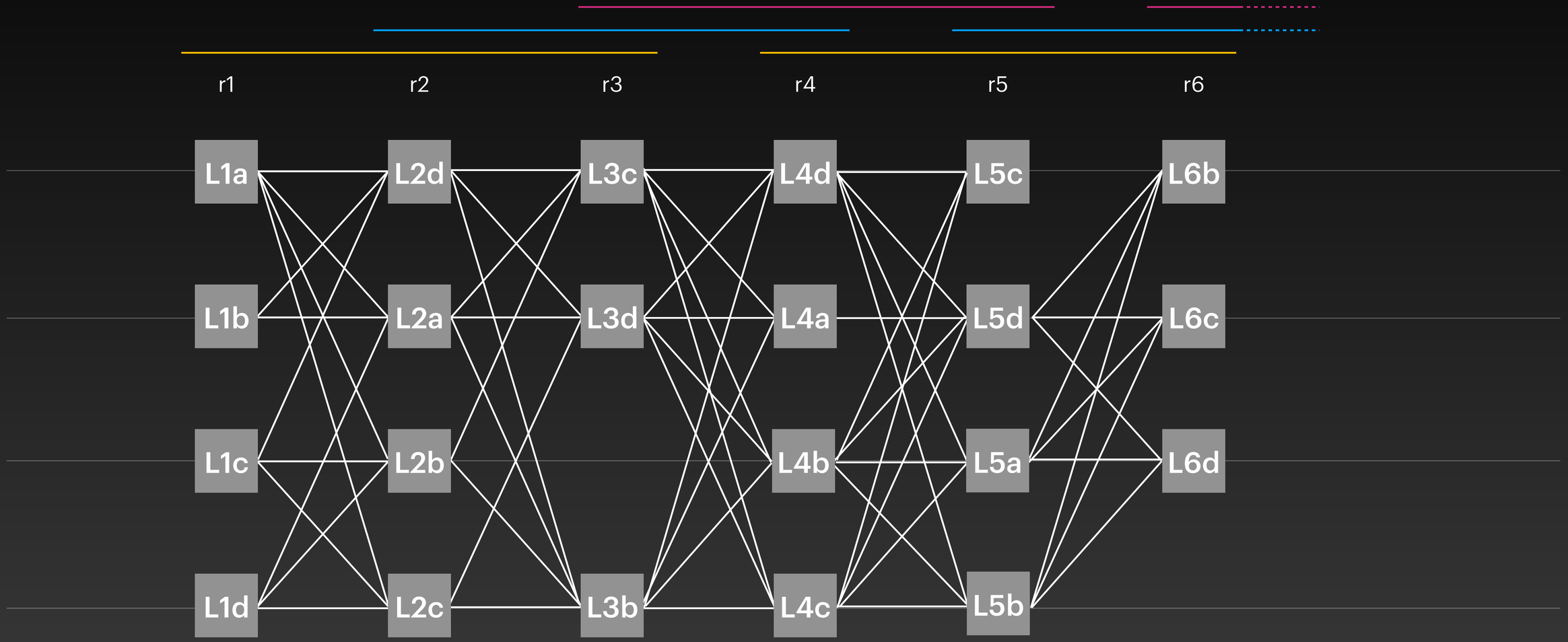

## 2. Certified link

- **Commit** if `B <-> certified link <-> A` otherwise **Skip**



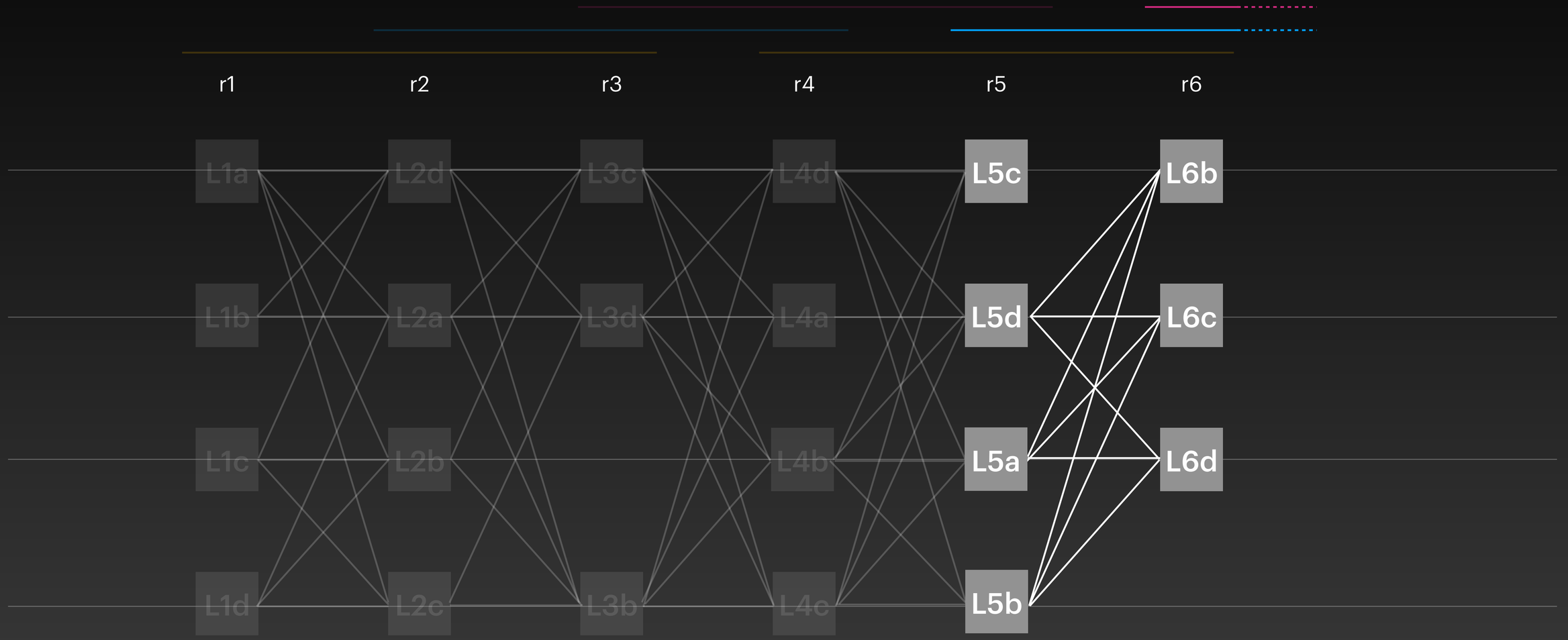
# Apply Direct Rule

## Mark all leaders as Undecided



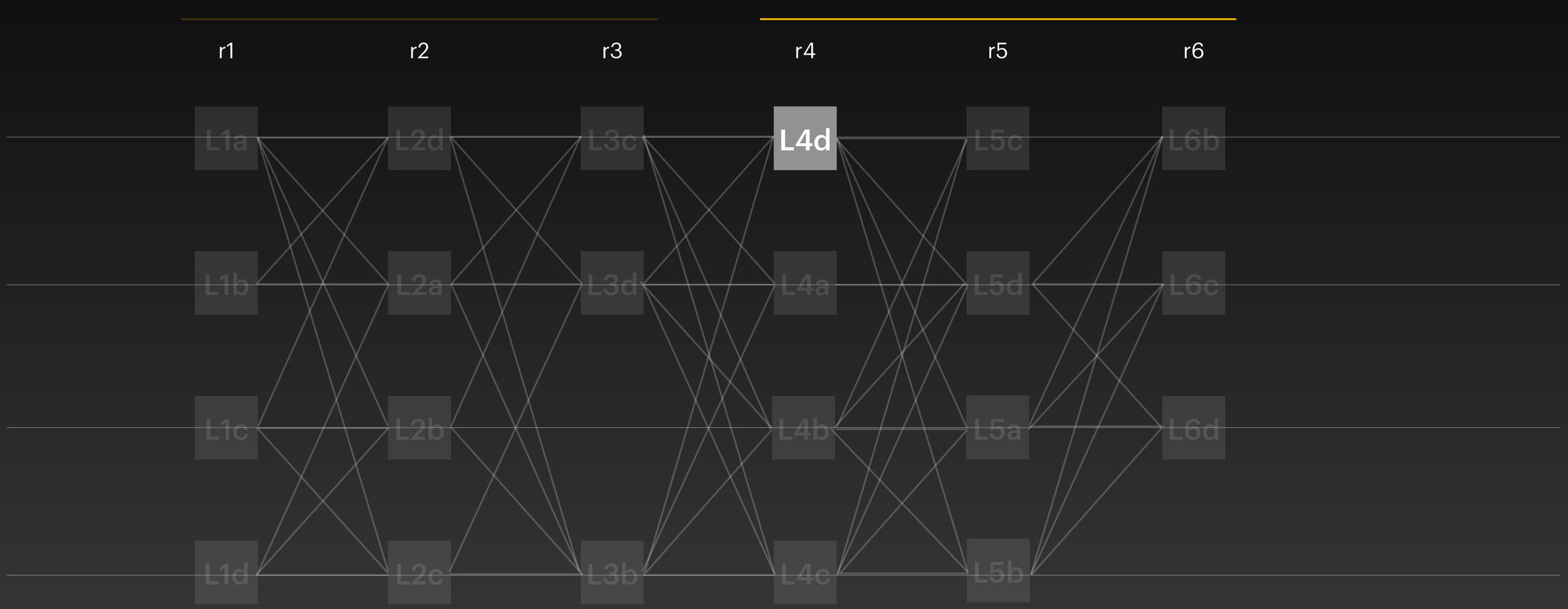
# Apply Direct Rule

## Cannot decide incomplete waves



# Apply Direct Rule

## Start with highest round and go backward



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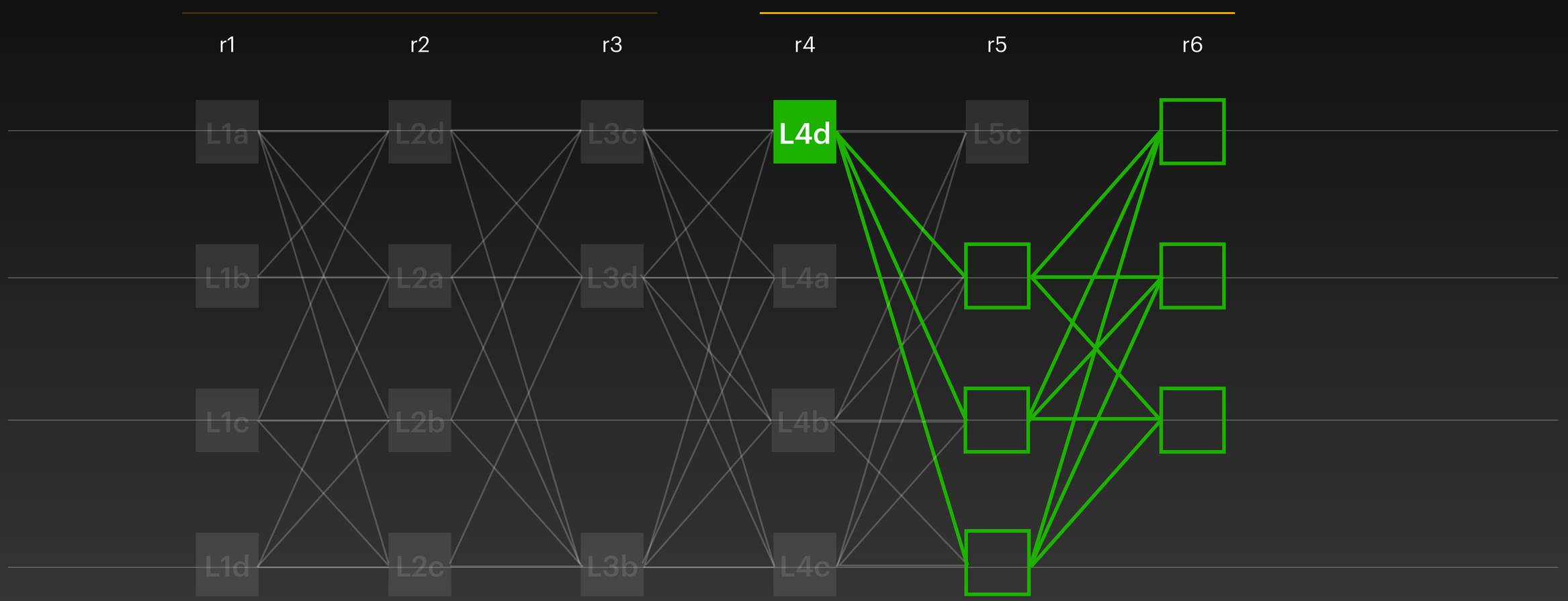

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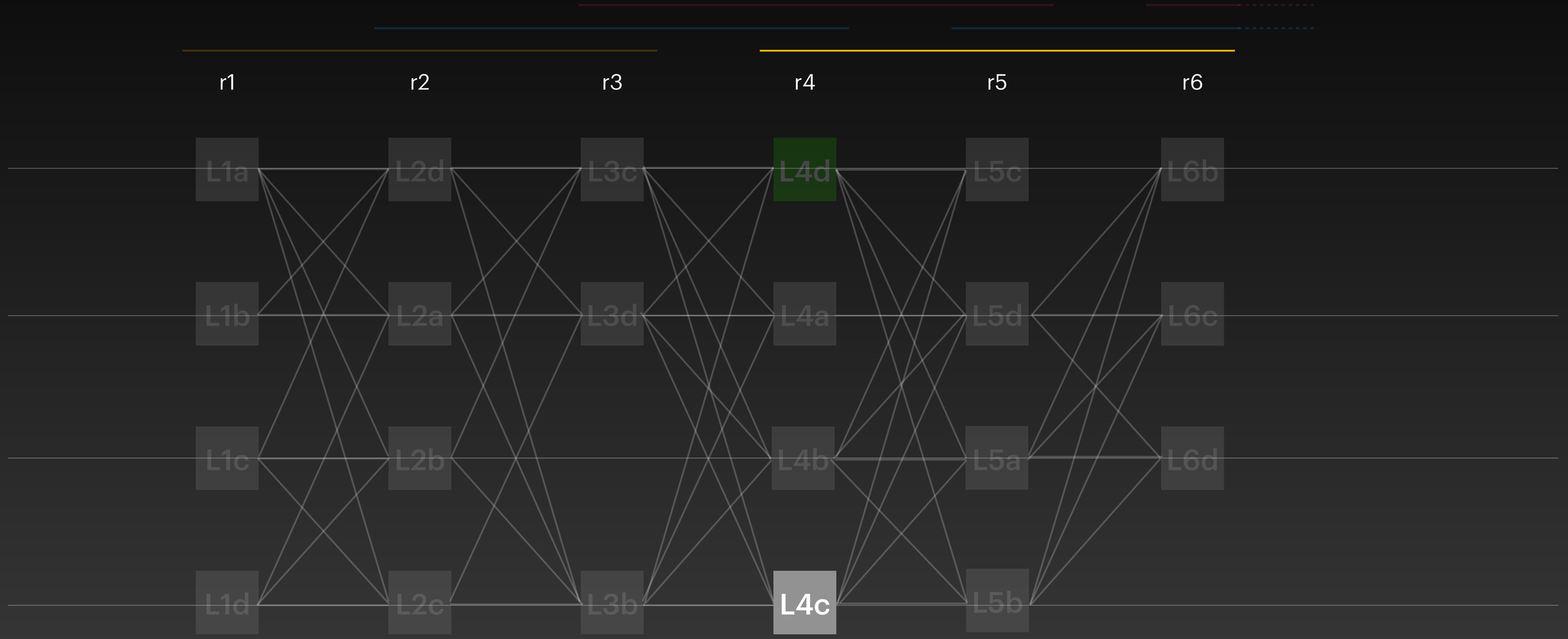

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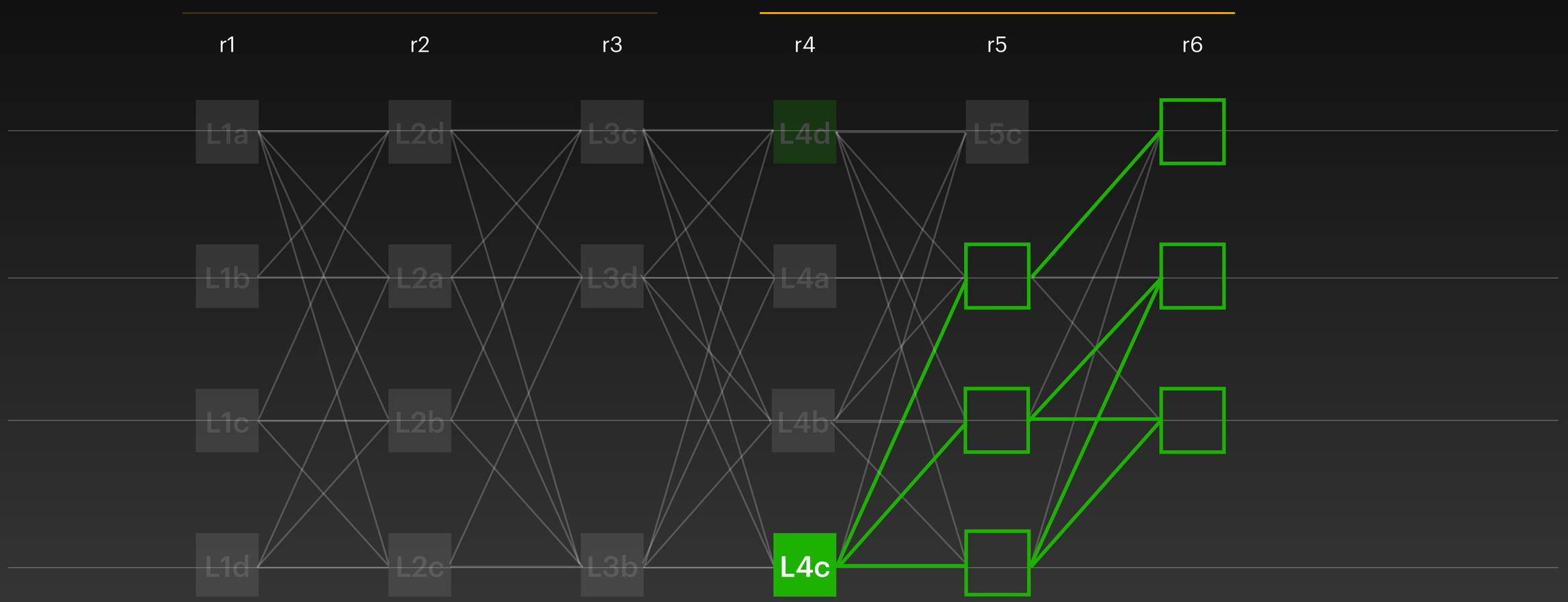

