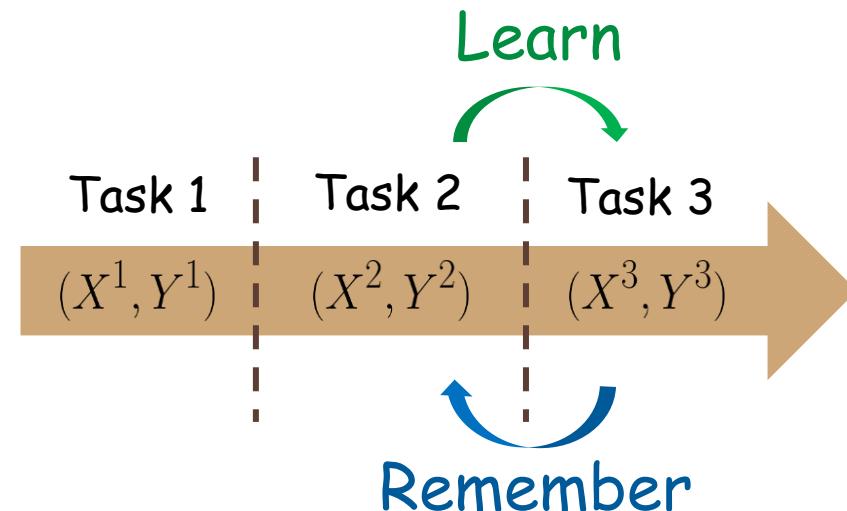


NISPA: Neuro-Inspired Stability-Plasticity Adaptation for Continual Learning in Sparse Networks

M. Burak Gurbuz and Constantine Dovrolis

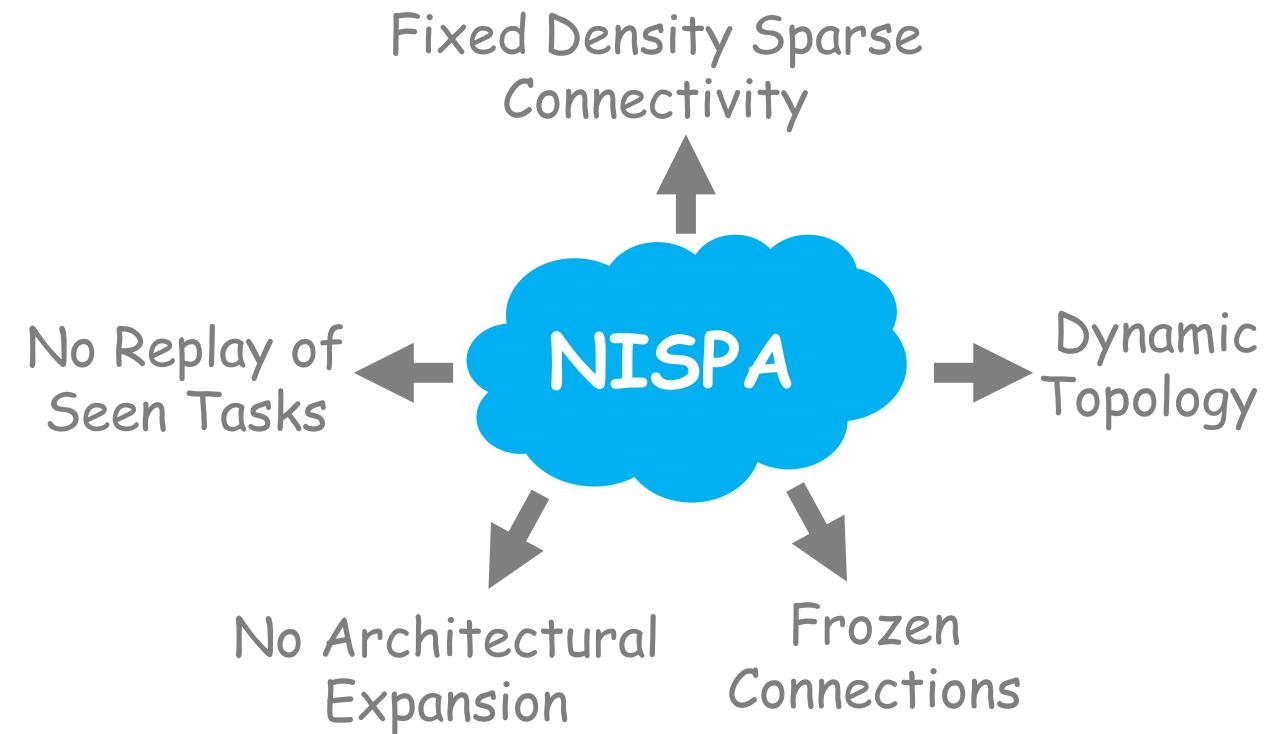
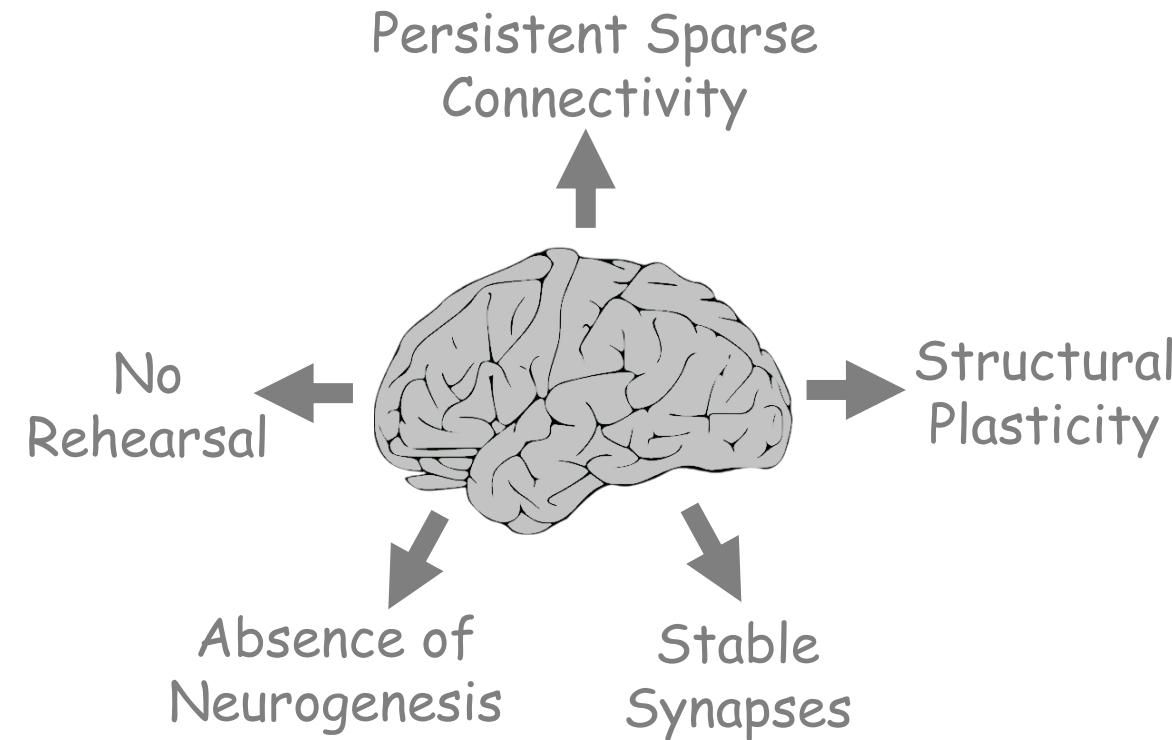
Continual Learning and Catastrophic Forgetting

- Standard Neural Network Training
 - Shuffled inputs satisfy i.i.d assumption
- Continual Learning
 - Tasks encountered sequentially
 - Catastrophic Forgetting: overwrite information from past task(s)



From Neuroscience to Deep Learning

- Five facts about brain's structure and function.



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- ❖ Babadi & Sompolinsky, Sparseness and expansion in sensory representations, *Neuron* 2014
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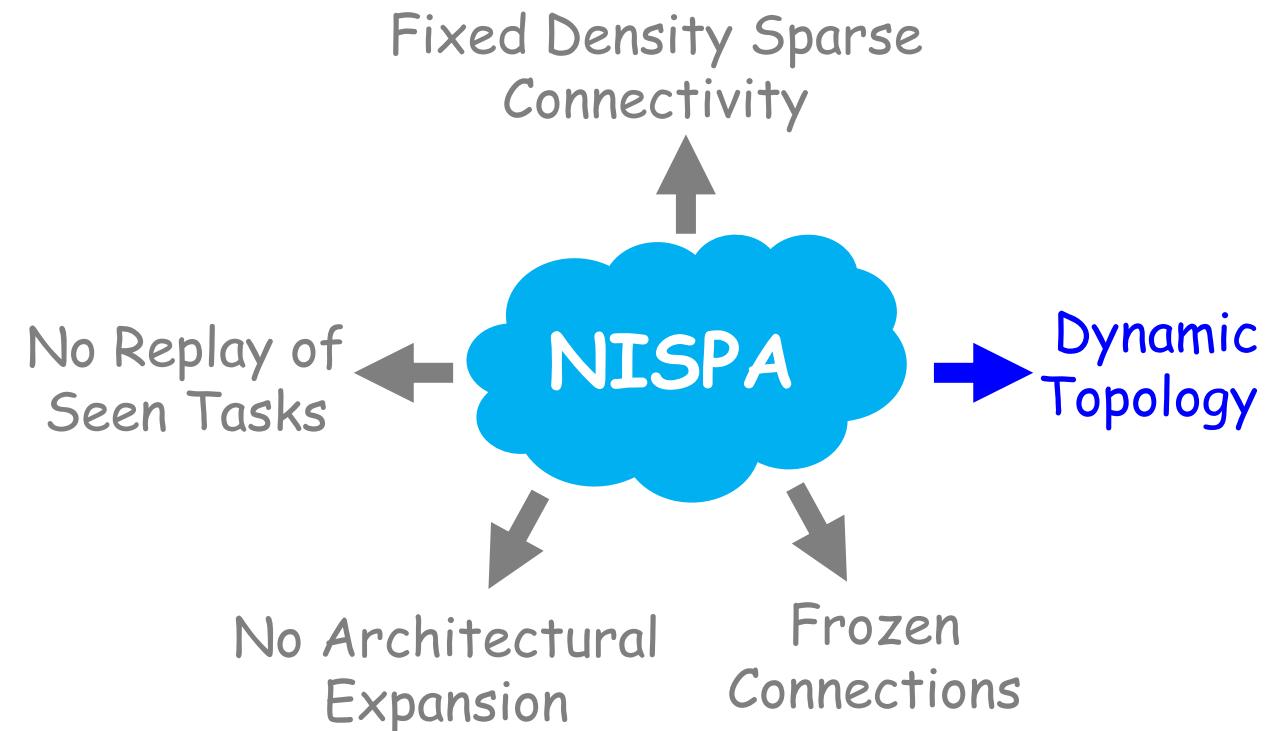
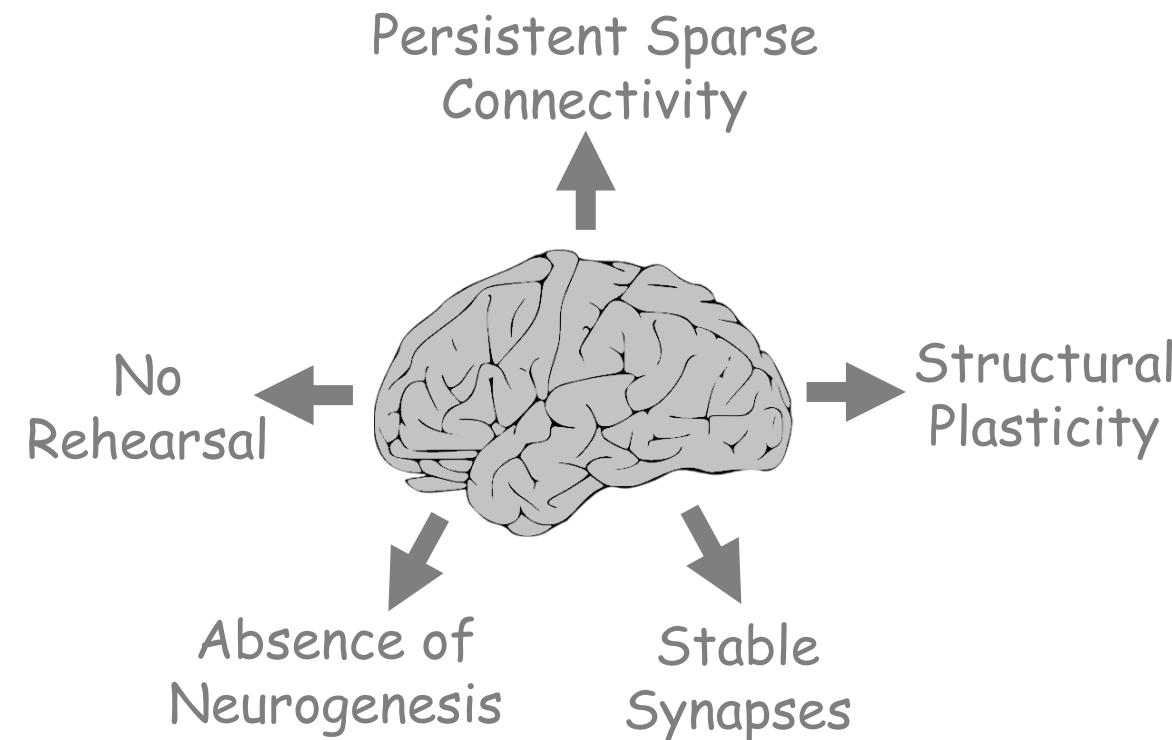
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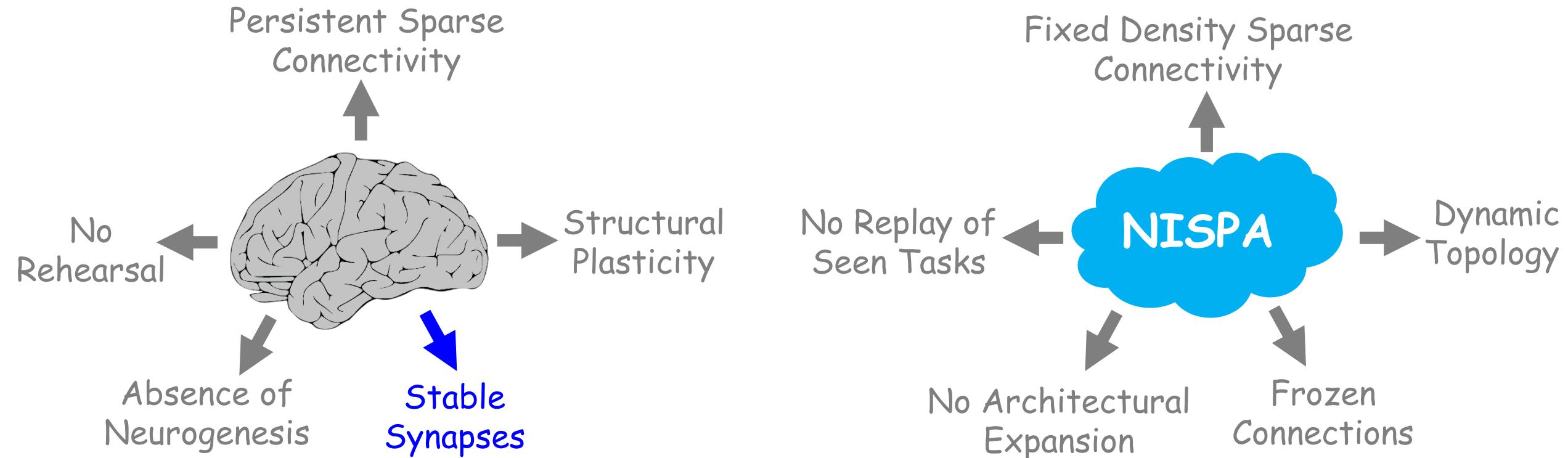
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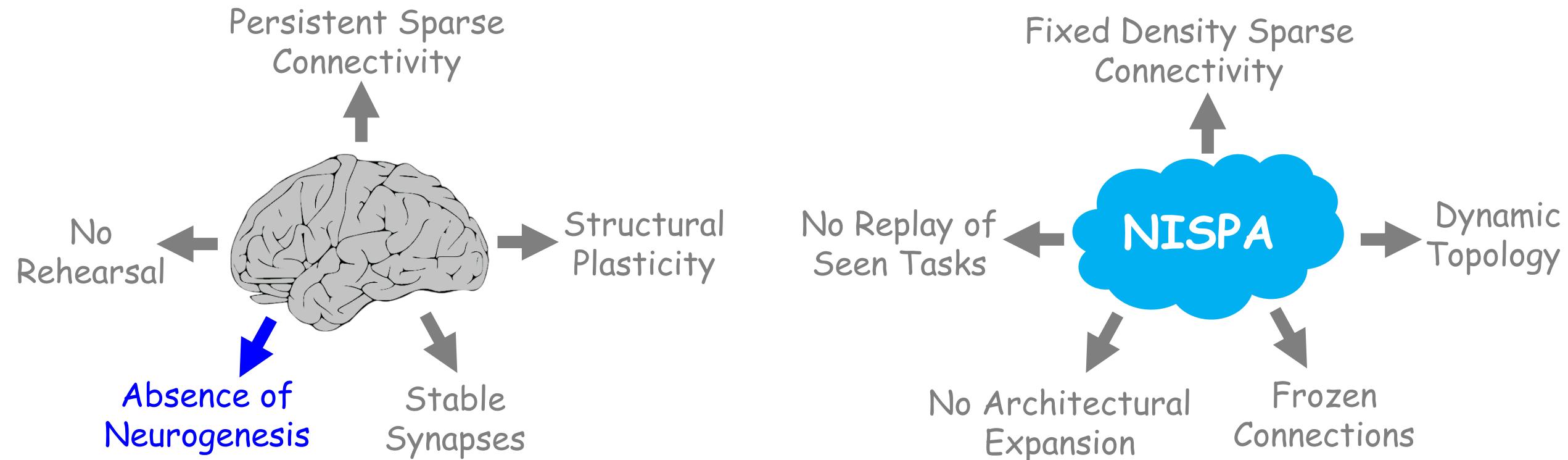
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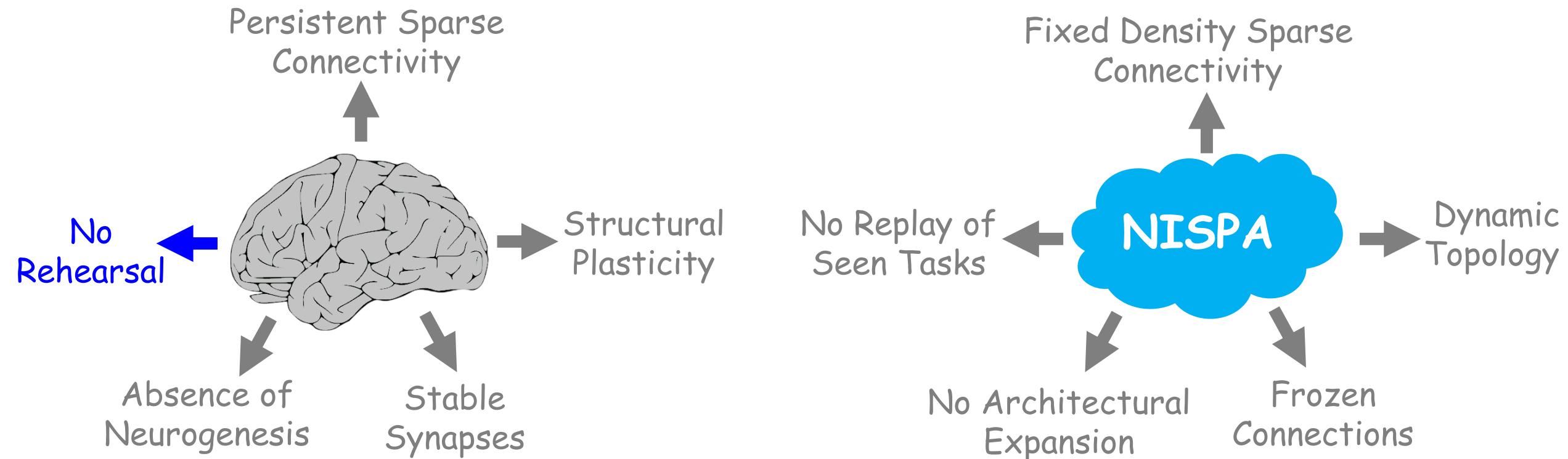
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NISPA: Stable Unit Selection