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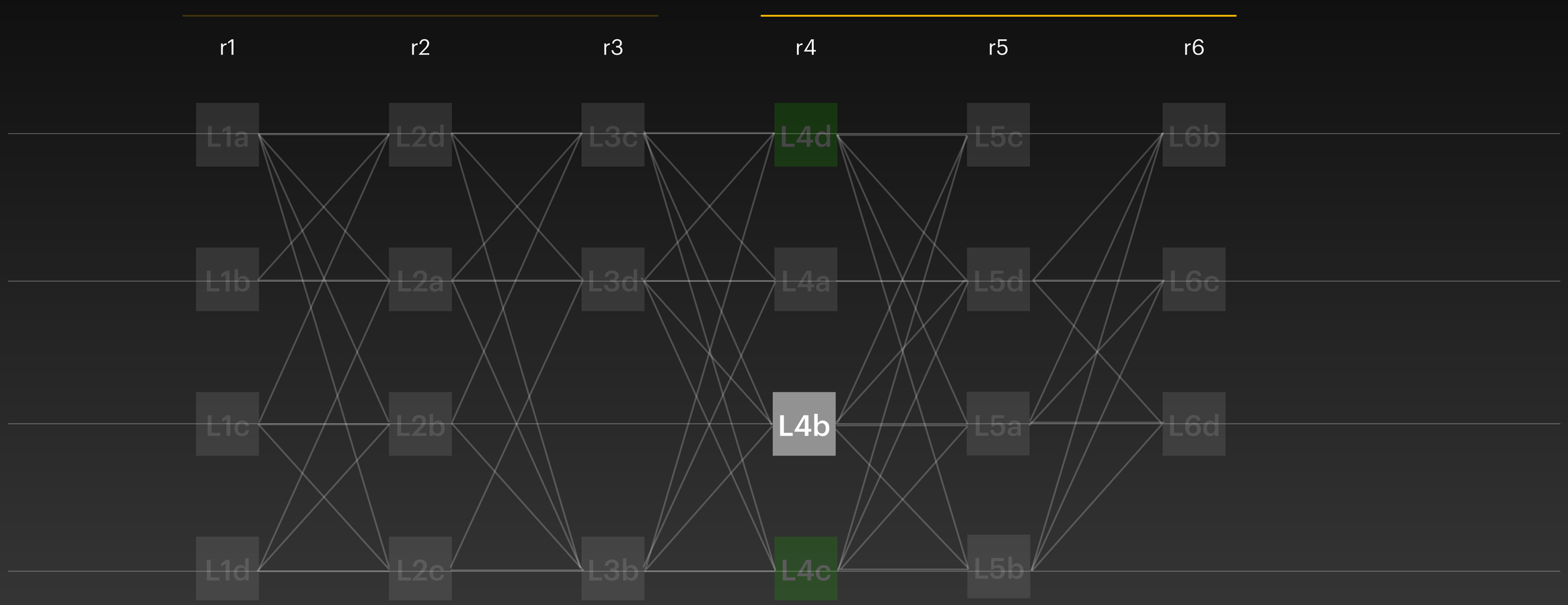

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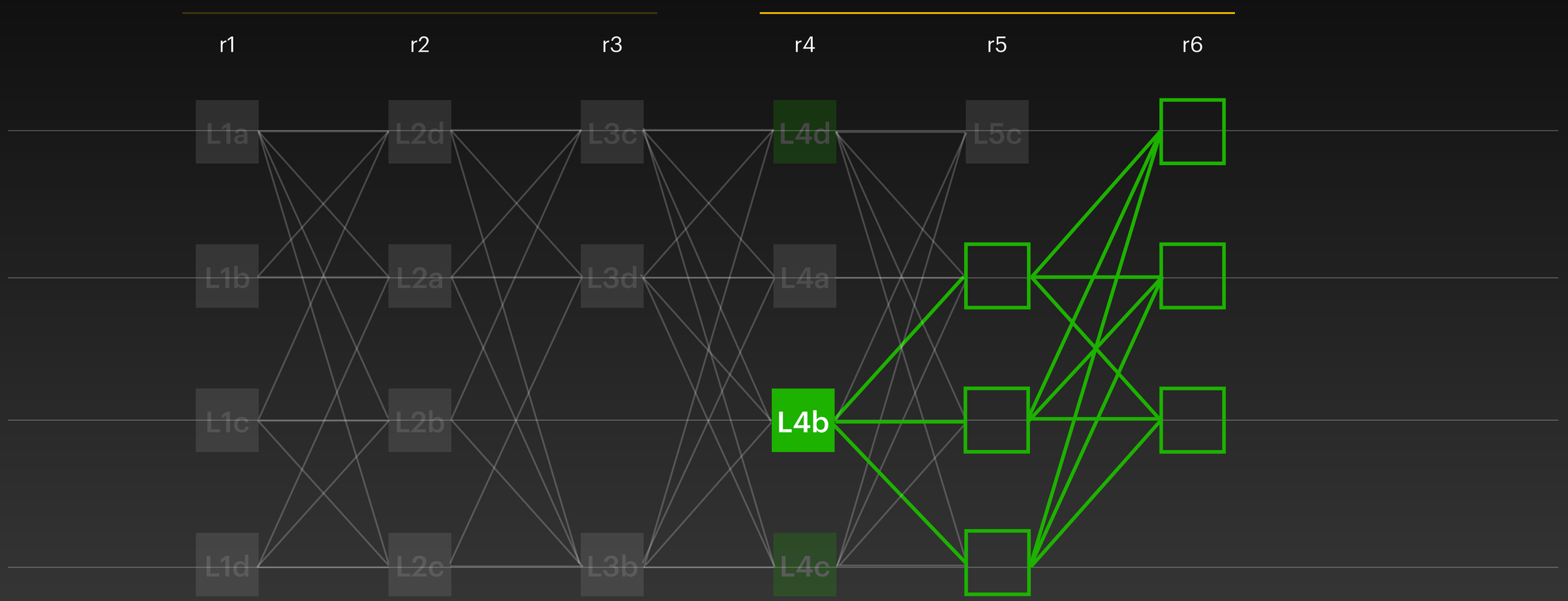

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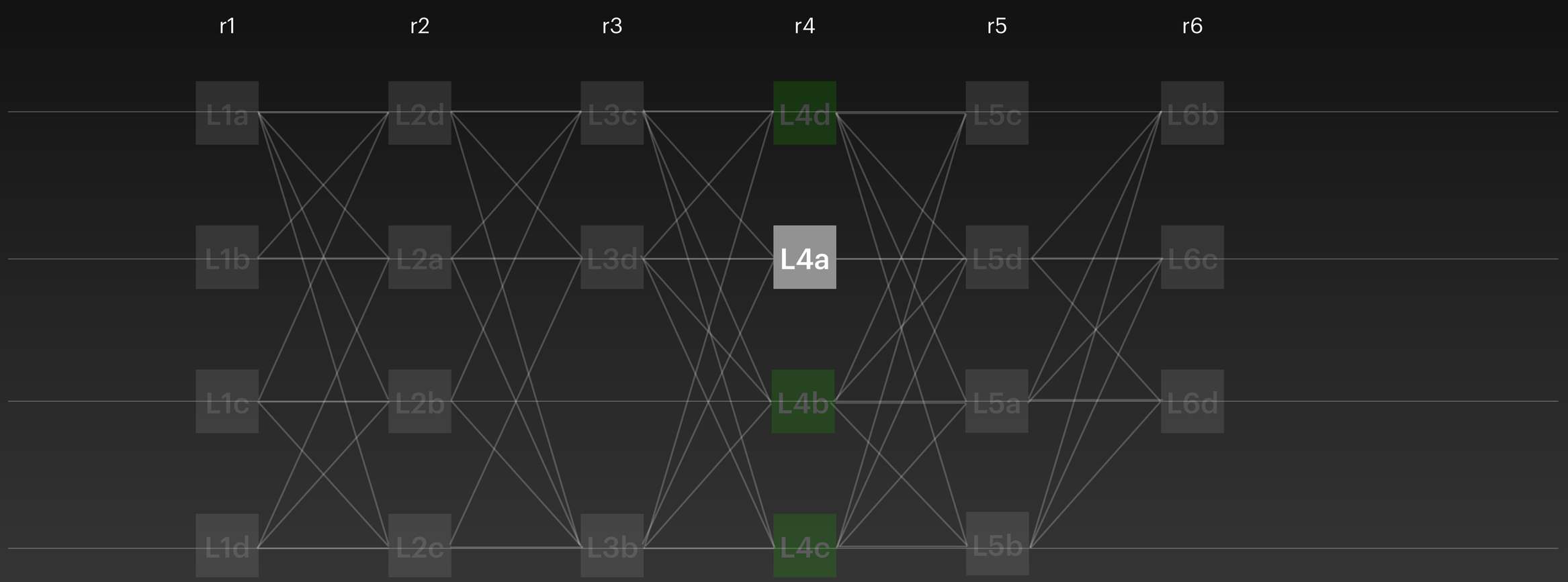

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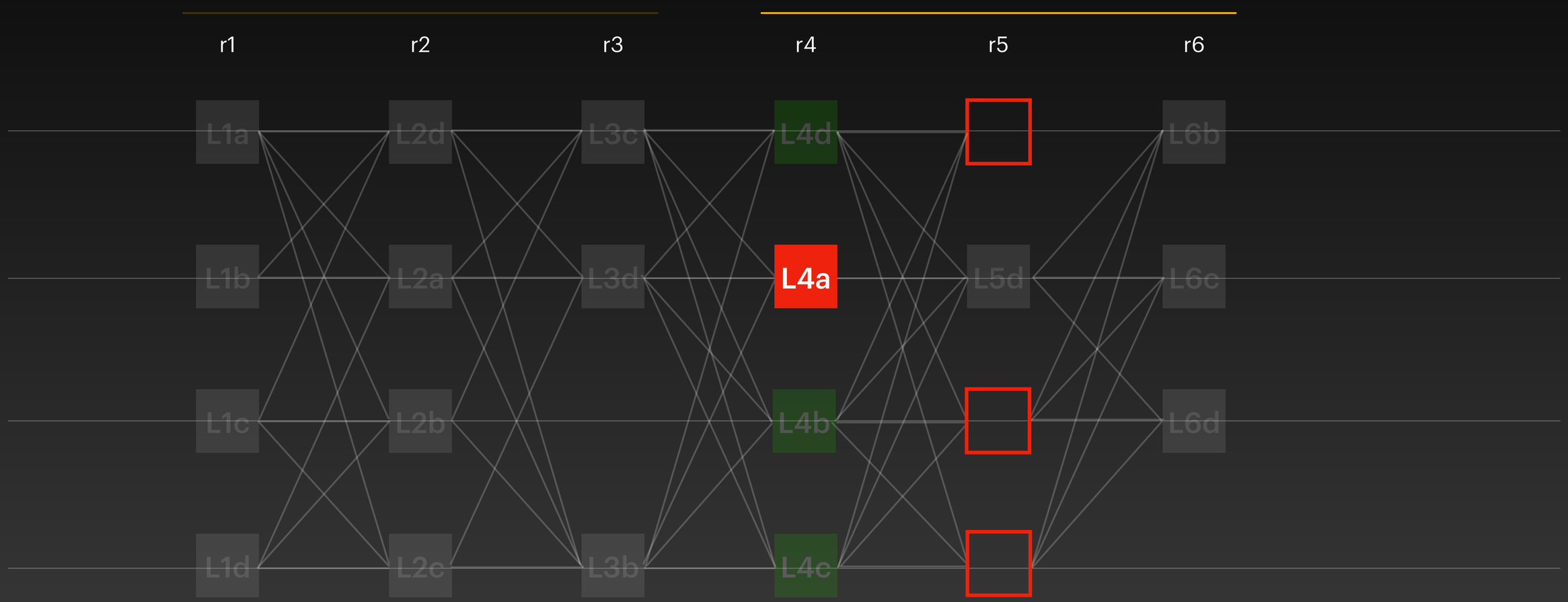

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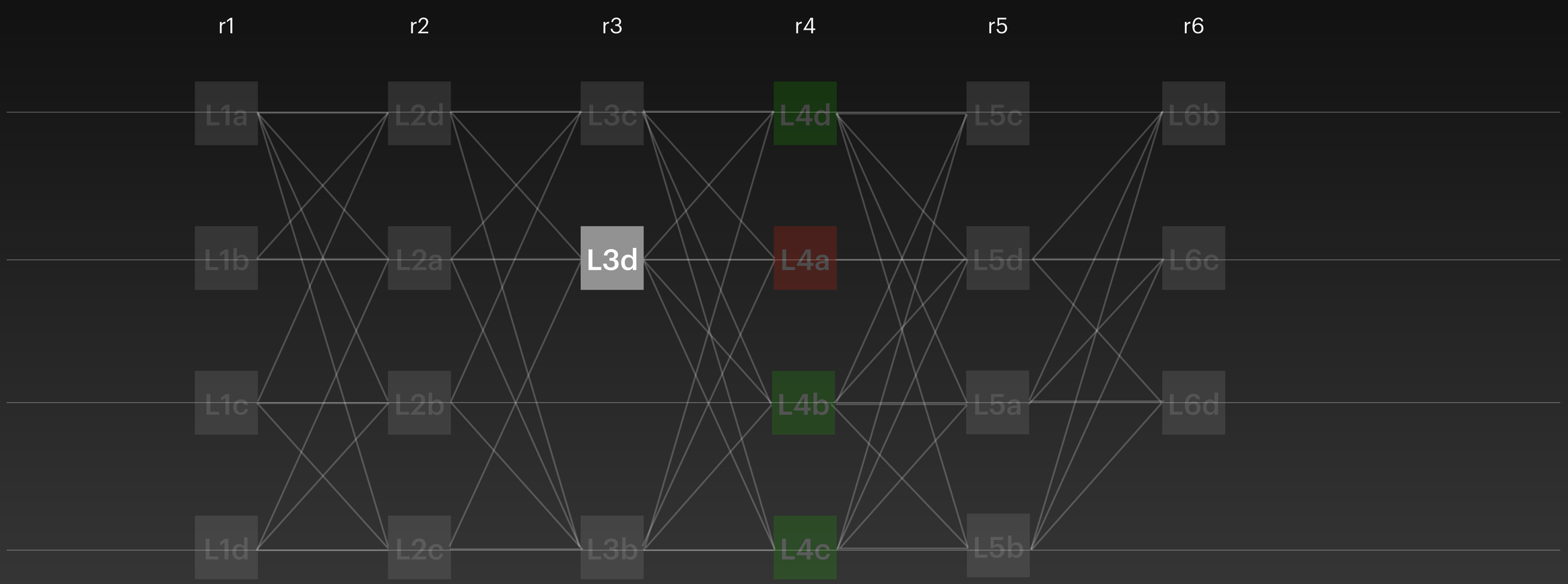

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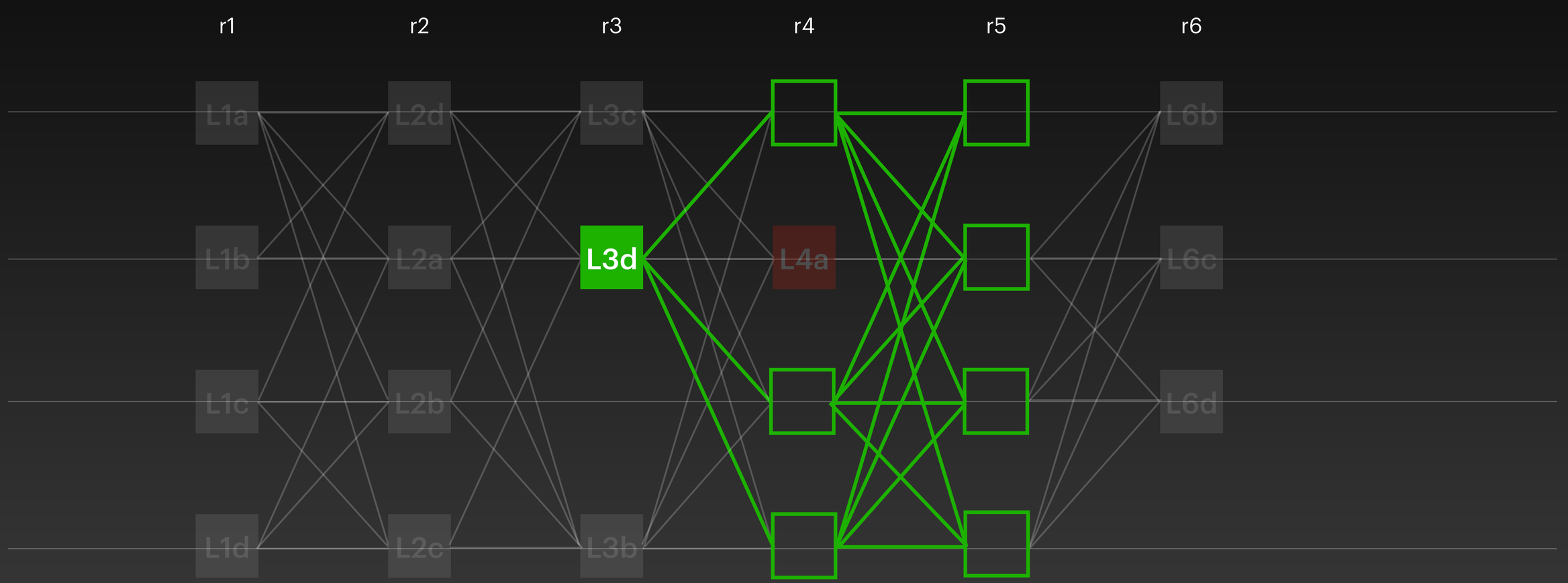

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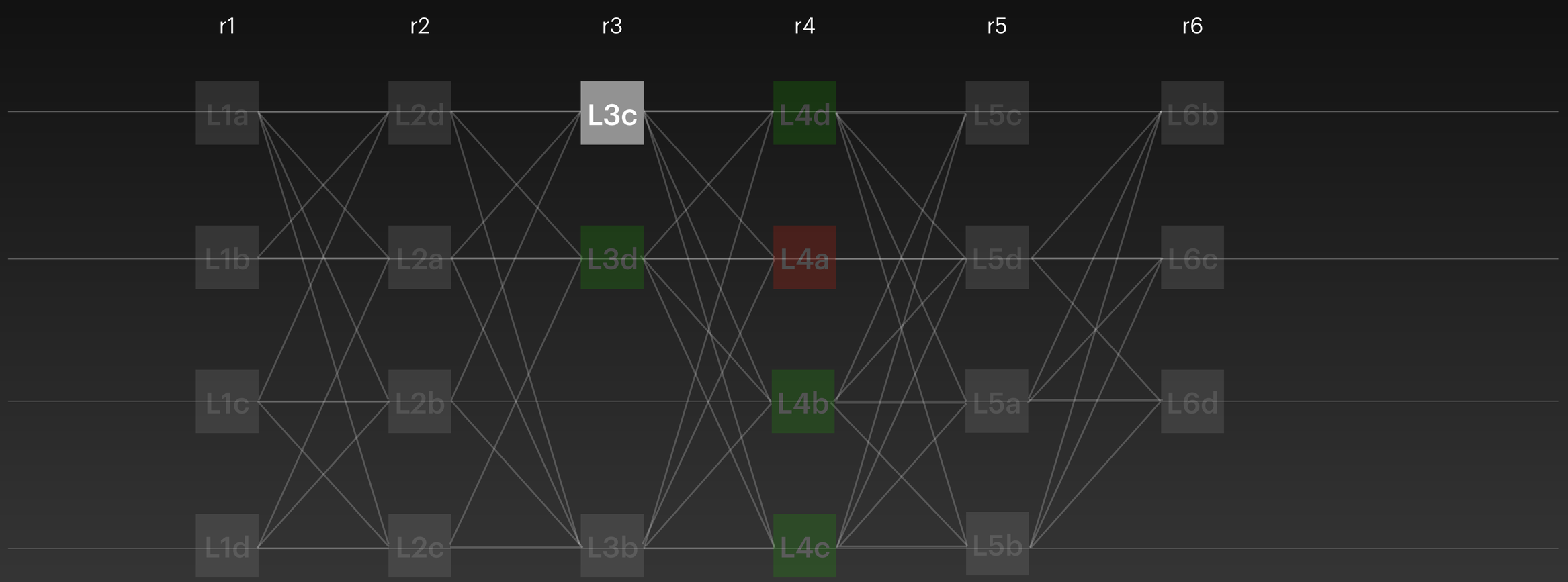

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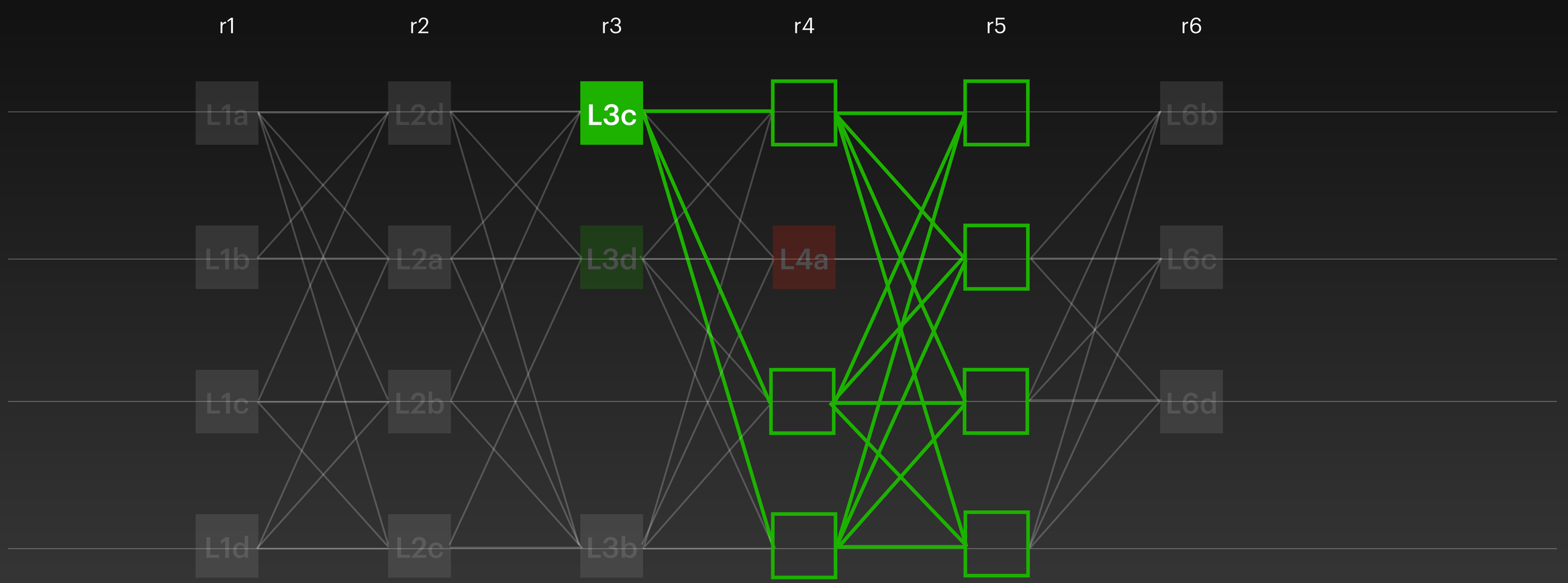

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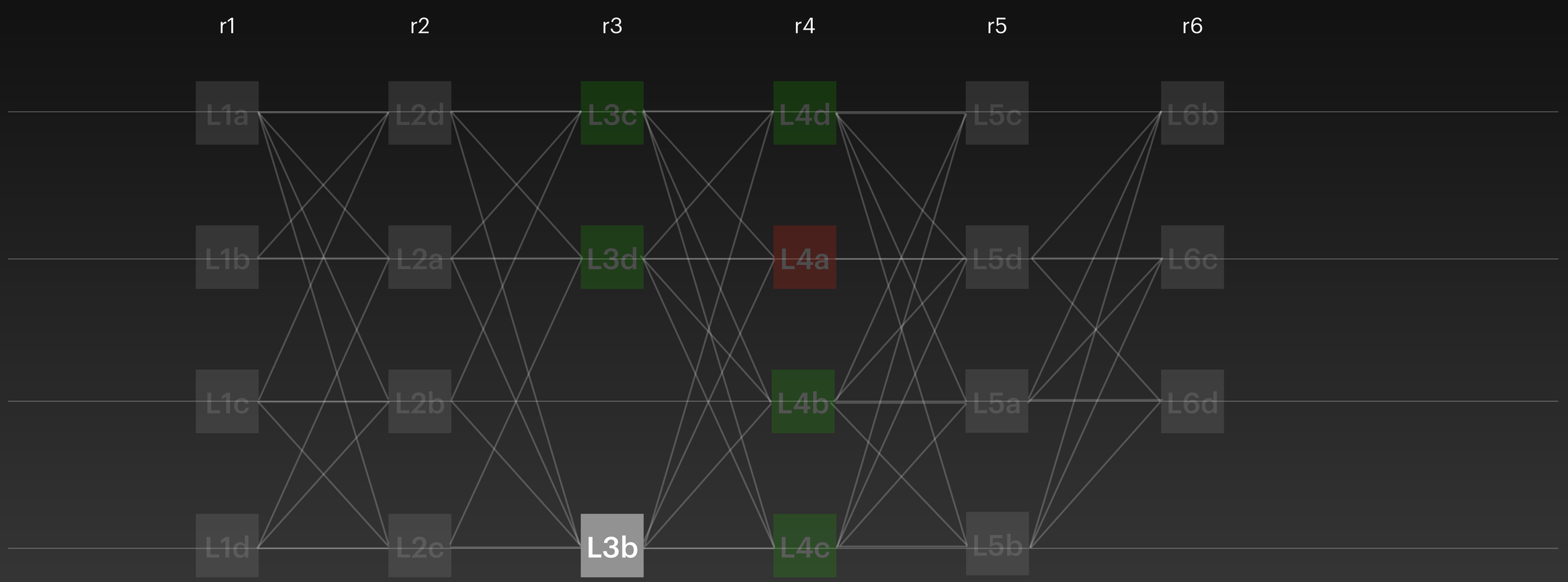

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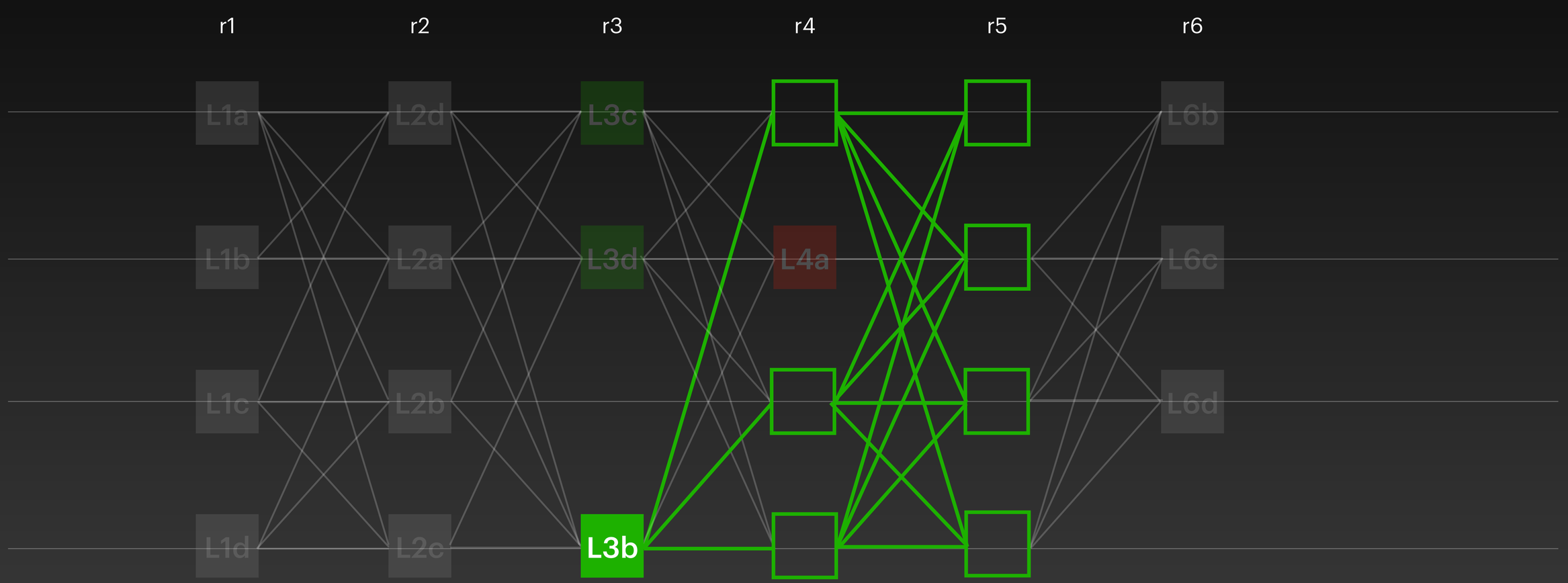

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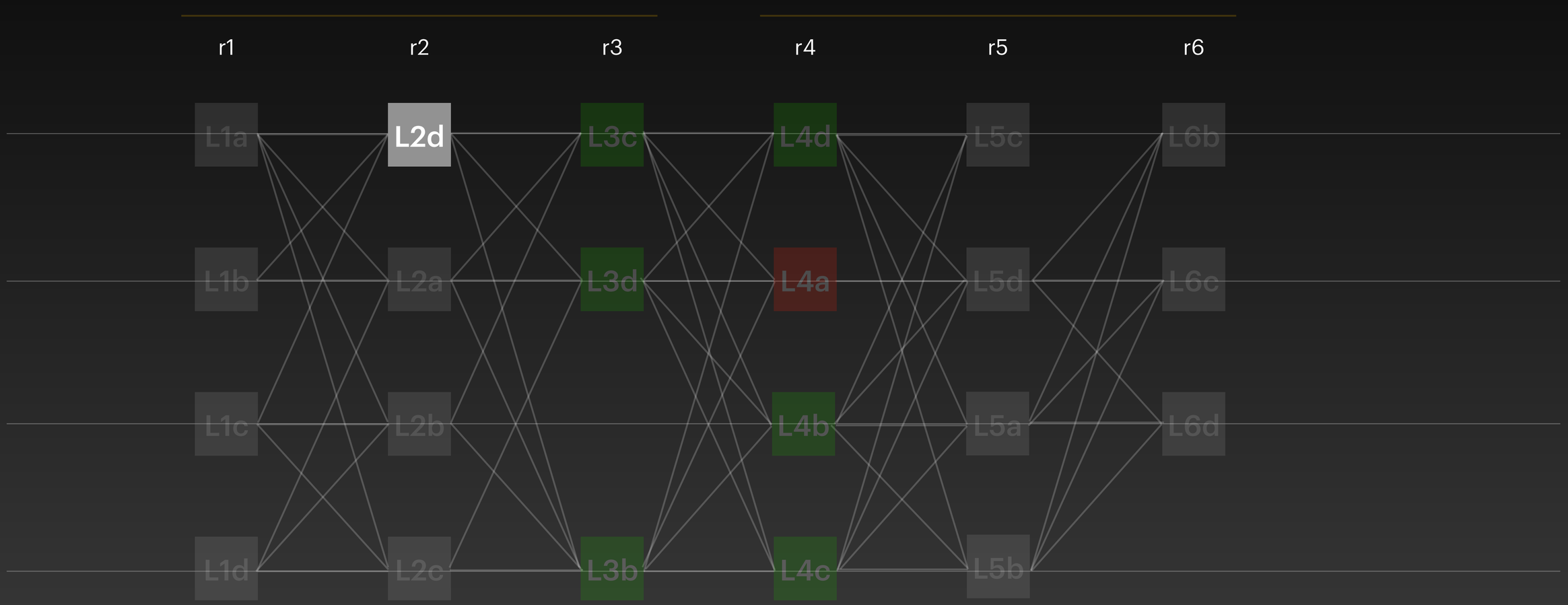

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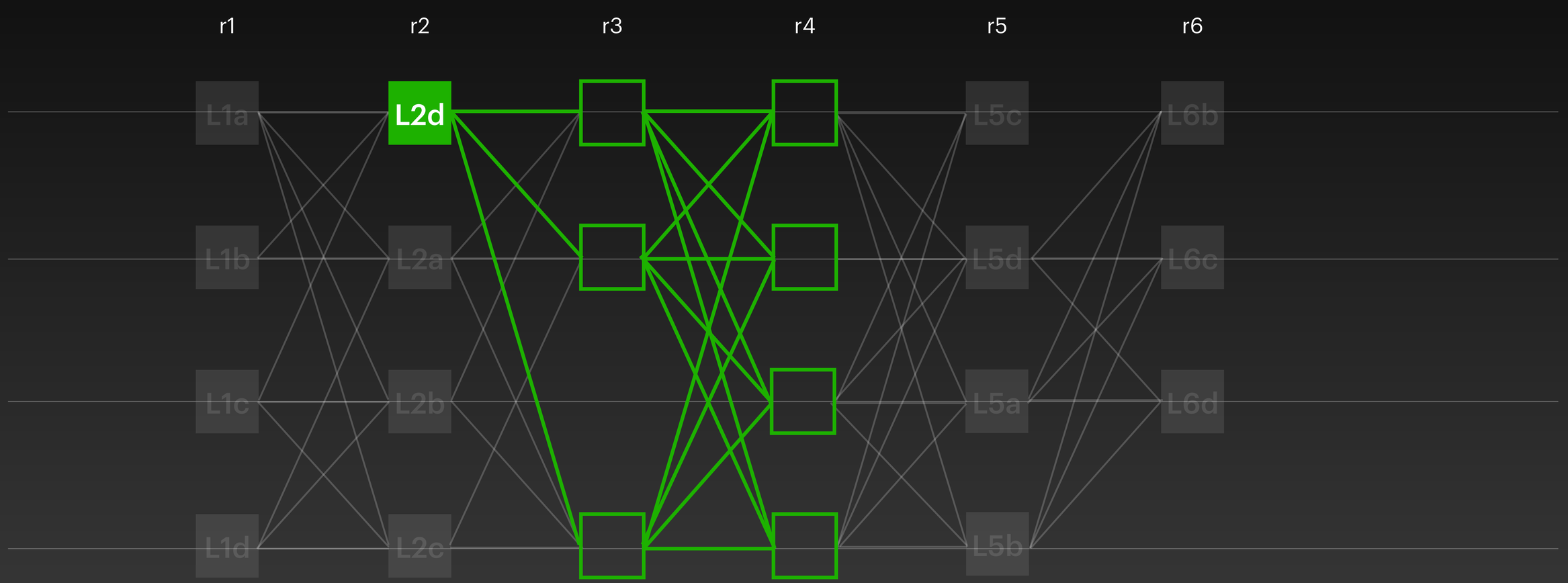