Plastic Units

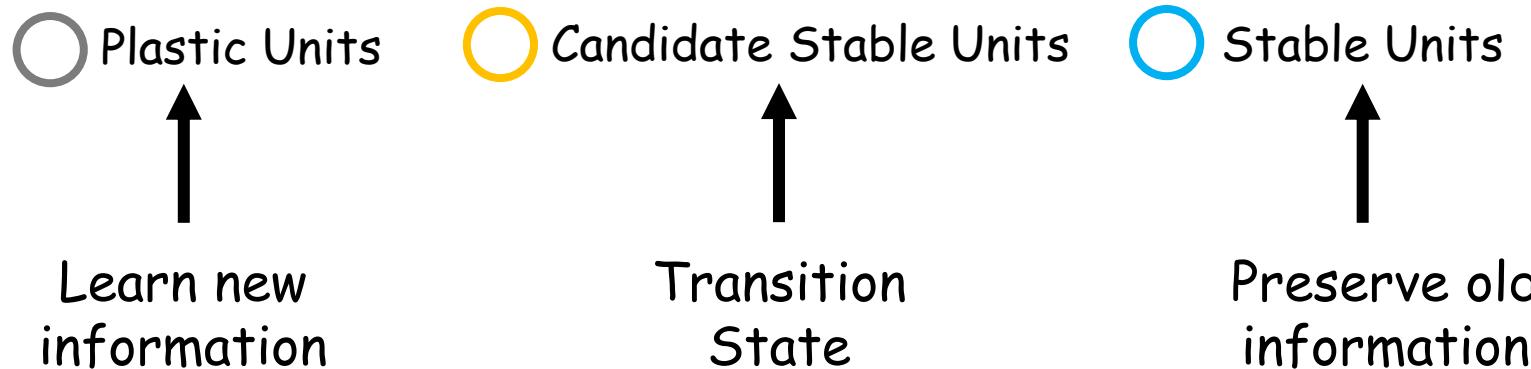


Candidate Stable Units



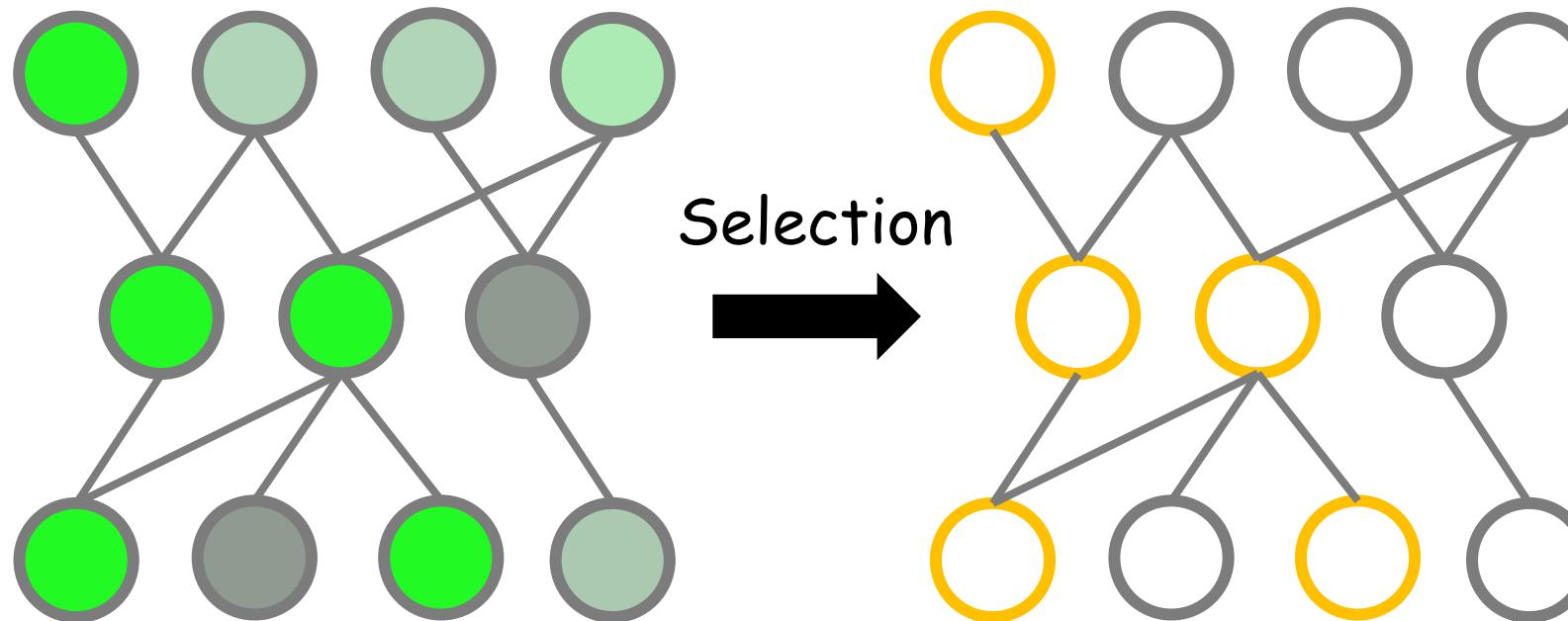
Stable Units

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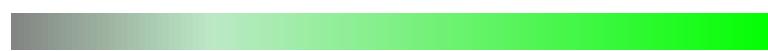