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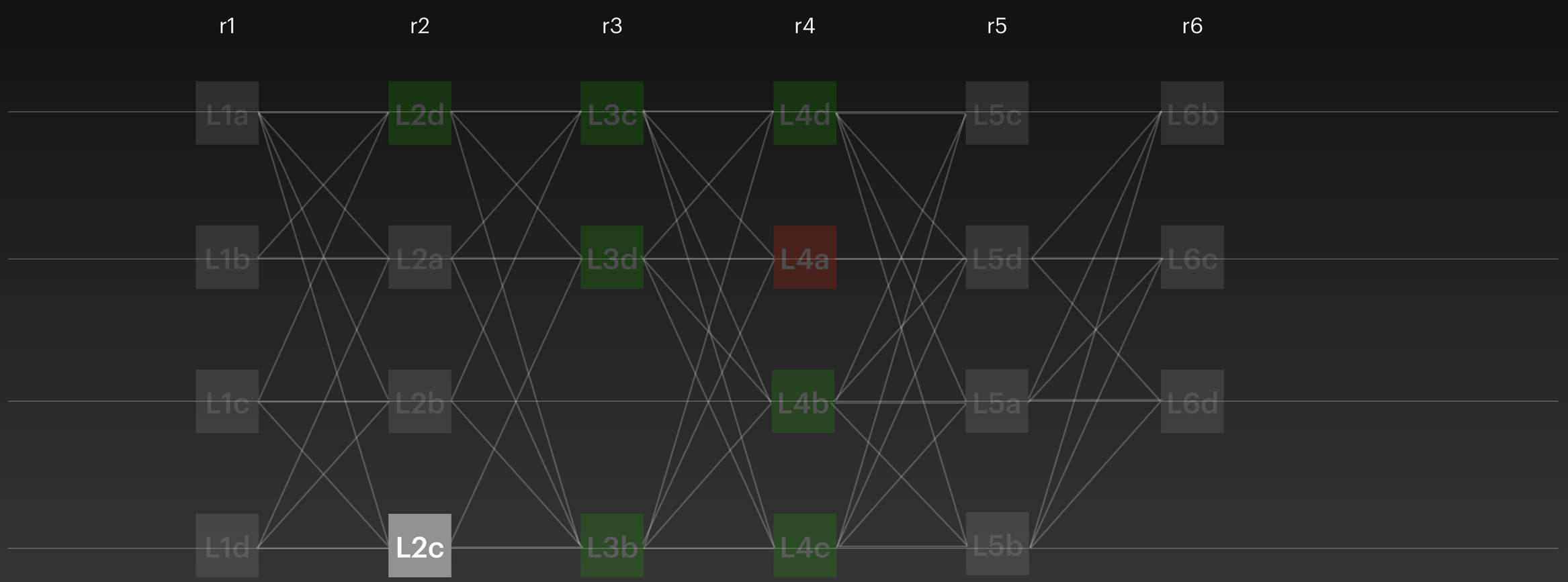

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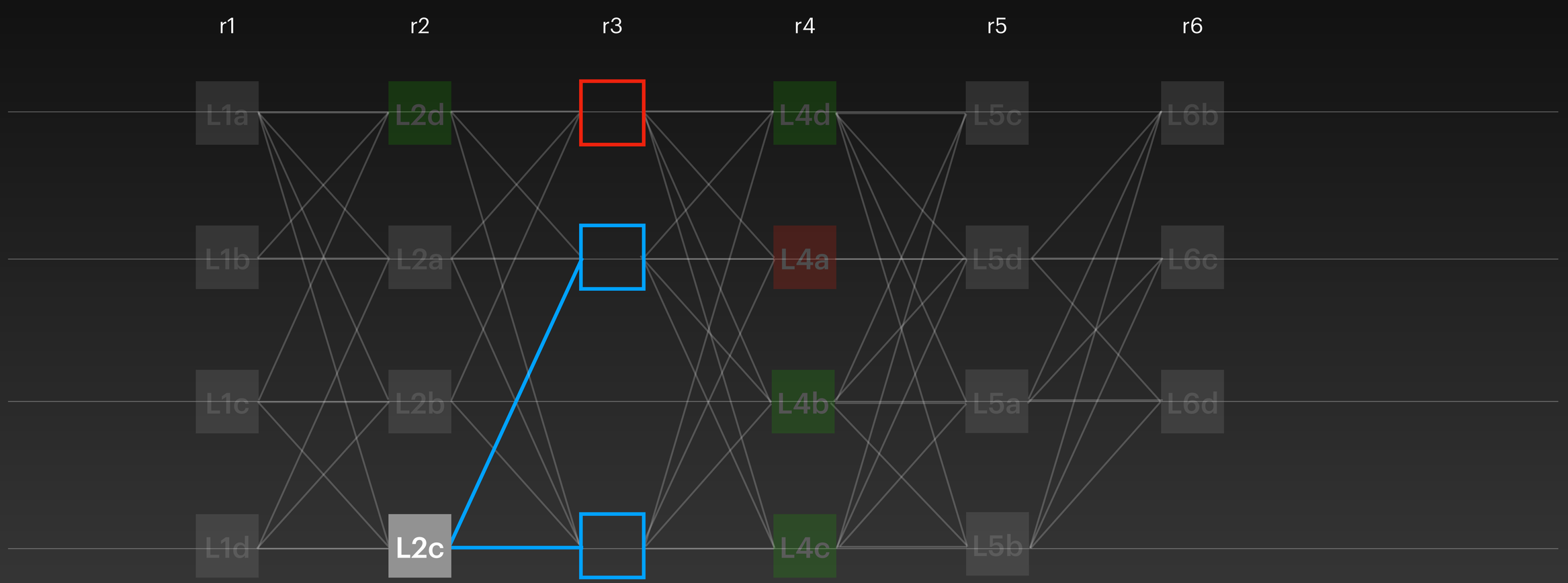
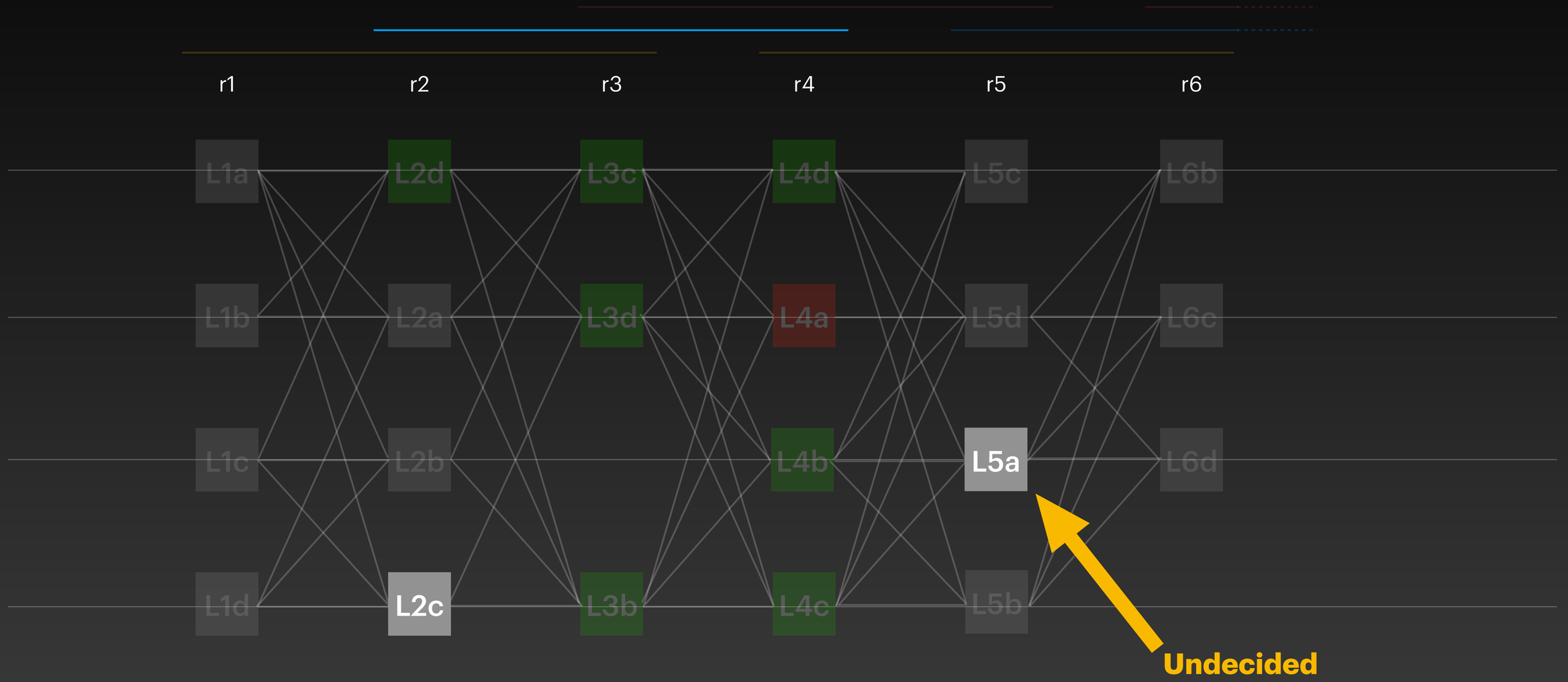


# Apply Indirect Rule

## Find anchor & Check certified links



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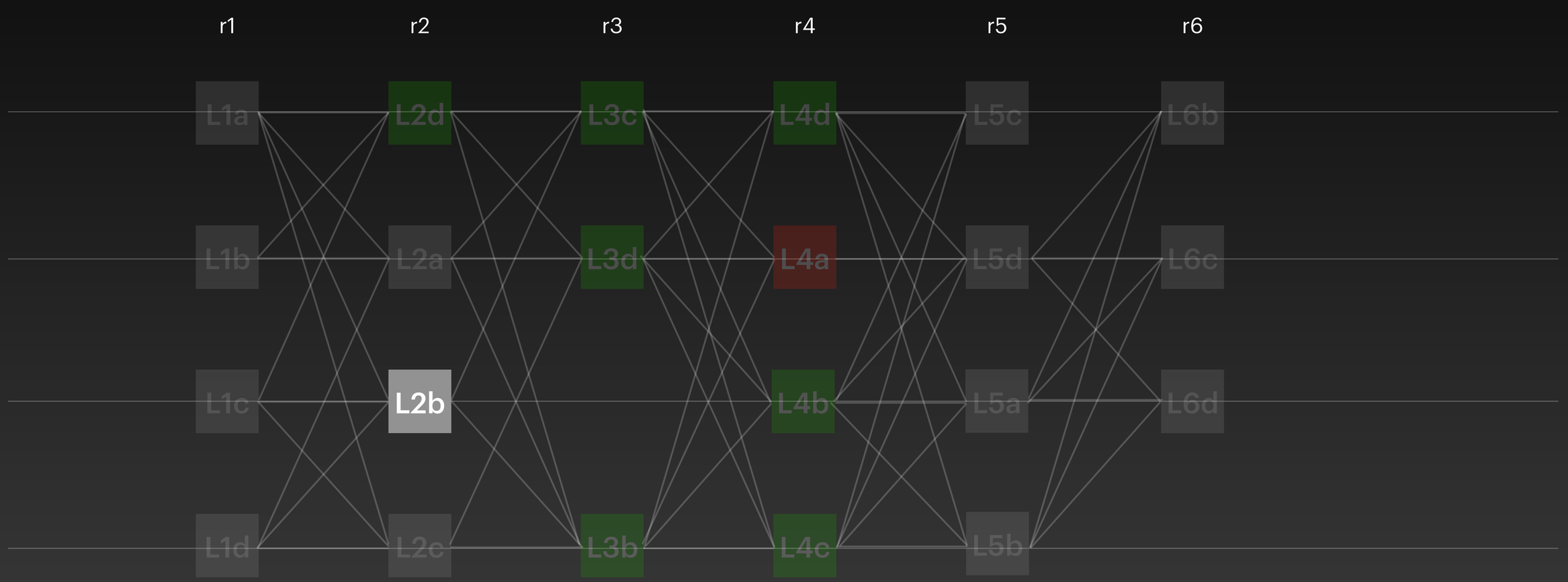

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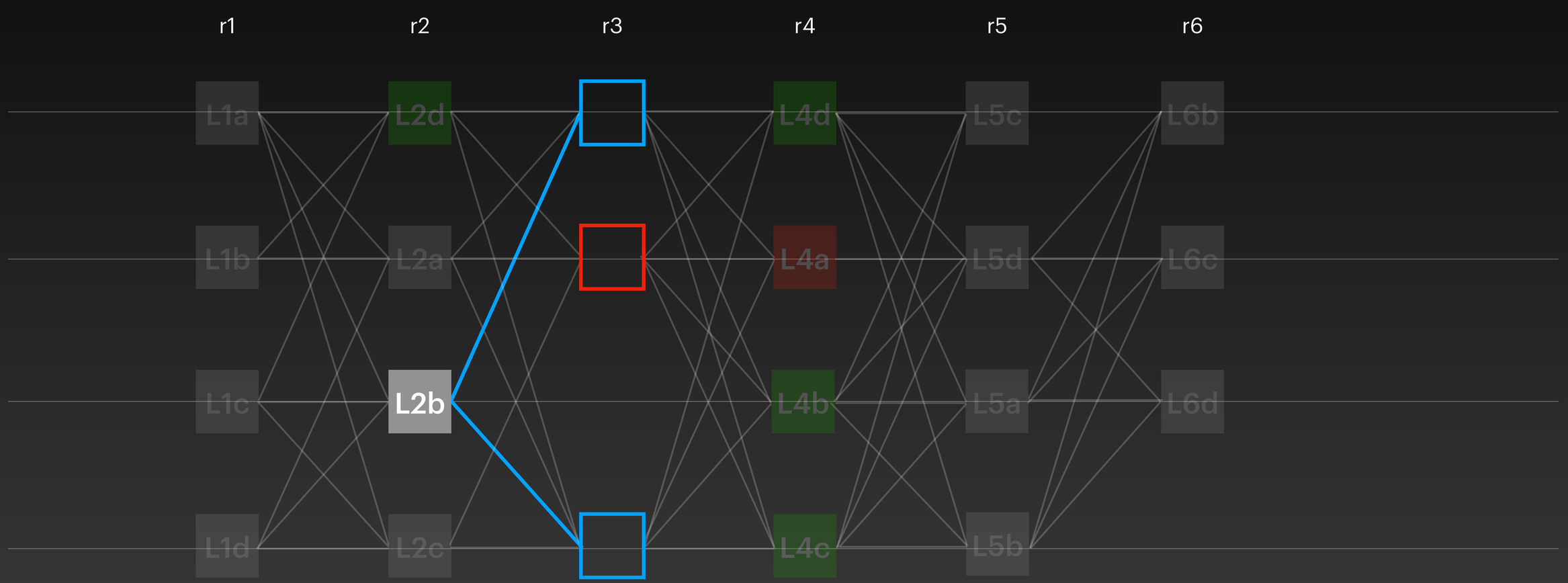

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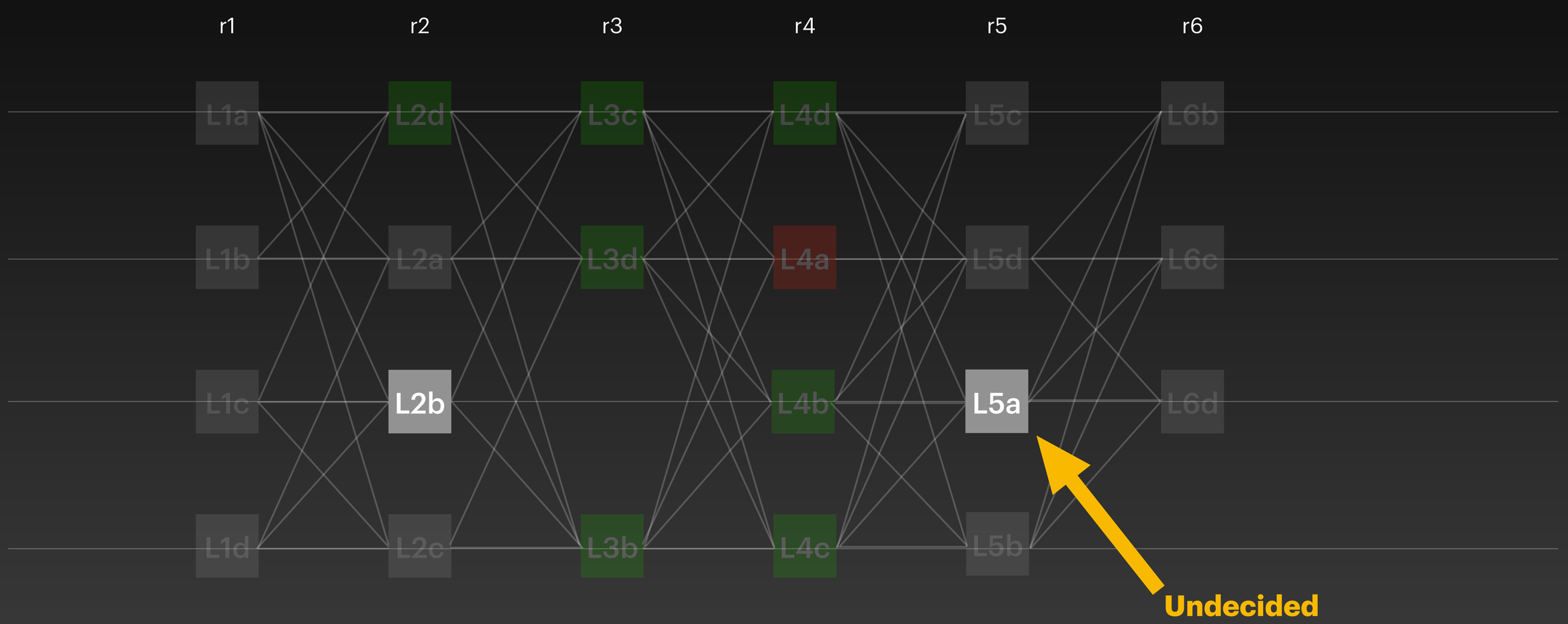