NISPA: Stable Unit Selection

○ Plastic Units ○ Candidate Stable Units ○ Stable Units



Less Activation



High Activation

NISPA: Rewiring



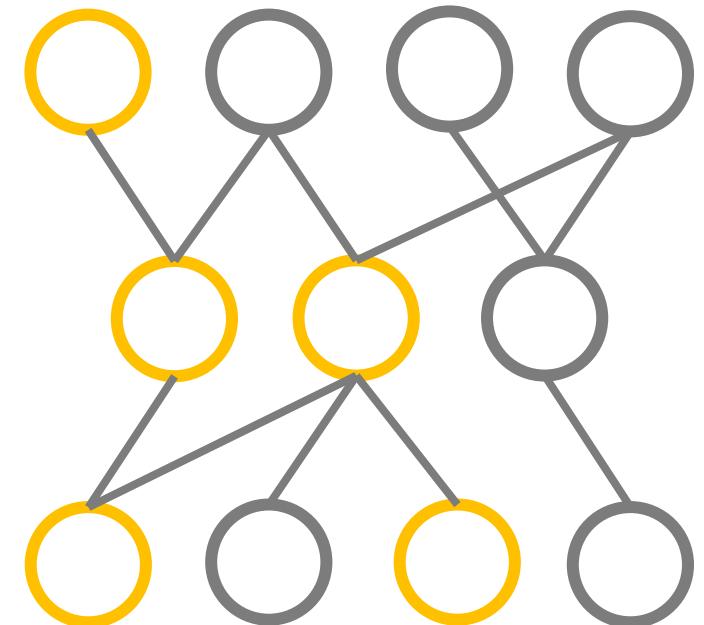
Plastic Units



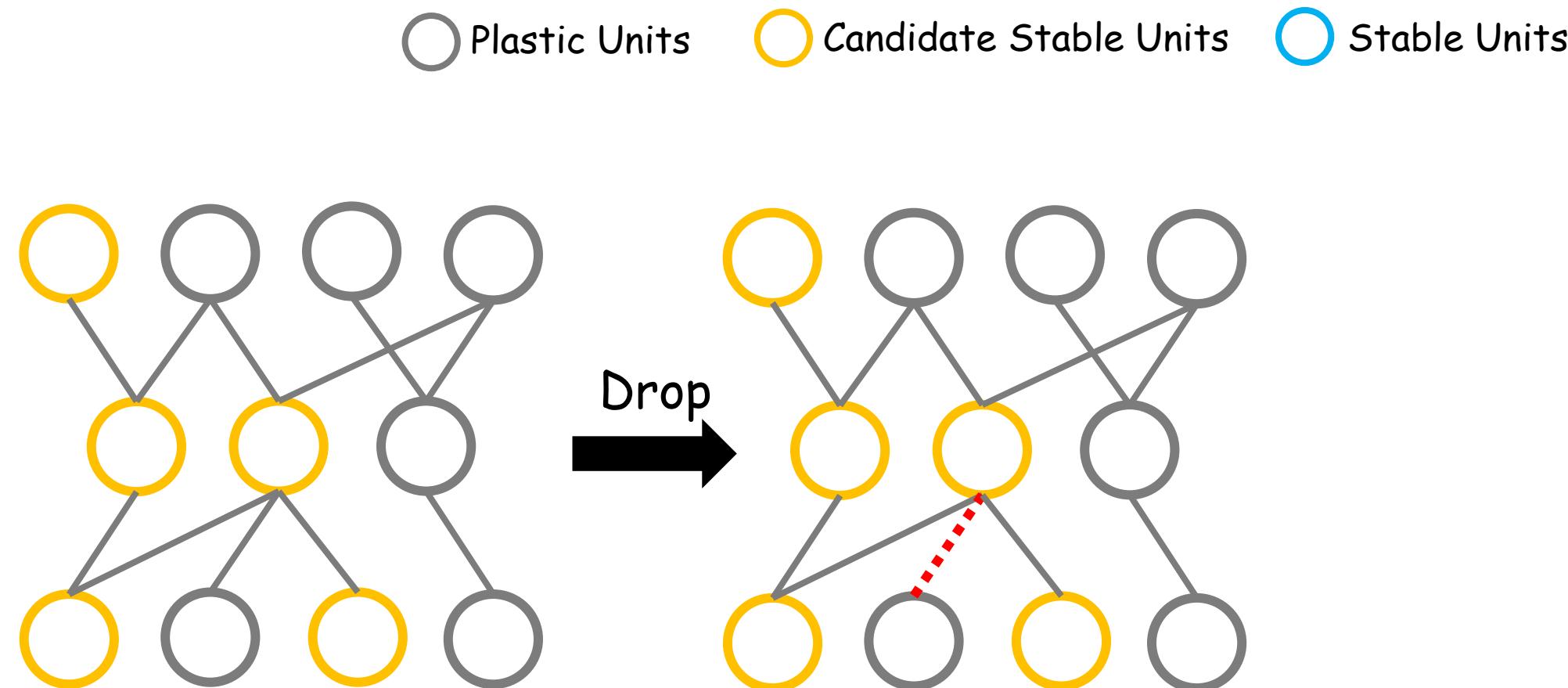
Candidate Stable Units