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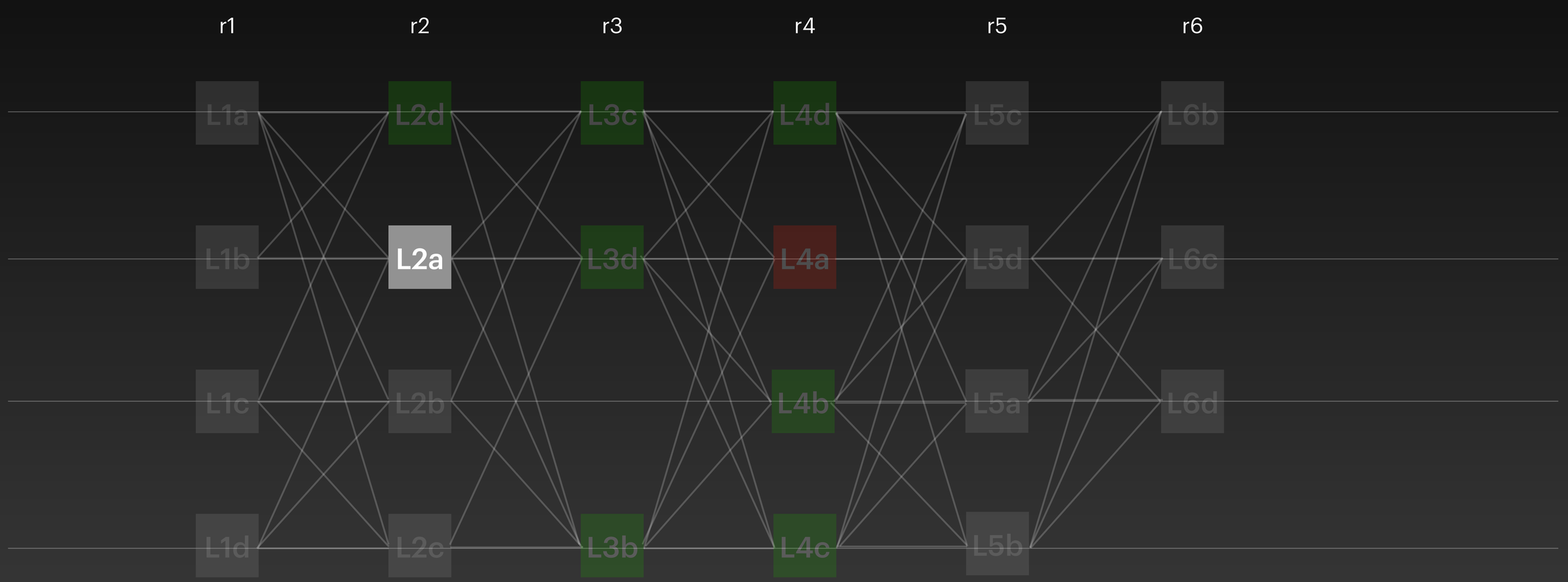
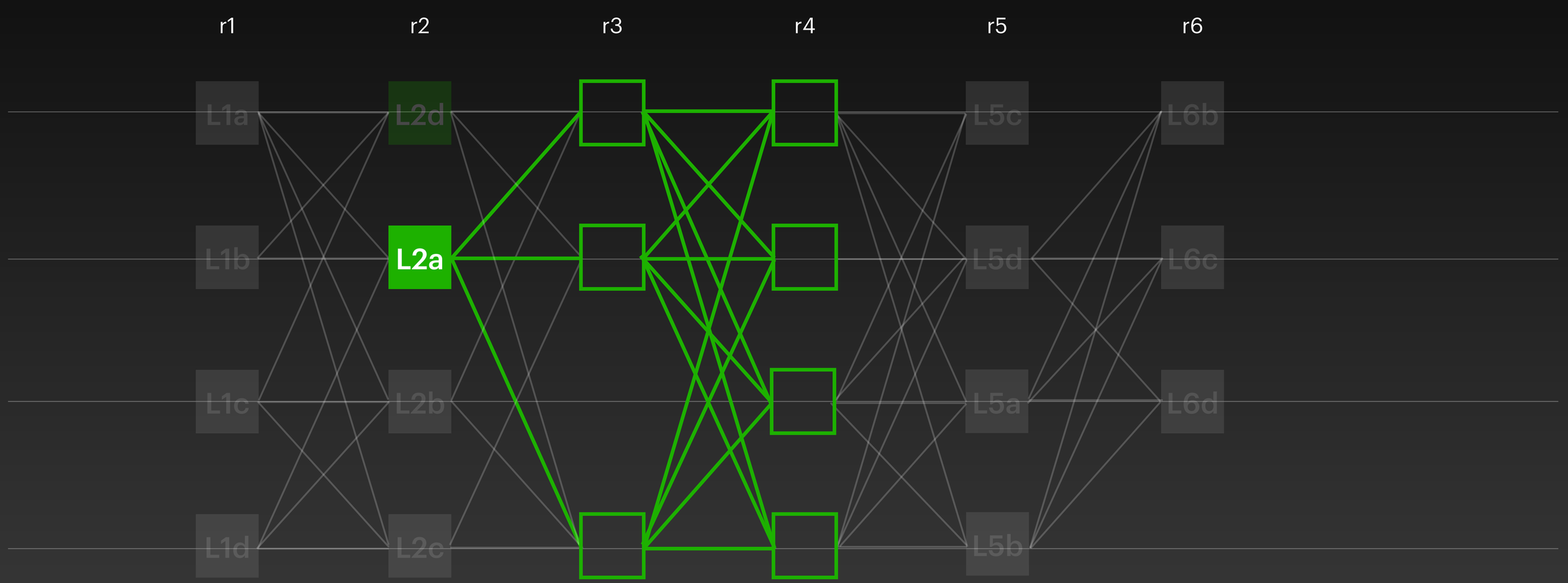


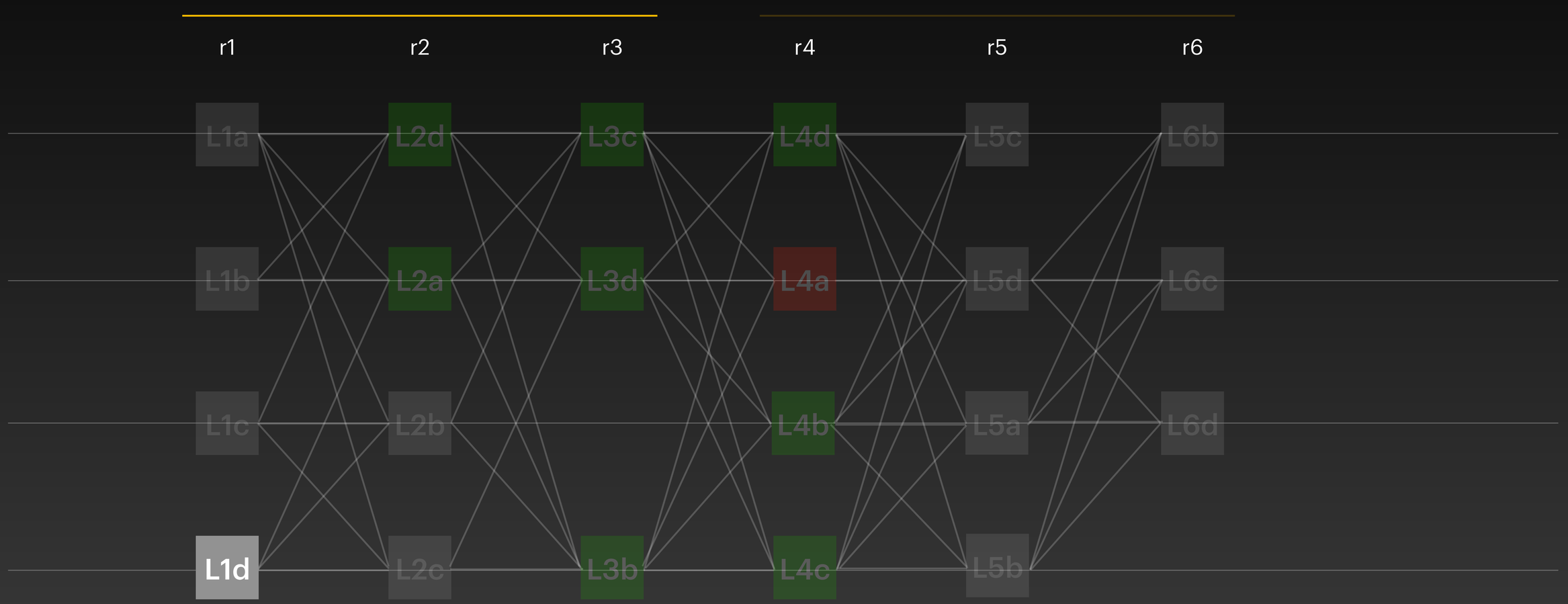
# Apply Direct Rule

## Start with highest round and go backward



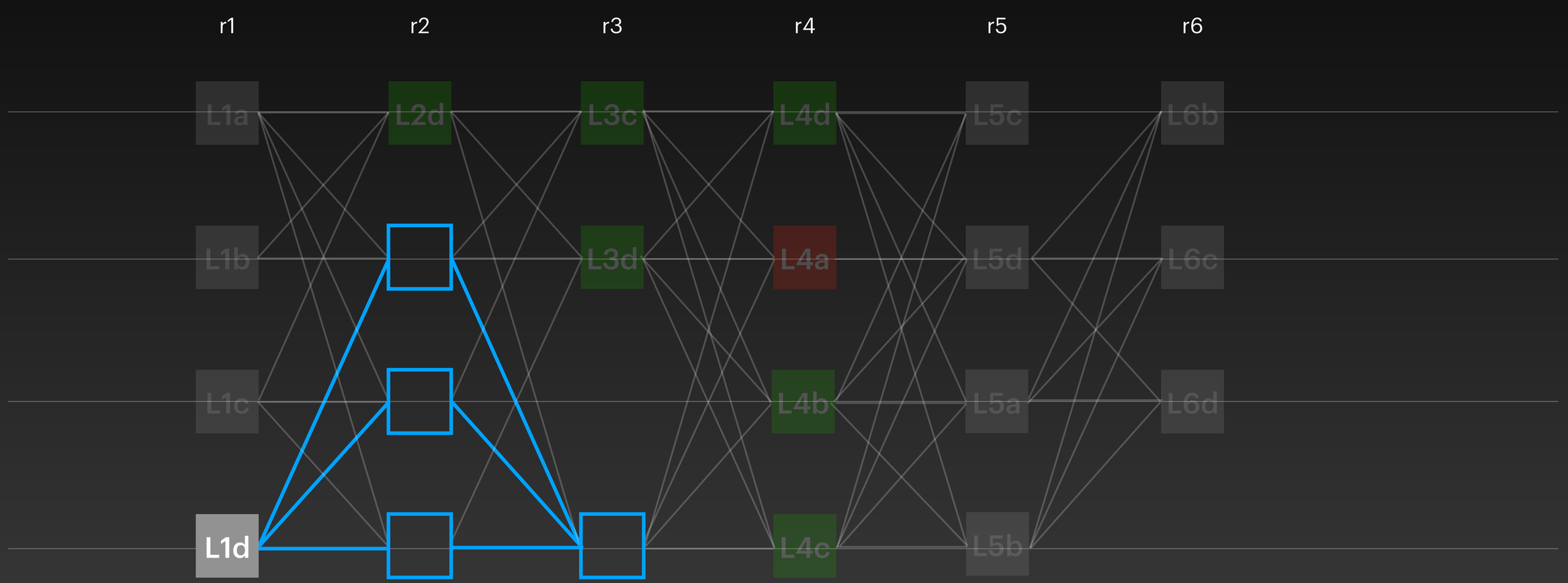
# Apply Direct Rule

## Start with highest round and go backward



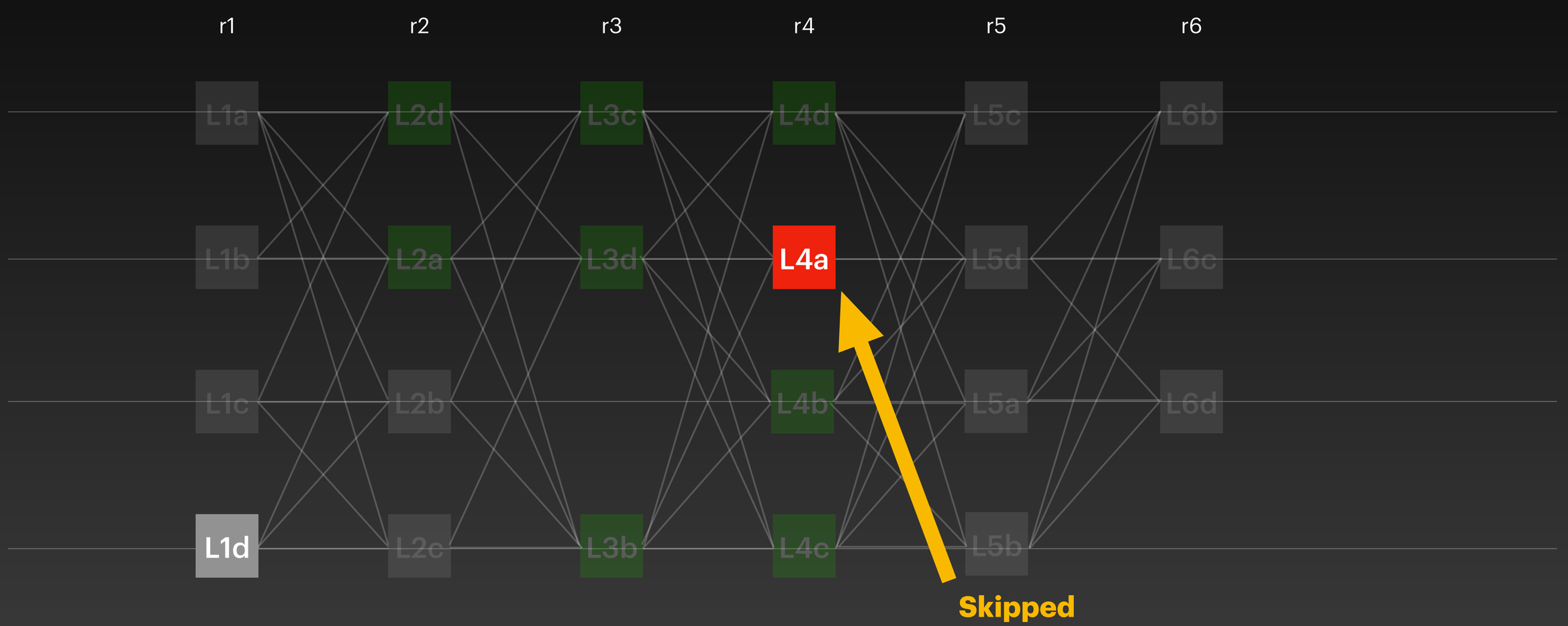
# Apply Direct Rule

## Start with highest round and go backward



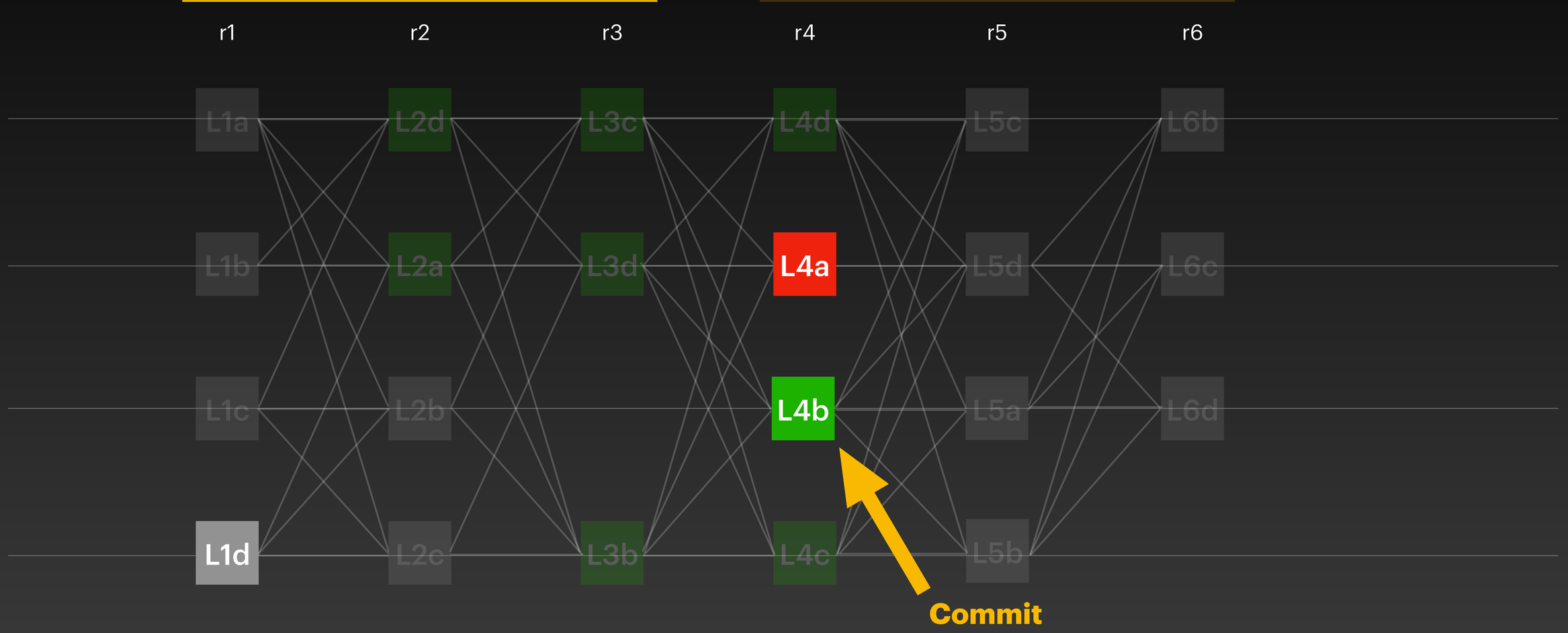
# Apply Indirect Rule

## Find anchor & Check certified links



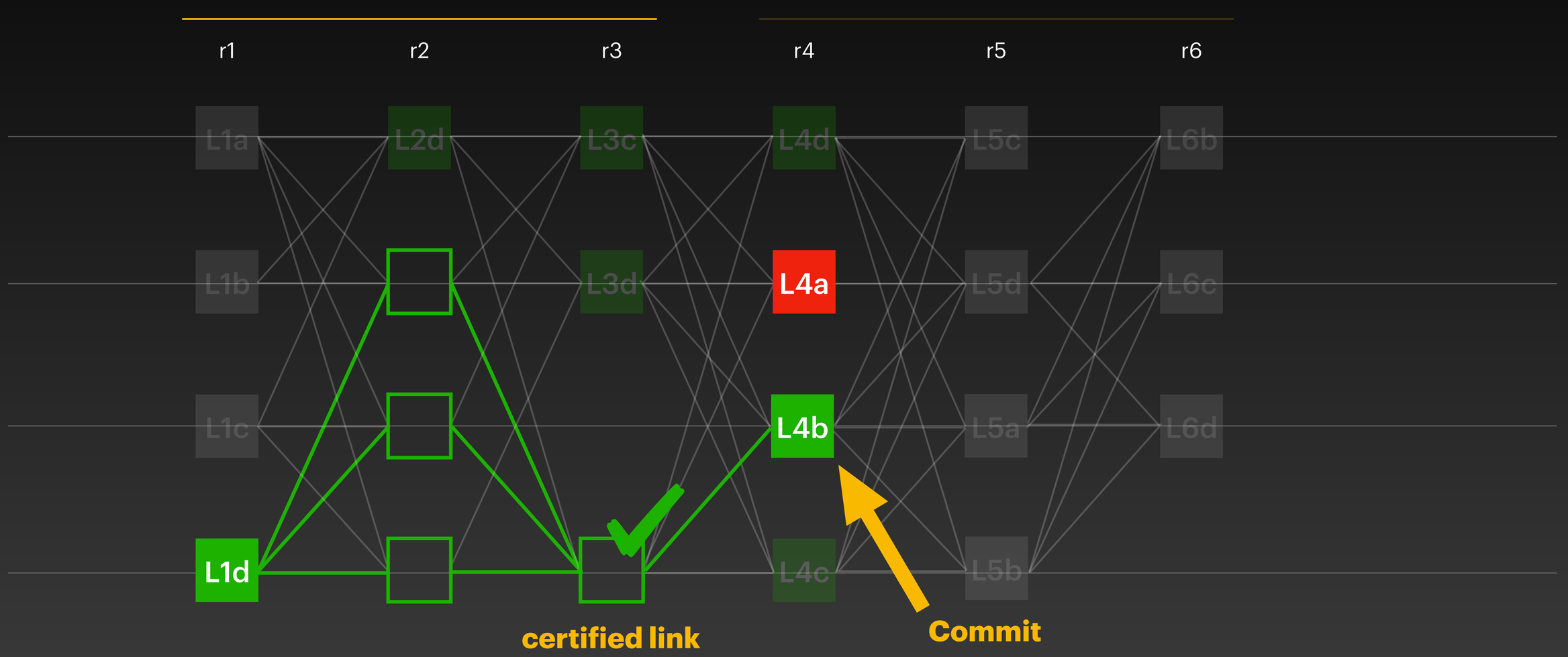
# Apply Indirect Rule

## Find anchor & Check certified links



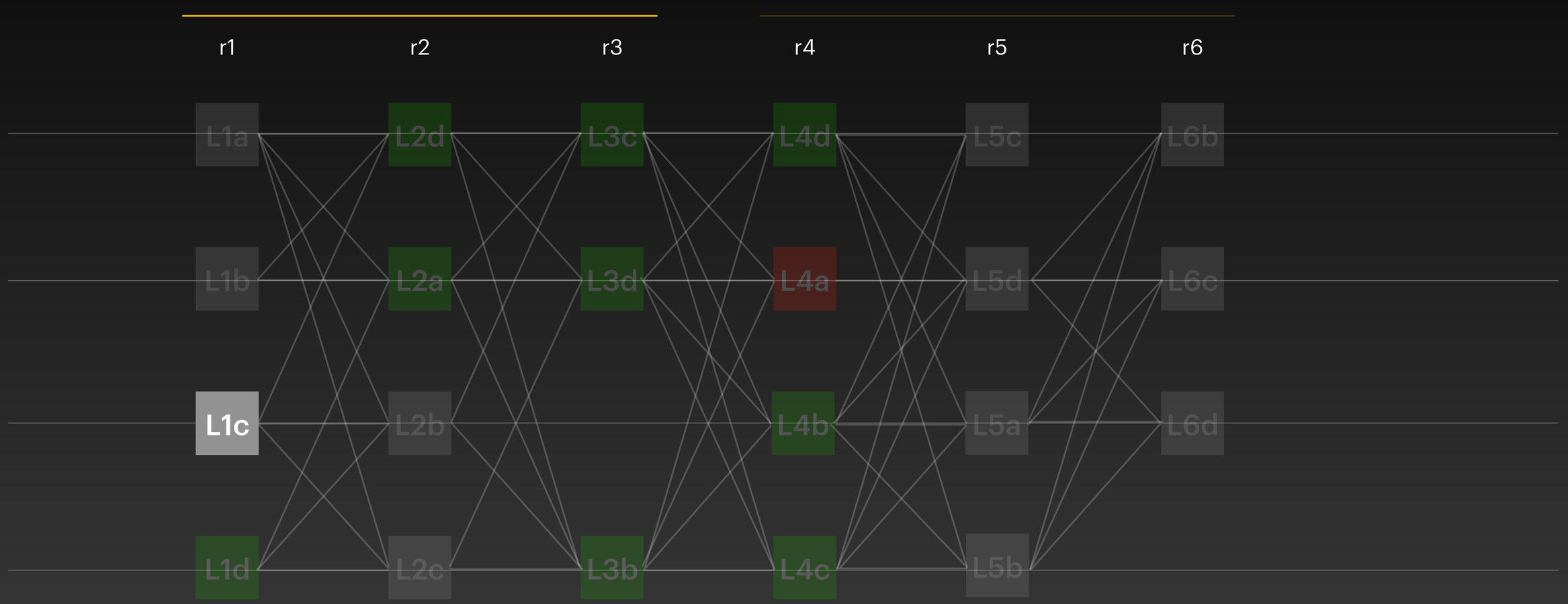
# Apply Indirect Rule

## Find anchor & Check certified links



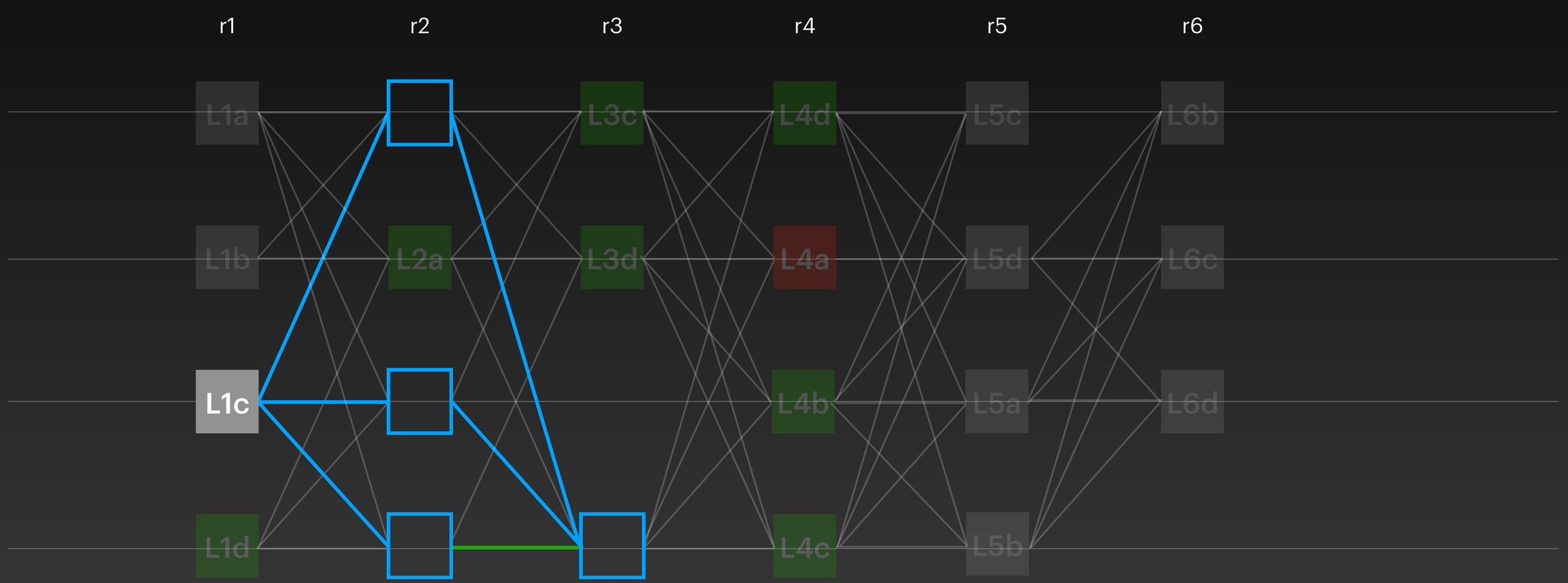