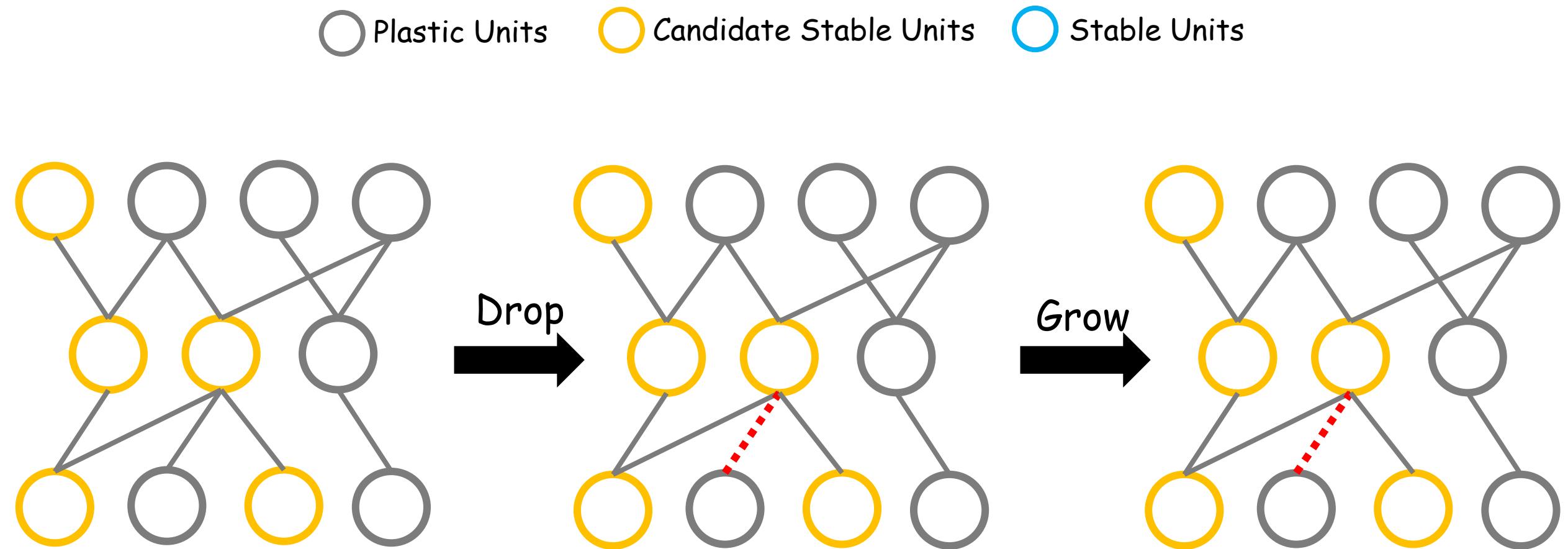
Stable Units



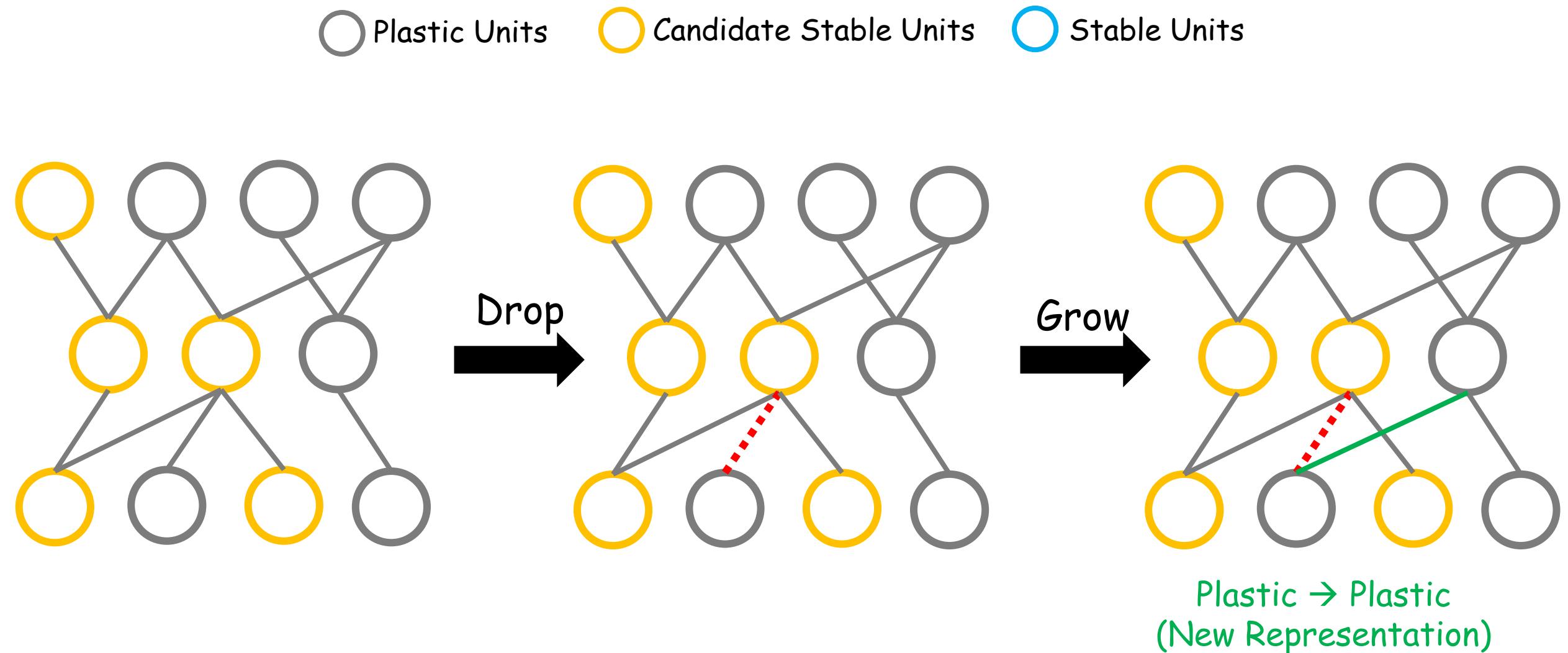
NISPA: Rewiring



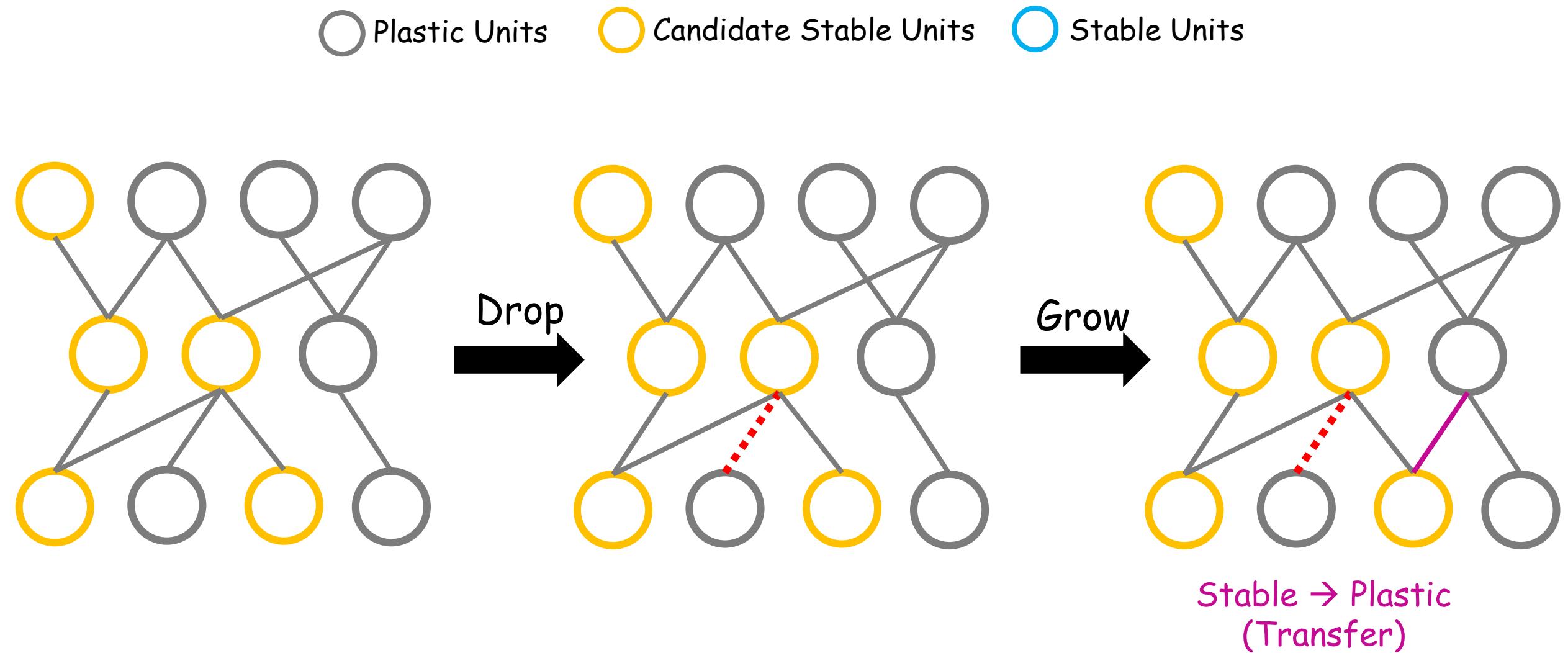
NISPA: Rewiring



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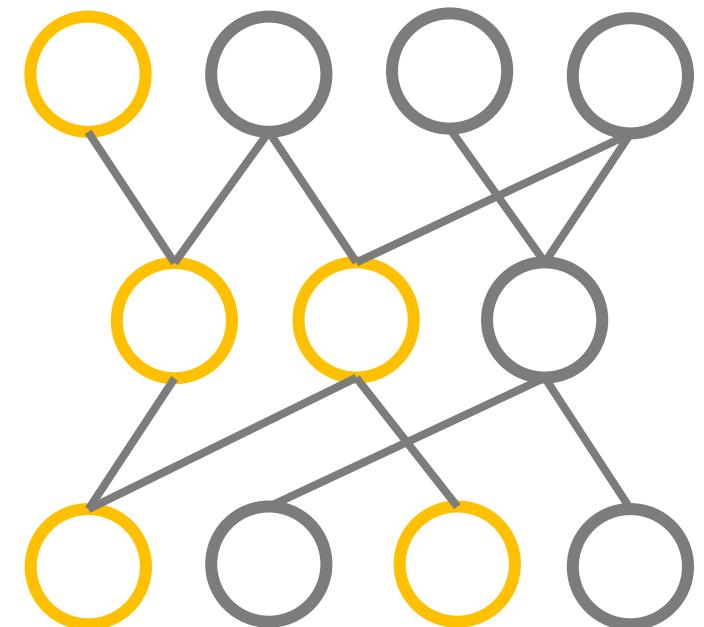