# Apply Direct Rule

## Start with highest round and go backward



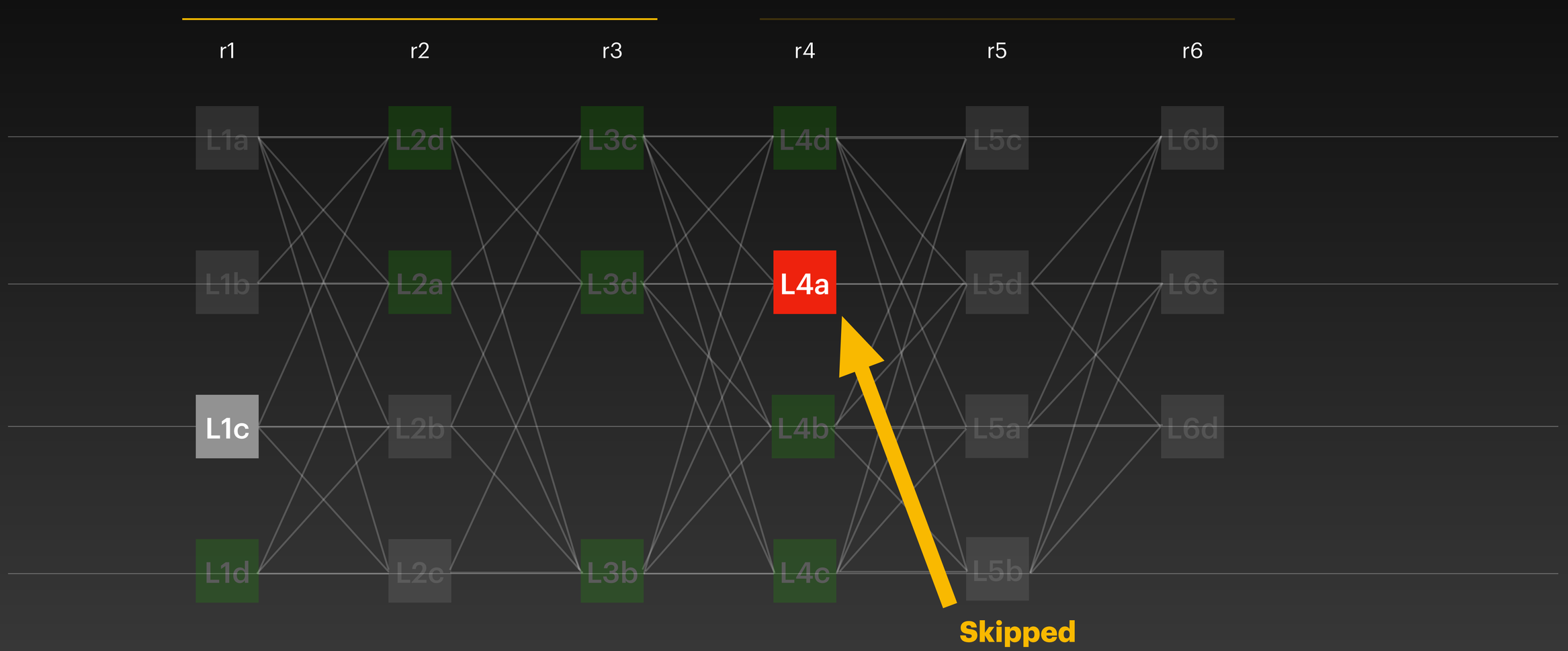
# Apply Direct Rule

## Start with highest round and go backward



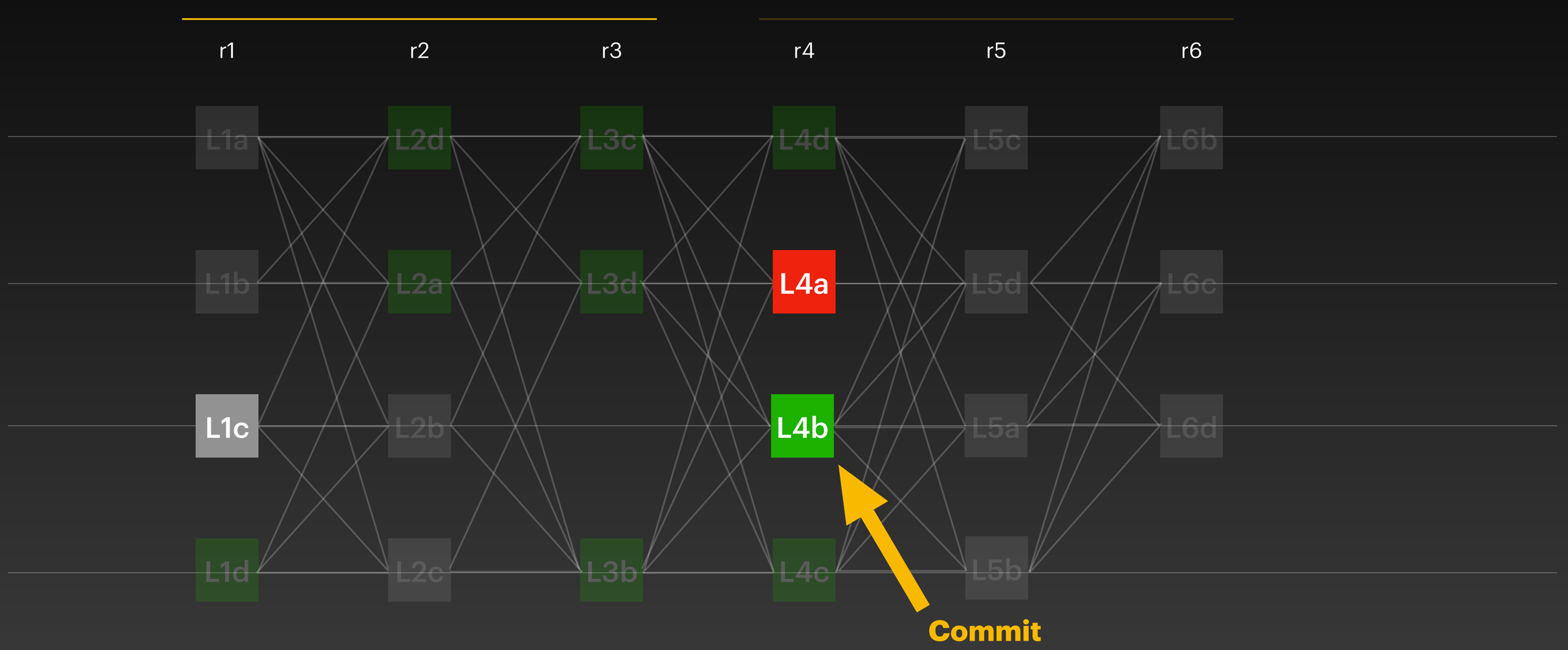
# Apply Indirect Rule

## Find anchor & Check certified links



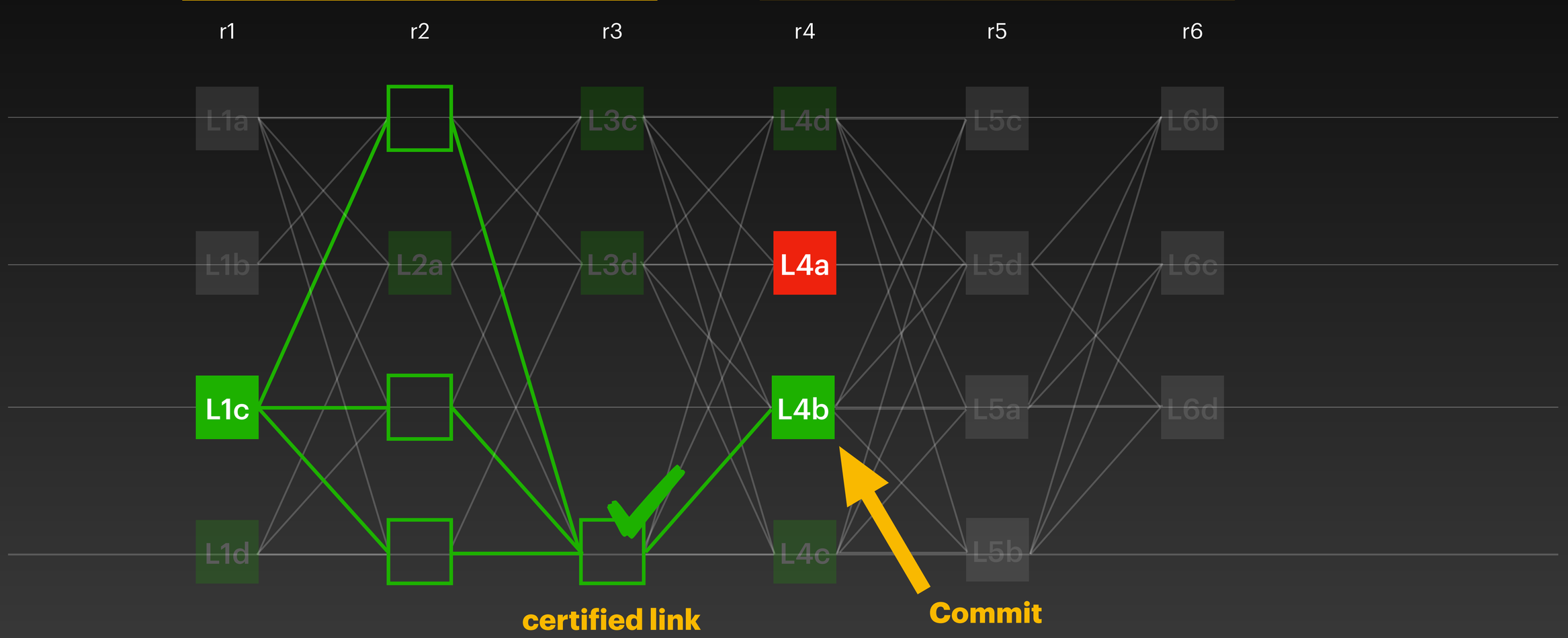
# Apply Indirect Rule

## Find anchor & Check certified links



# Apply Indirect Rule

## Find anchor & Check certified links



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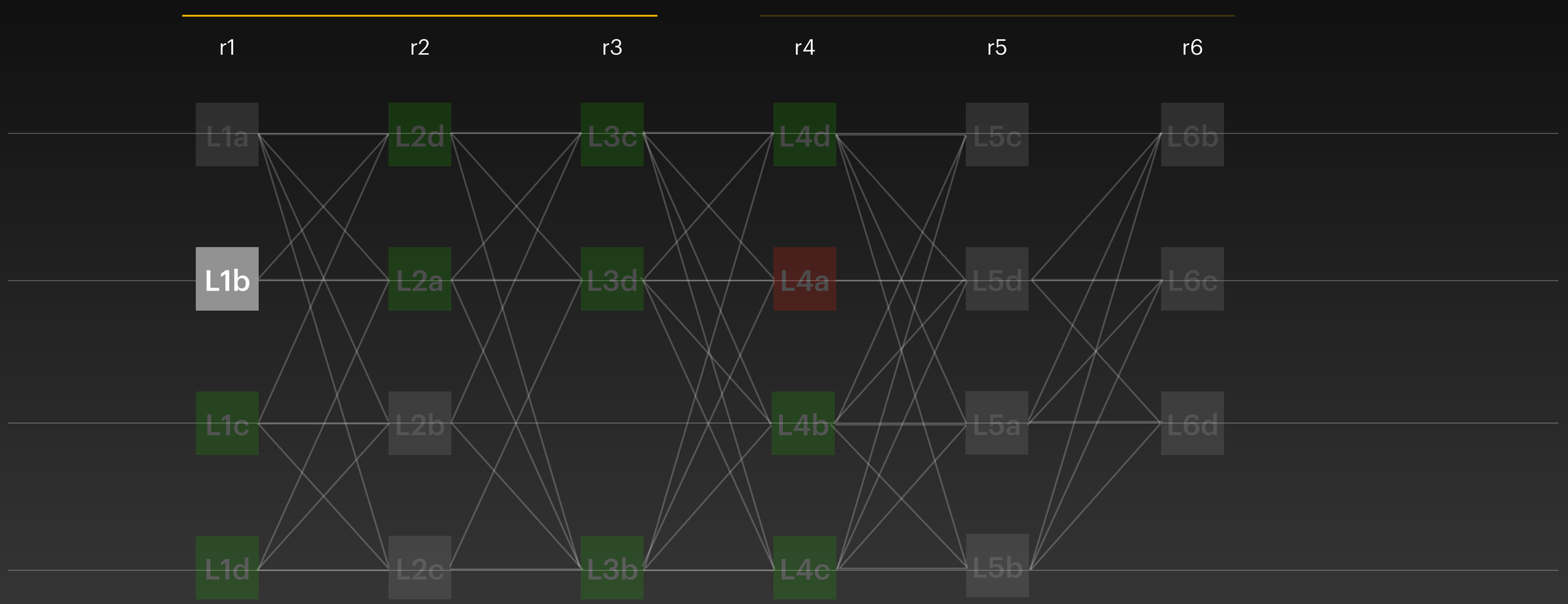
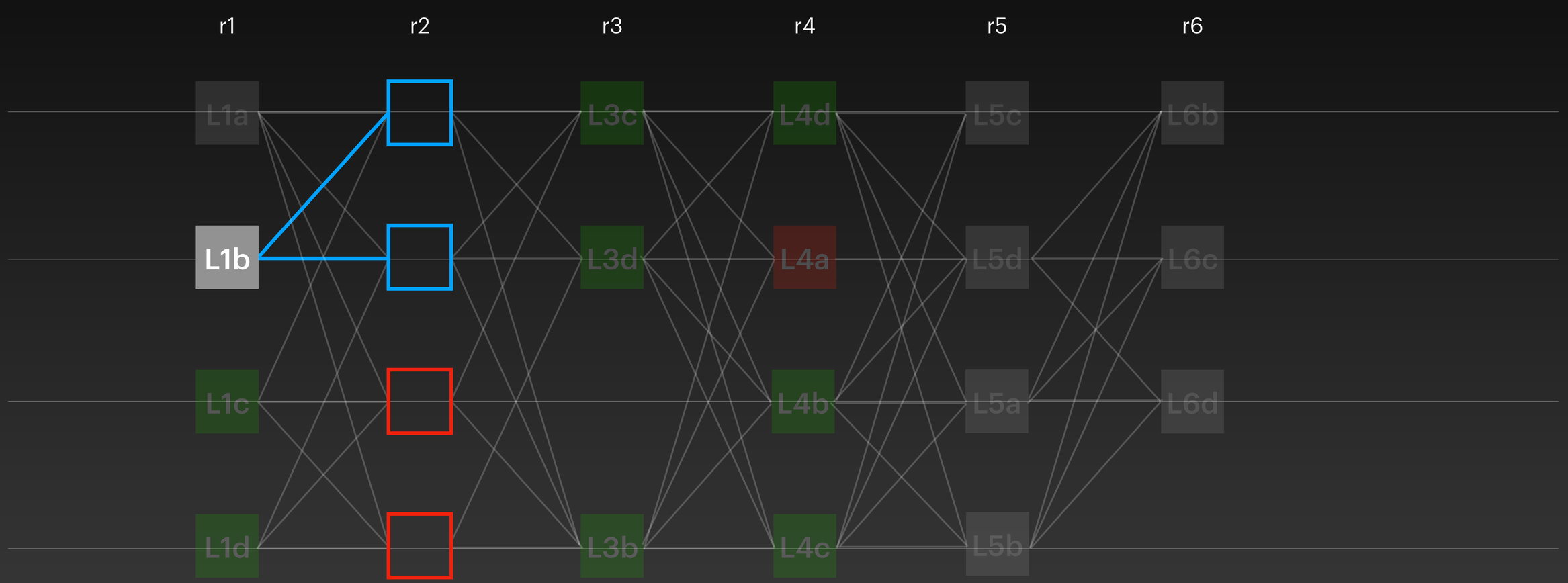
## Start with highest round and go backward