NISPA: Rewiring

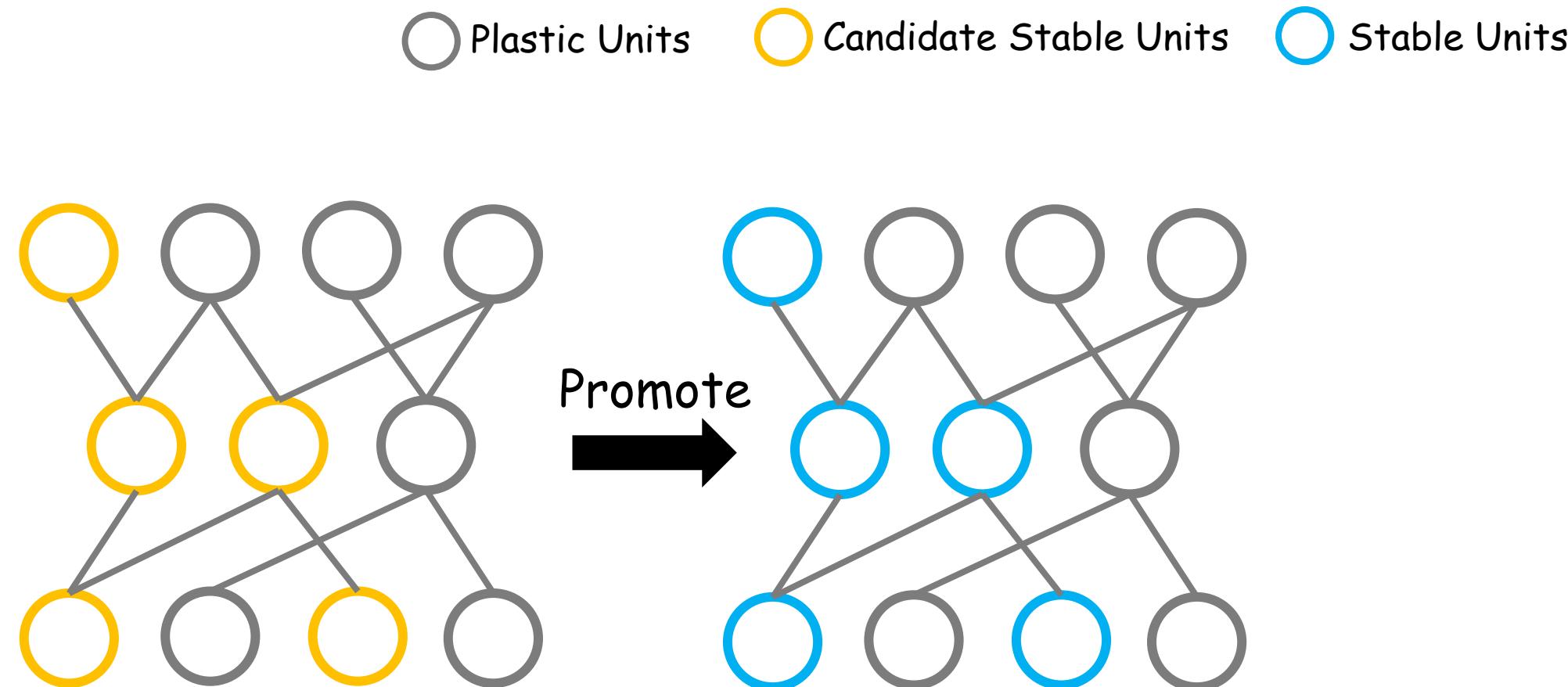


NISPA: Stabilizing a Unit

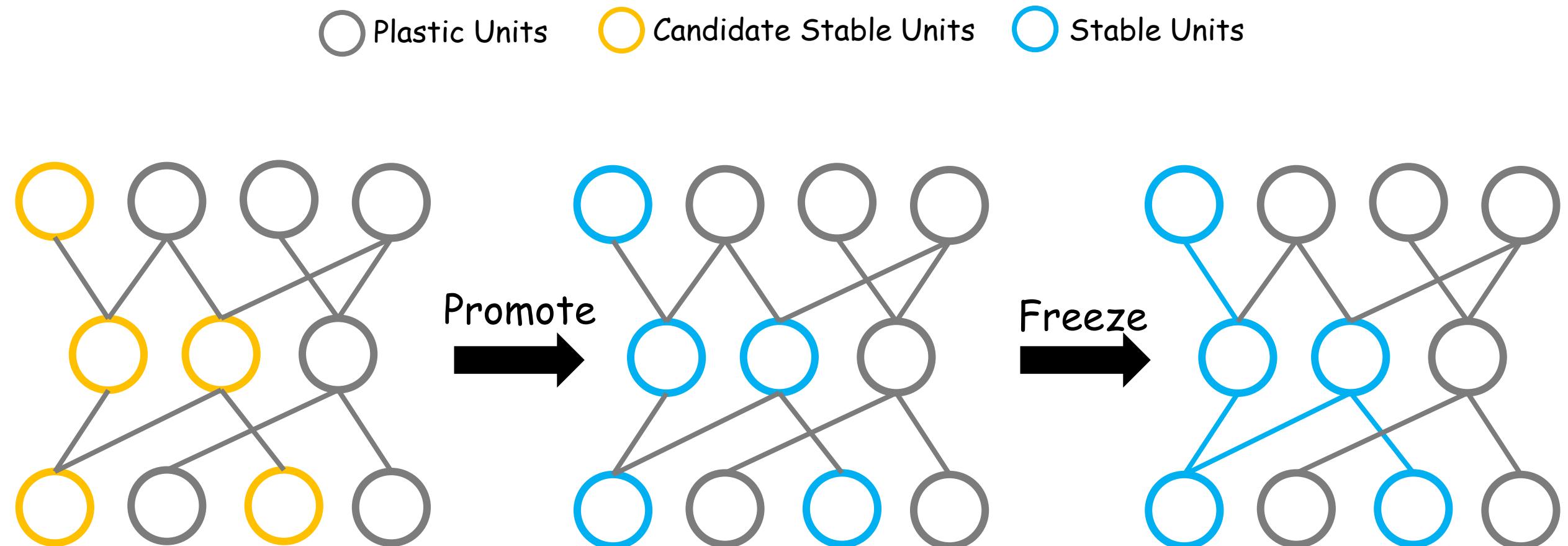
○ Plastic Units ○ Candidate Stable Units ○ Stable Units



NISPA: Stabilizing a Unit

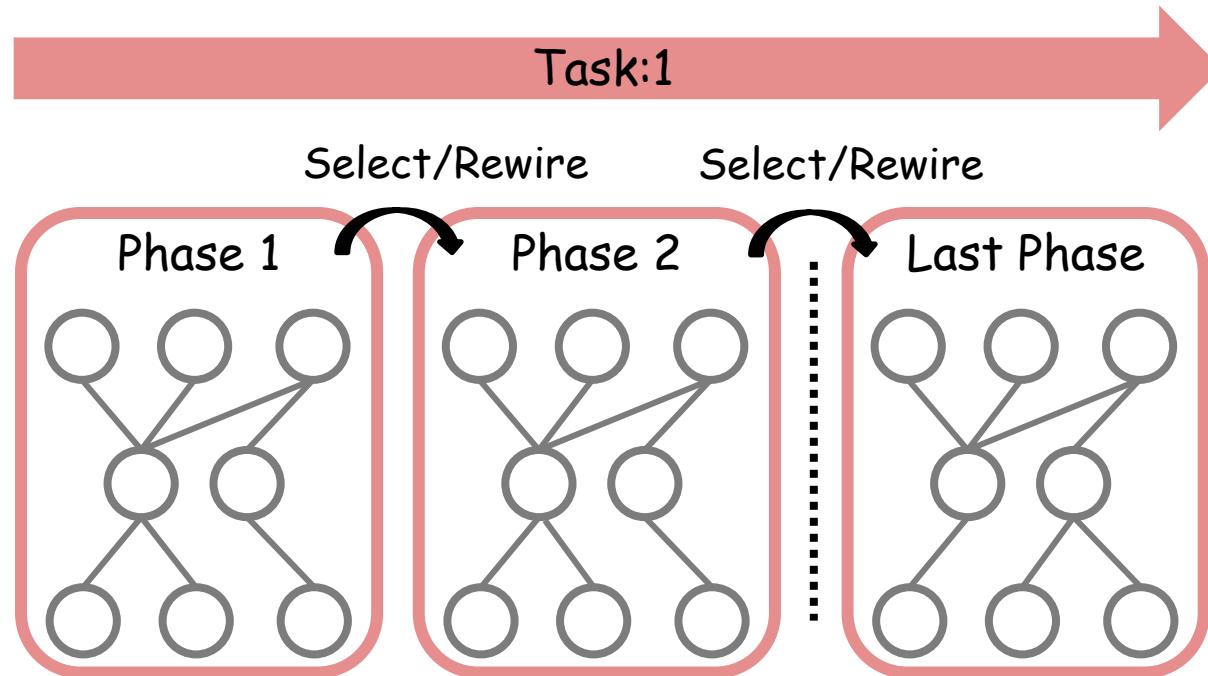


NISPA: Stabilizing a Unit

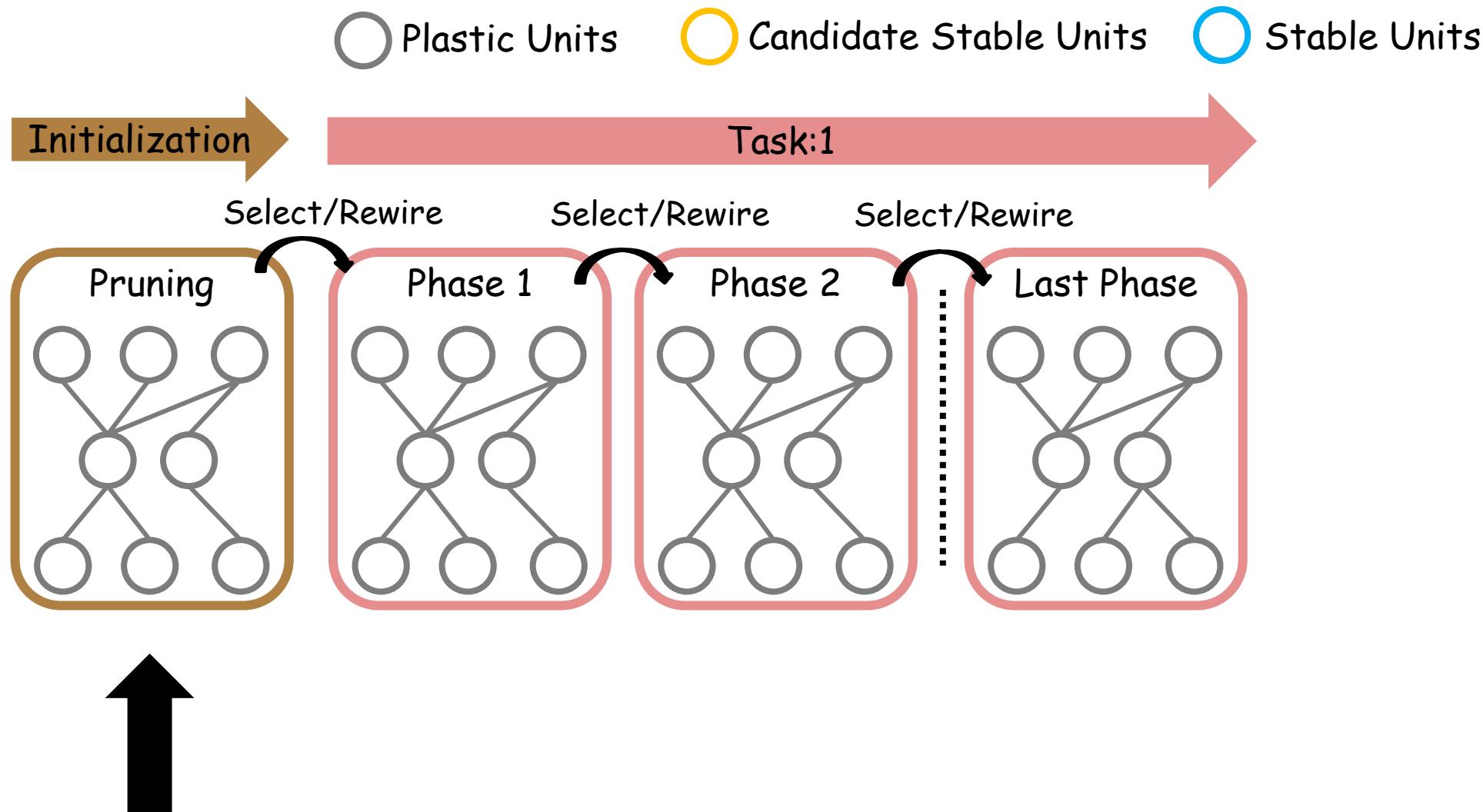


NISPA: Putting It All Together

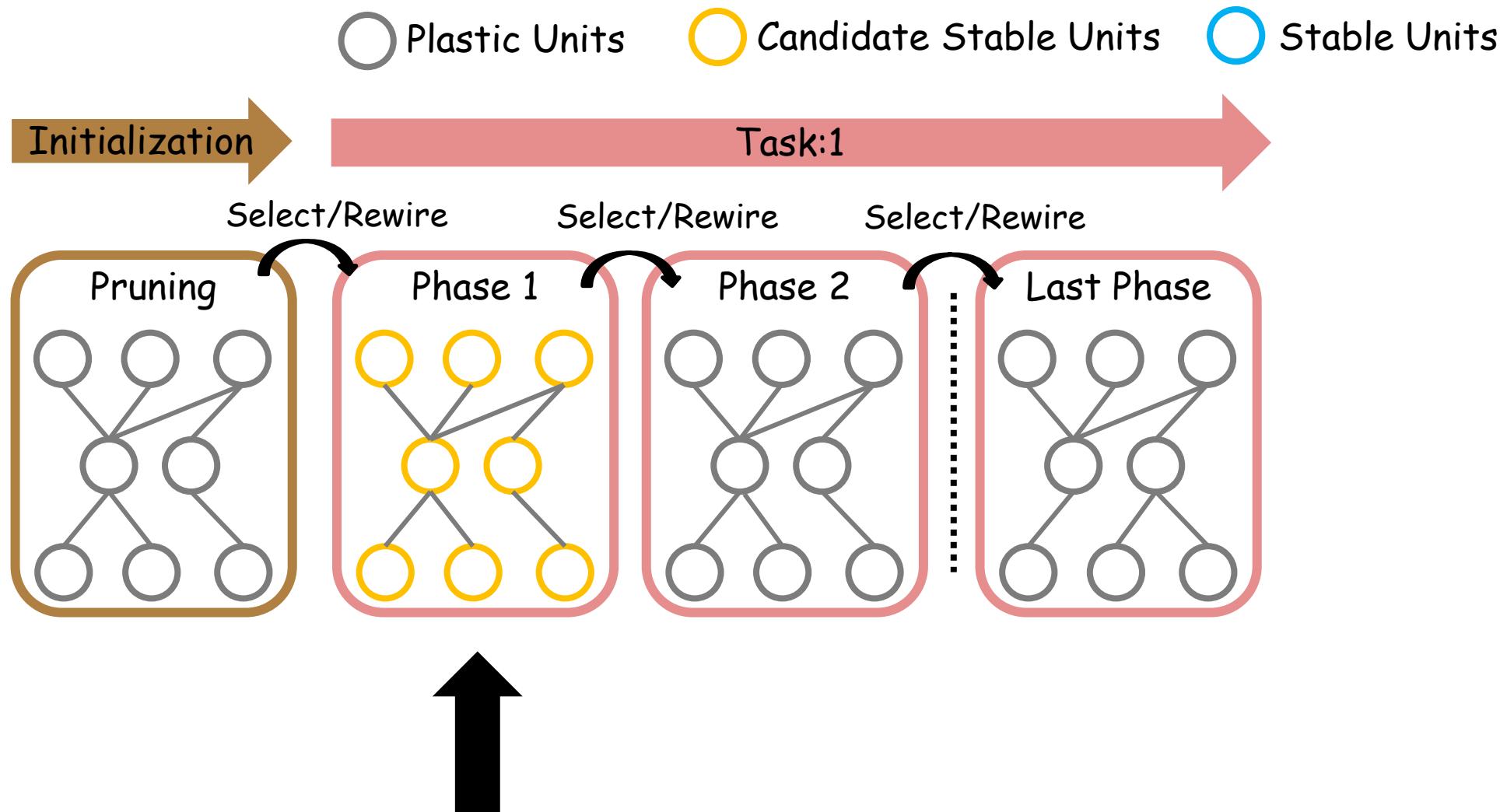
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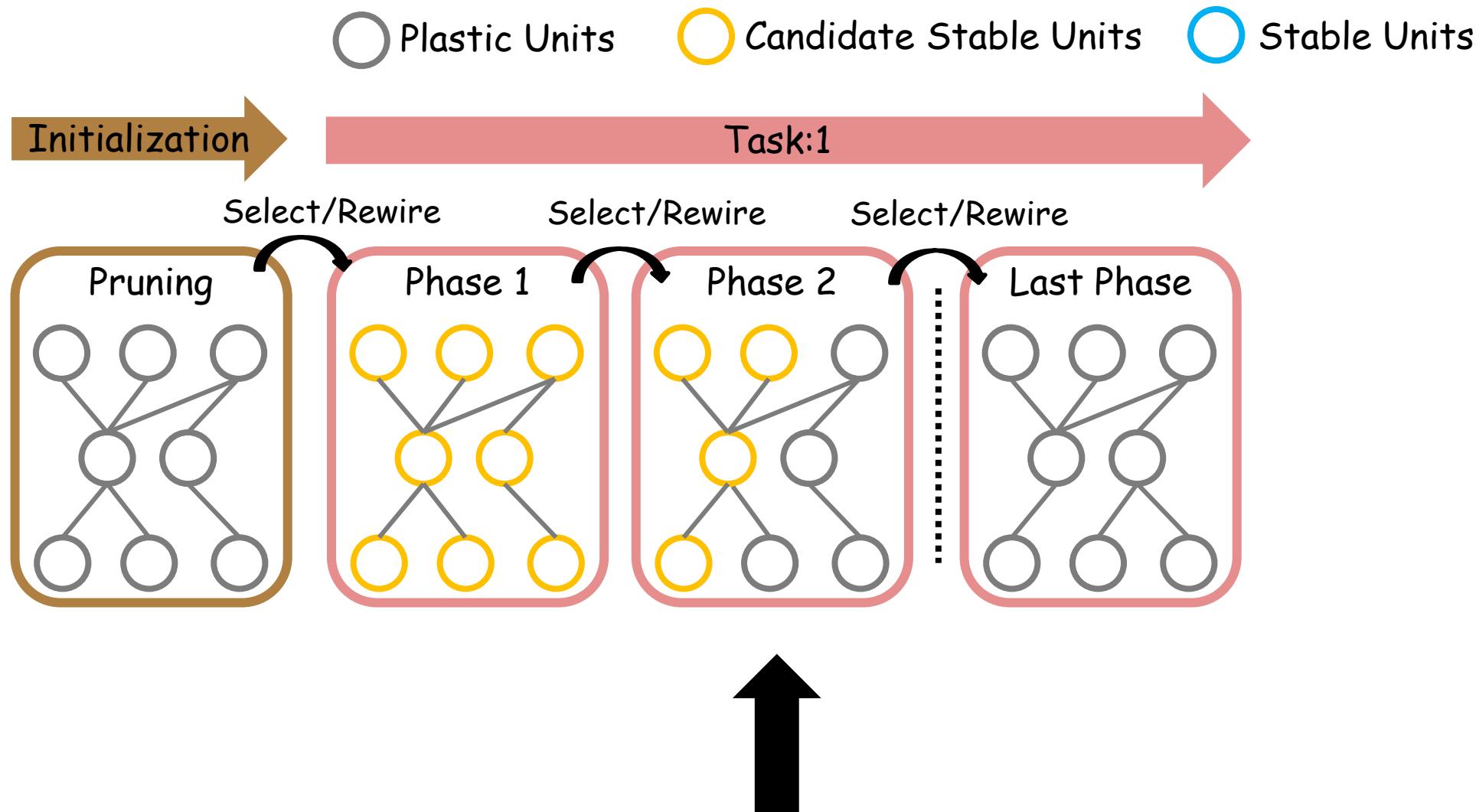
NISPA: Putting It All Together