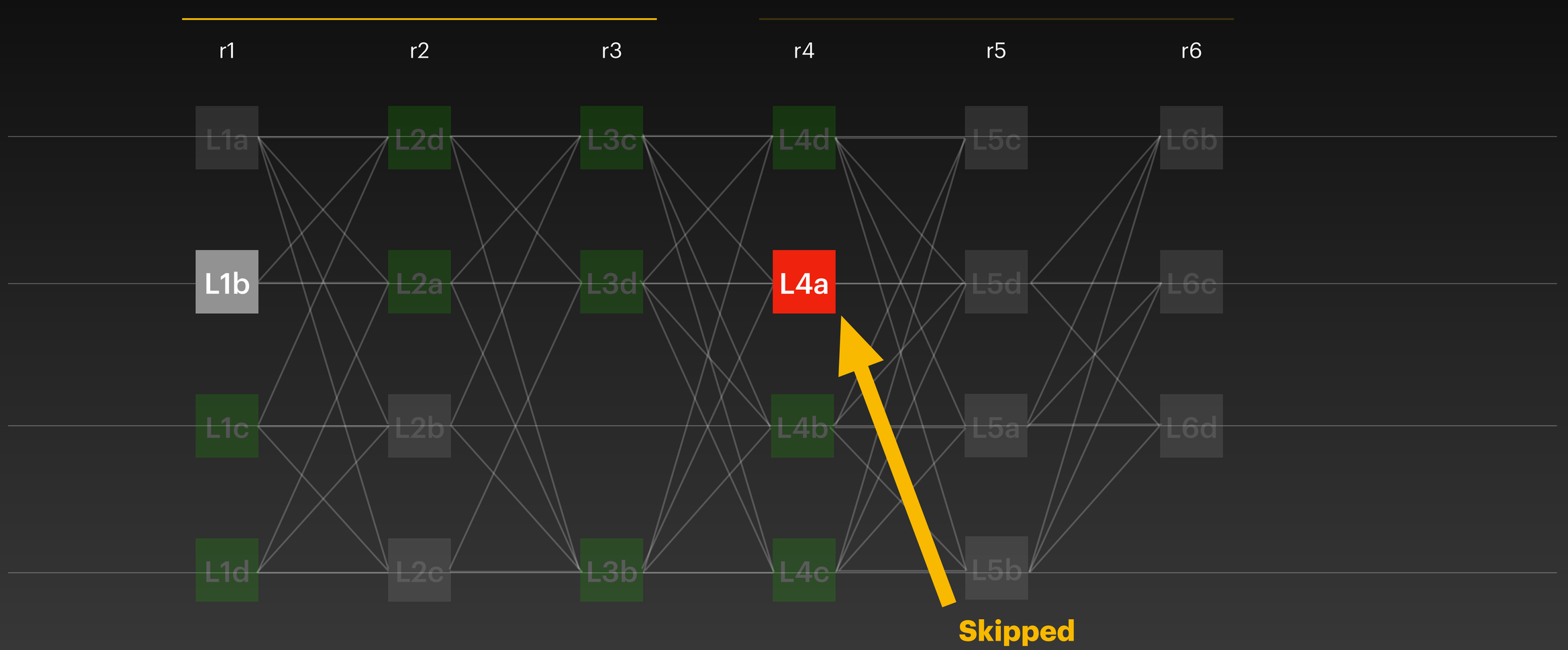
# Apply Direct Rule

## Start with highest round and go backward



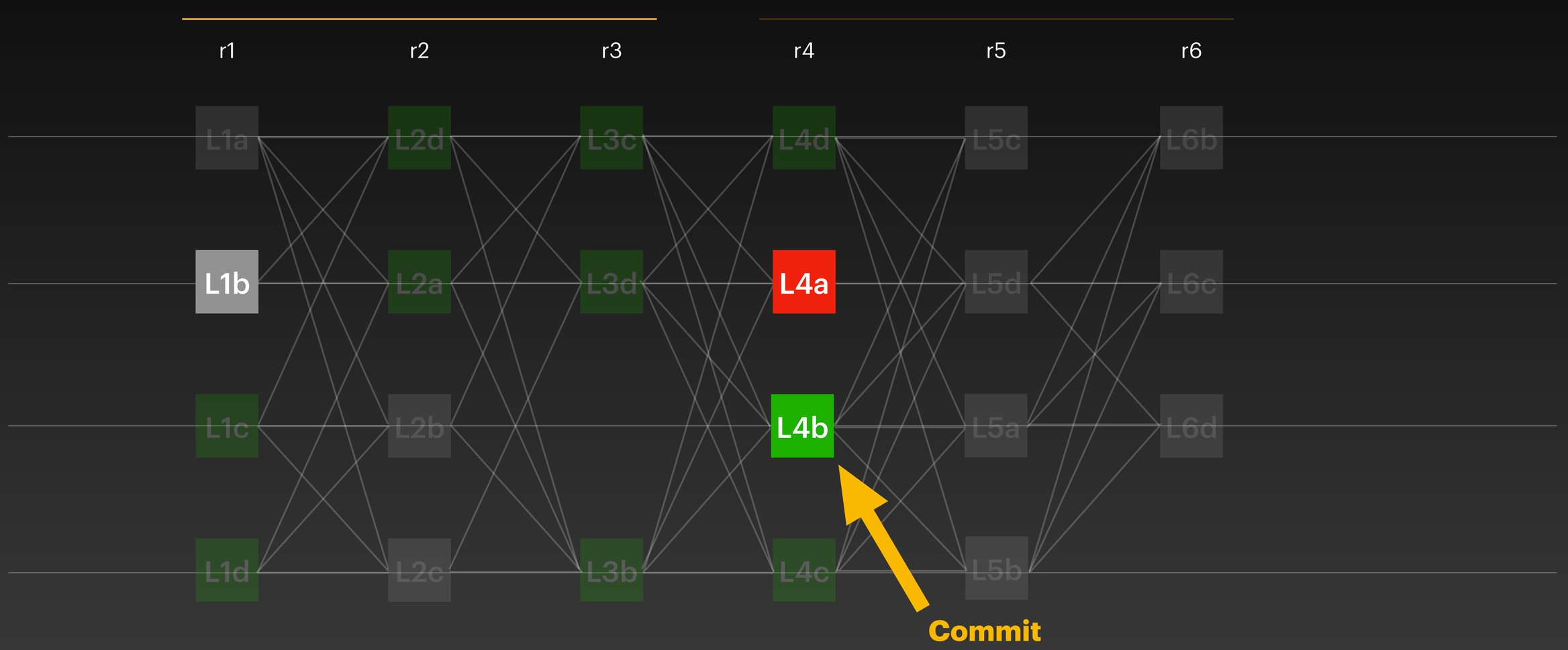
# Apply Indirect Rule

## Find anchor & Check certified links



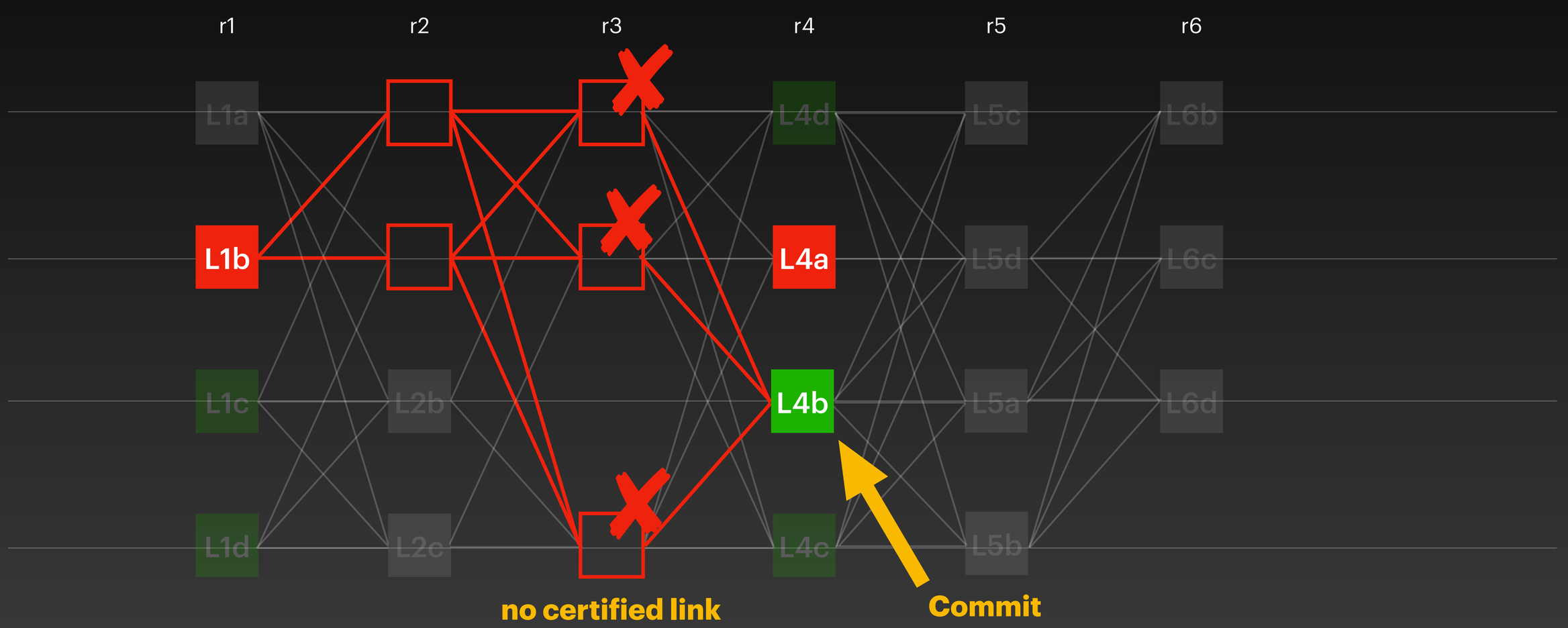
# Apply Indirect Rule

## Find anchor & Check certified links



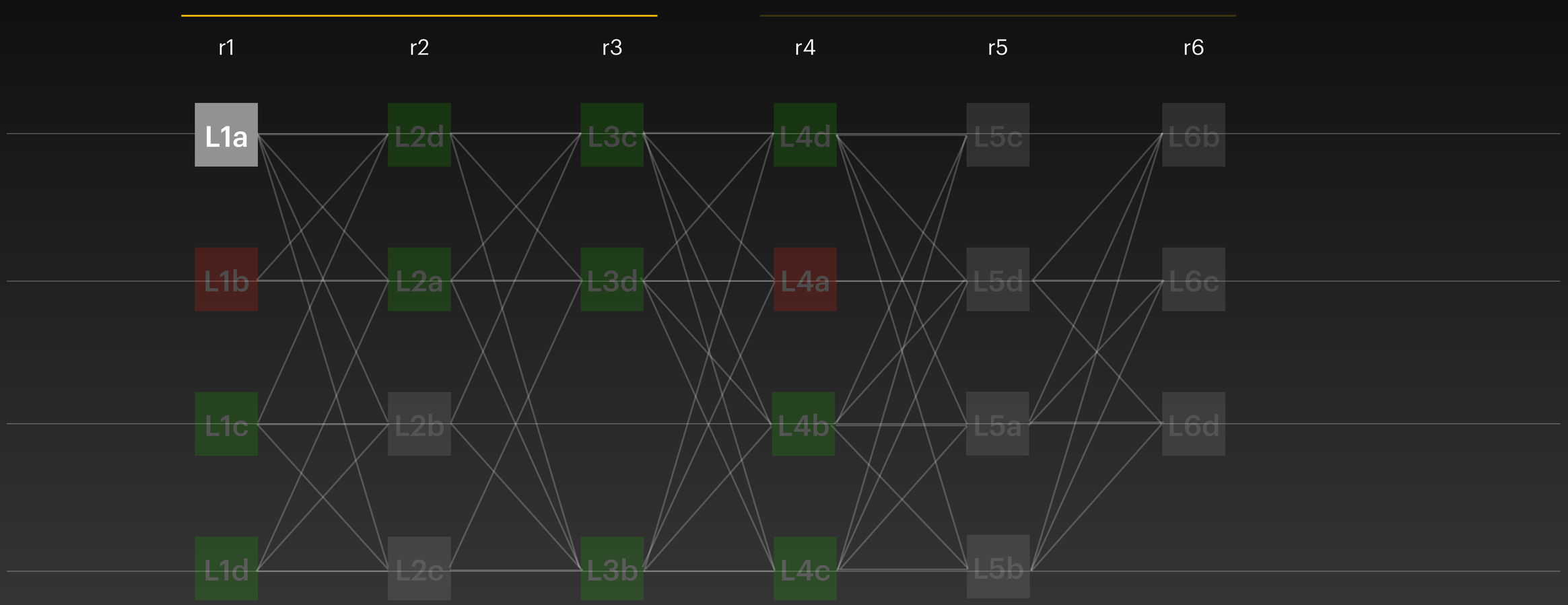
# Apply Indirect Rule

## Find anchor & Check certified links



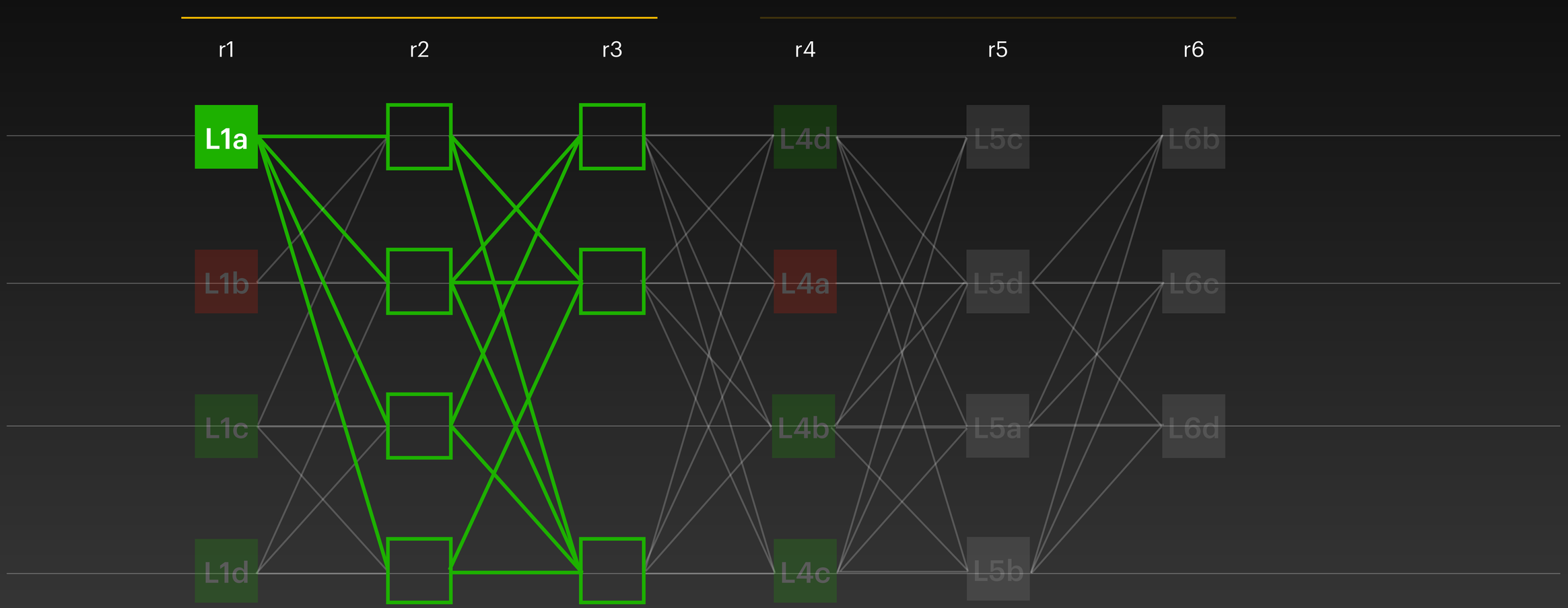
# Apply Direct Rule

## Start with highest round and go backward

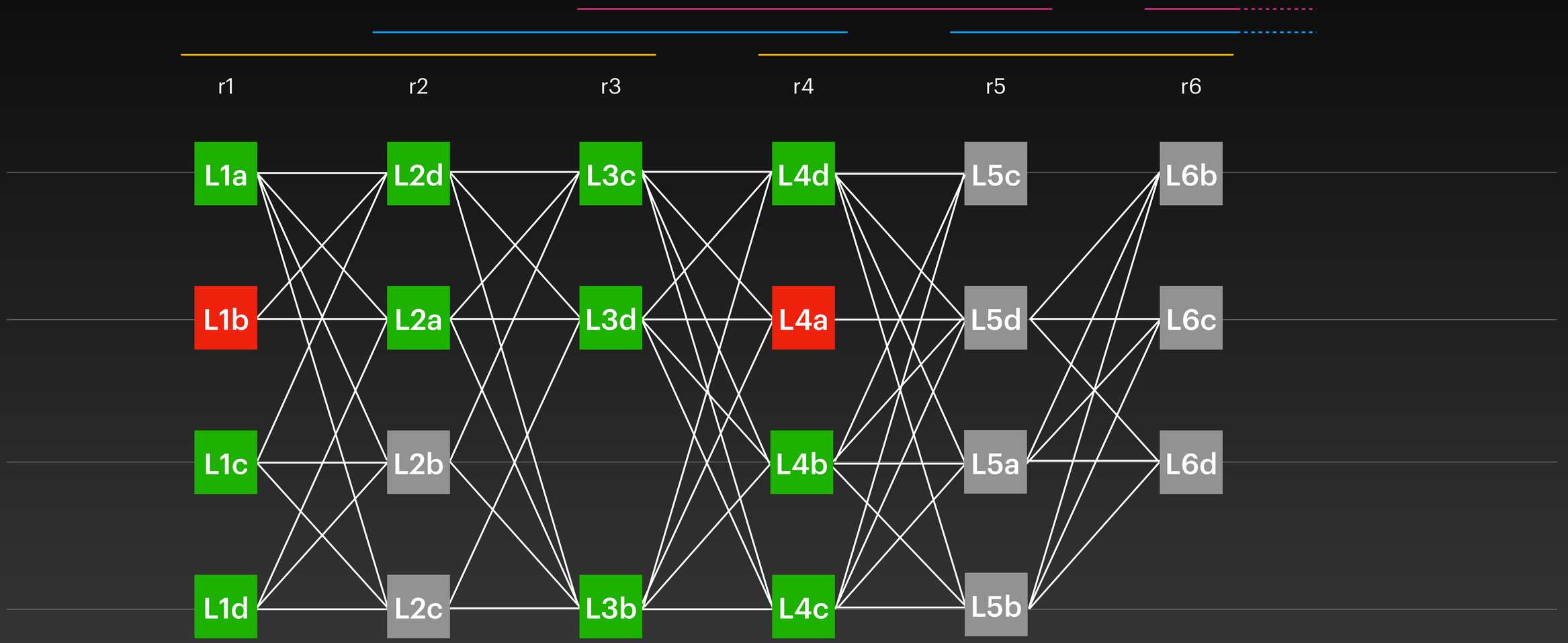


# Apply Direct Rule

## Start with highest round and go backward

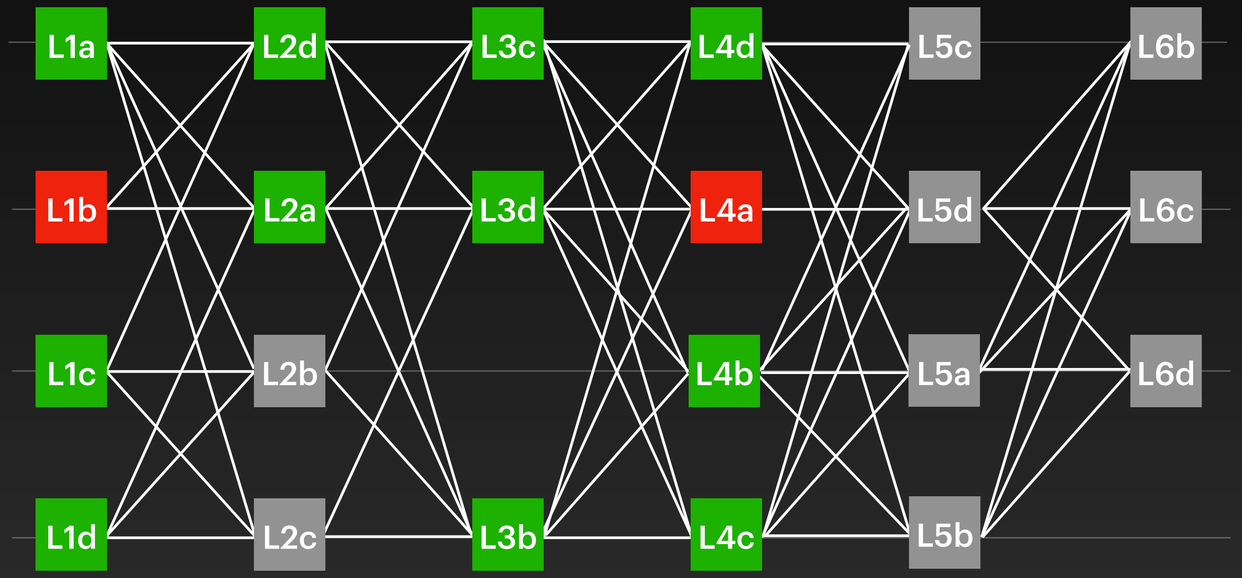


# Current Status



# Commit Sequence

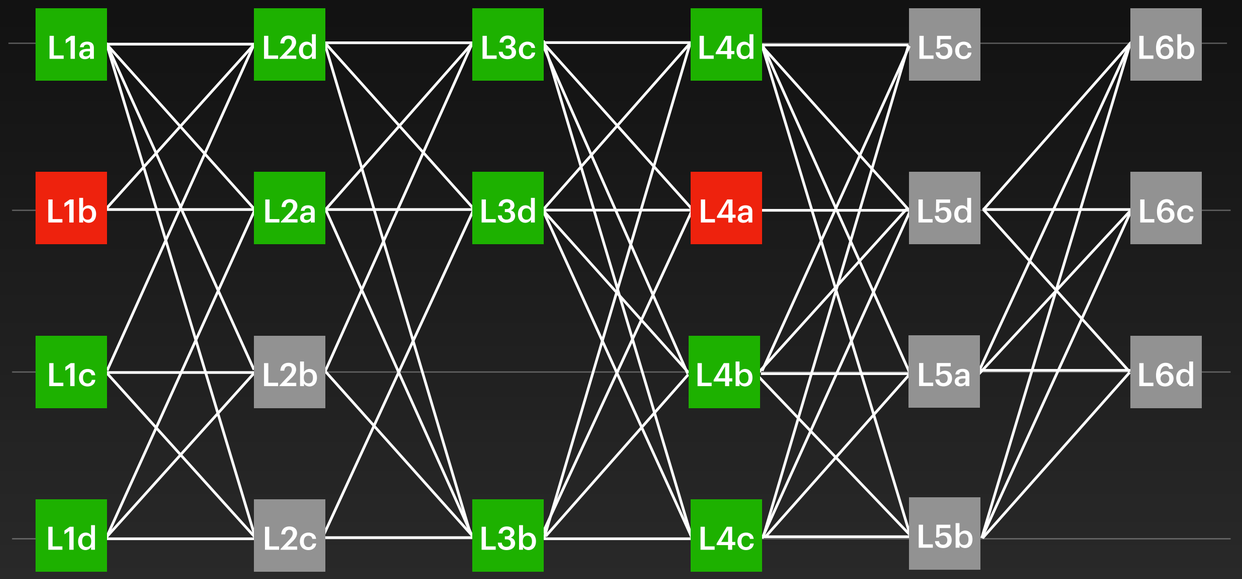
## Take all leaders in order




**sequence:** L1a L1b L1c L1d L2a L2b L2c L2d L3a L3b L3c L3d L4a L4b L4c L4d

# Commit Sequence

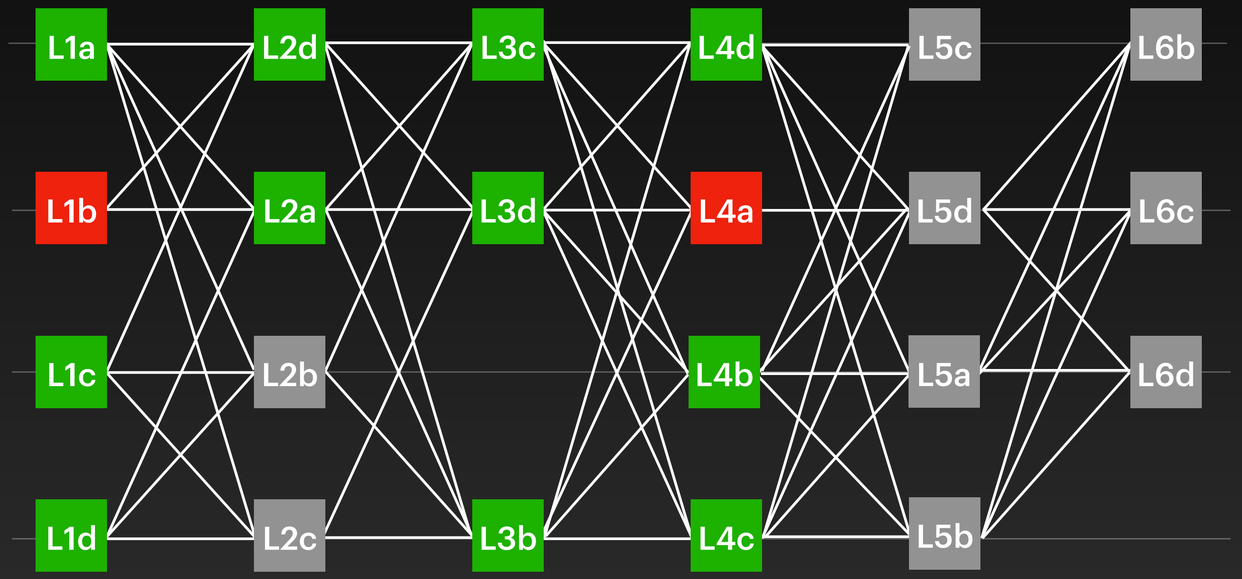
## Stop at the first Undecided leader

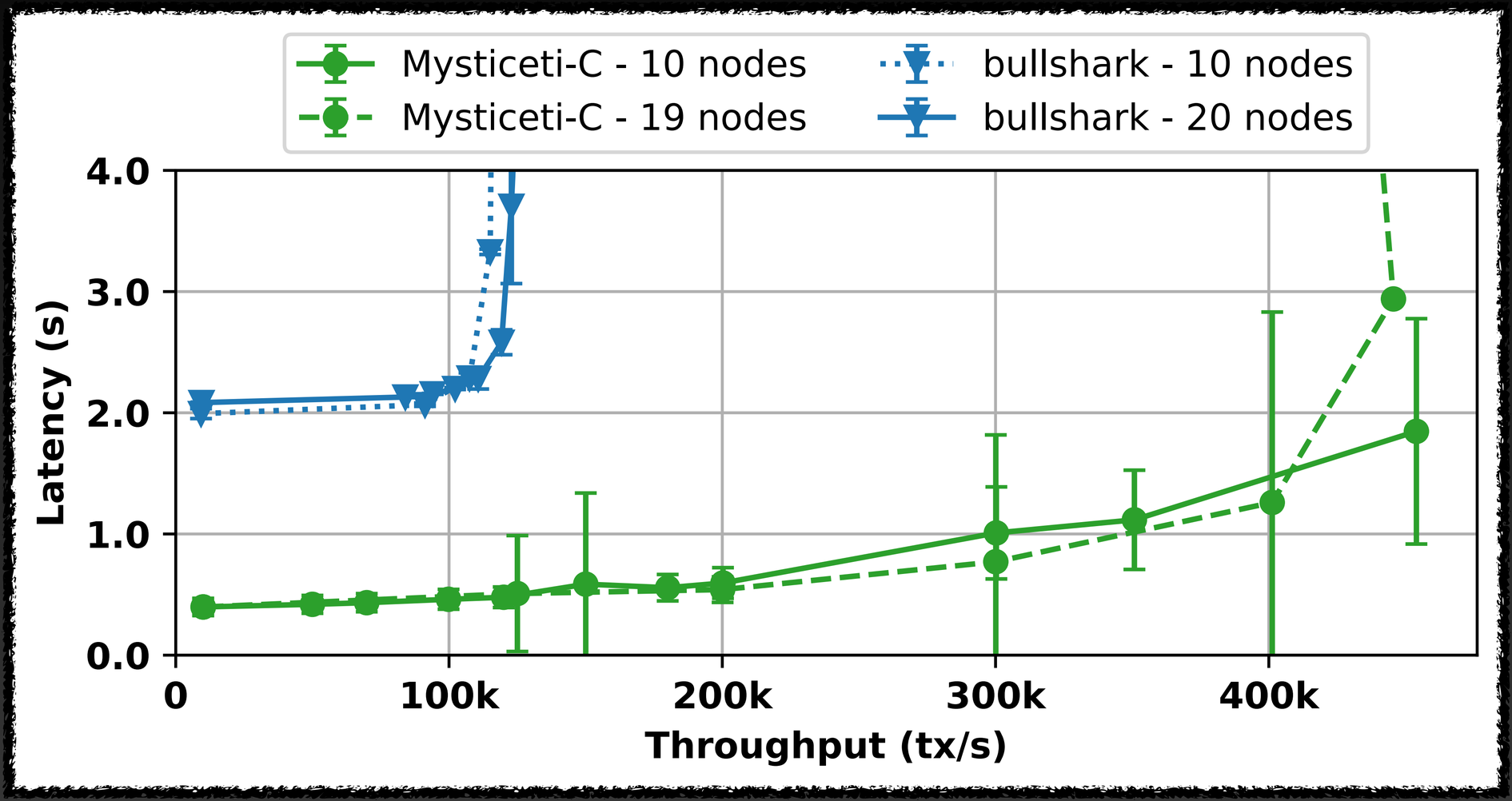



**sequence:** L1a L1b L1c L1d L2a | L2b L2c L2d L3a L3b L3c L3d L4a L4b L4c L4d

# Current Status

## Remove skipped leaders




**sequence:** L1a L1b L1c L1d L2a L2b L2c L2d L3a L3b L3c L3d L4a L4b L4c L4d

# Preliminary Results