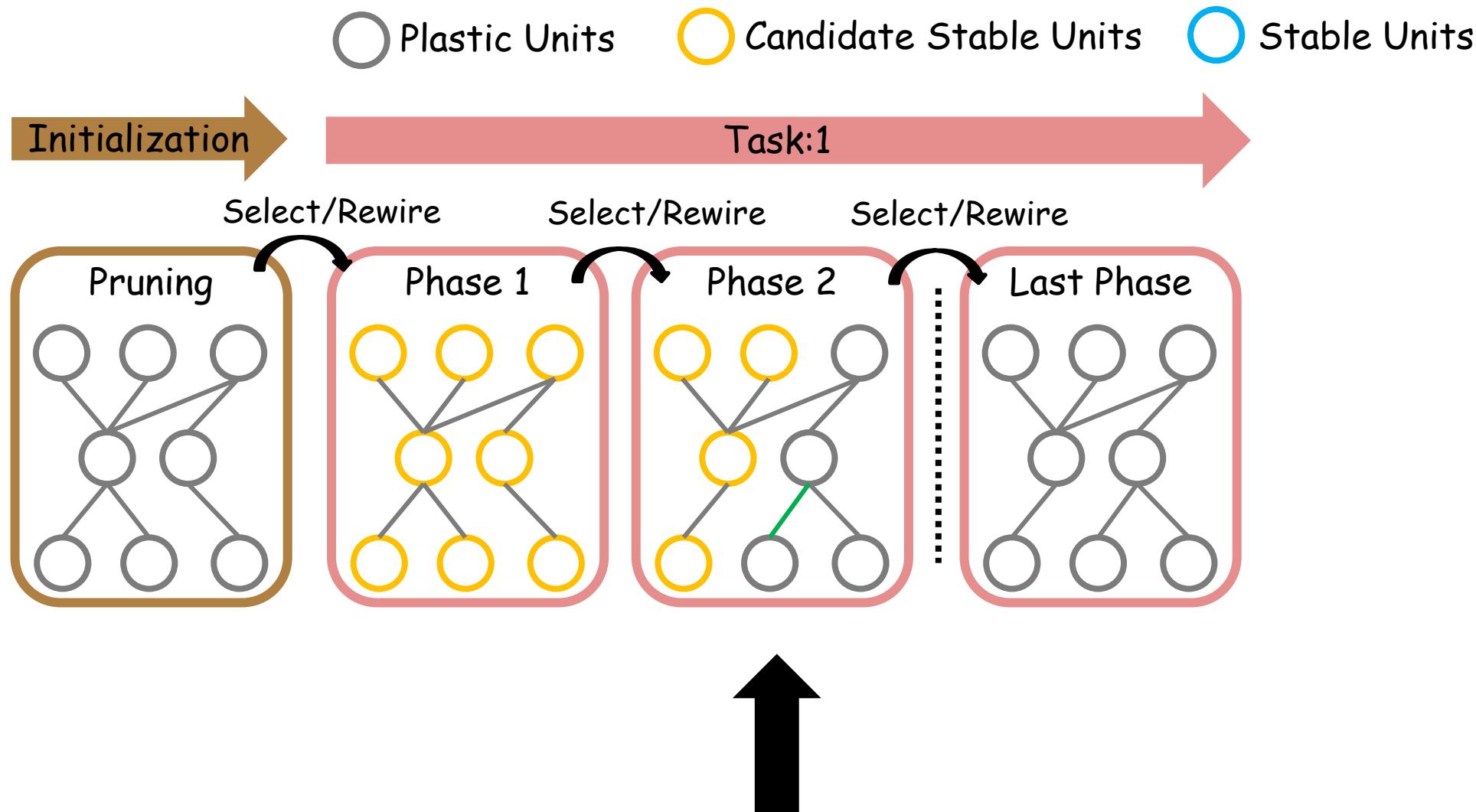
NISPA: Putting It All Together



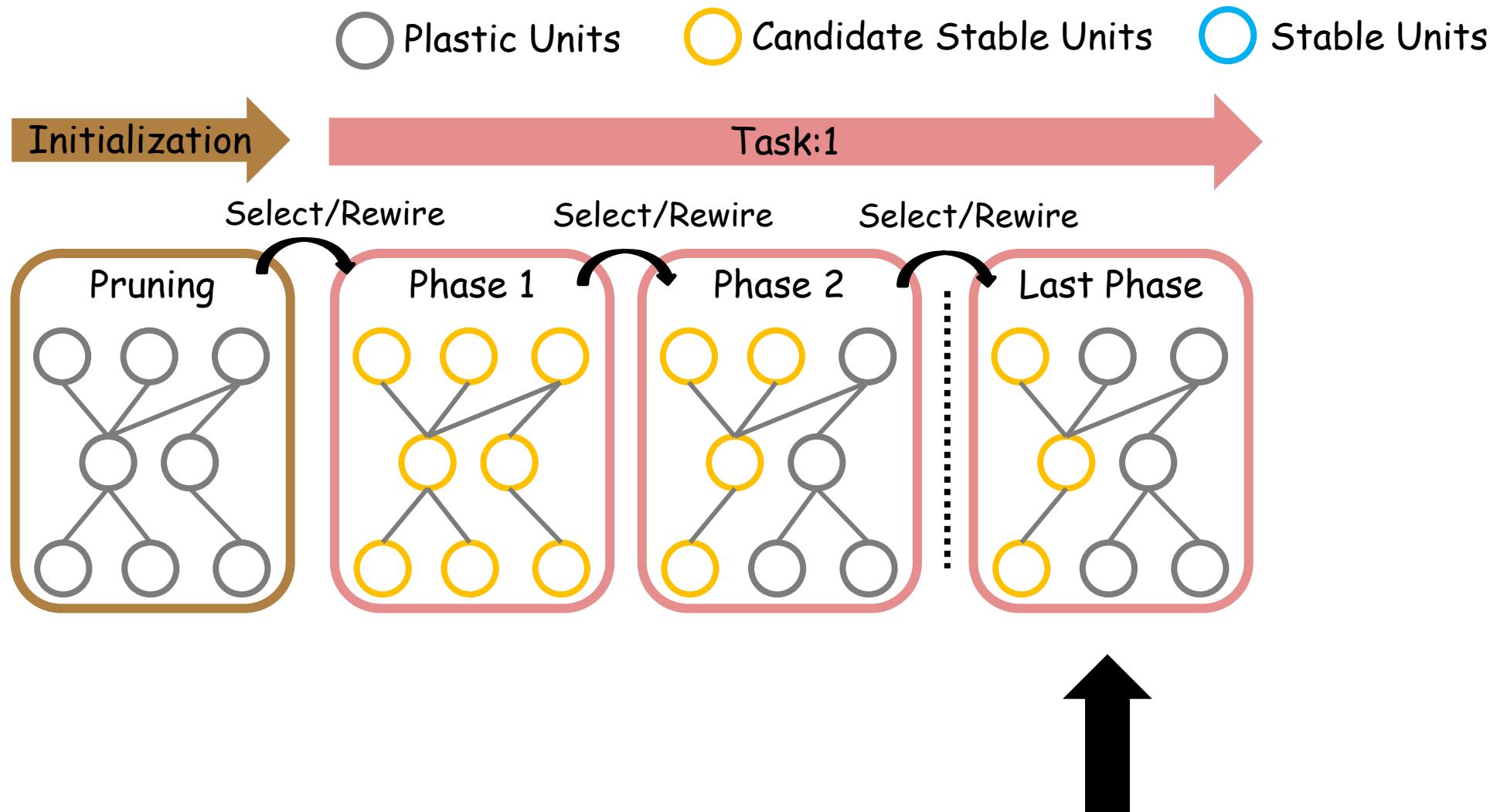
NISPA: Putting It All Together



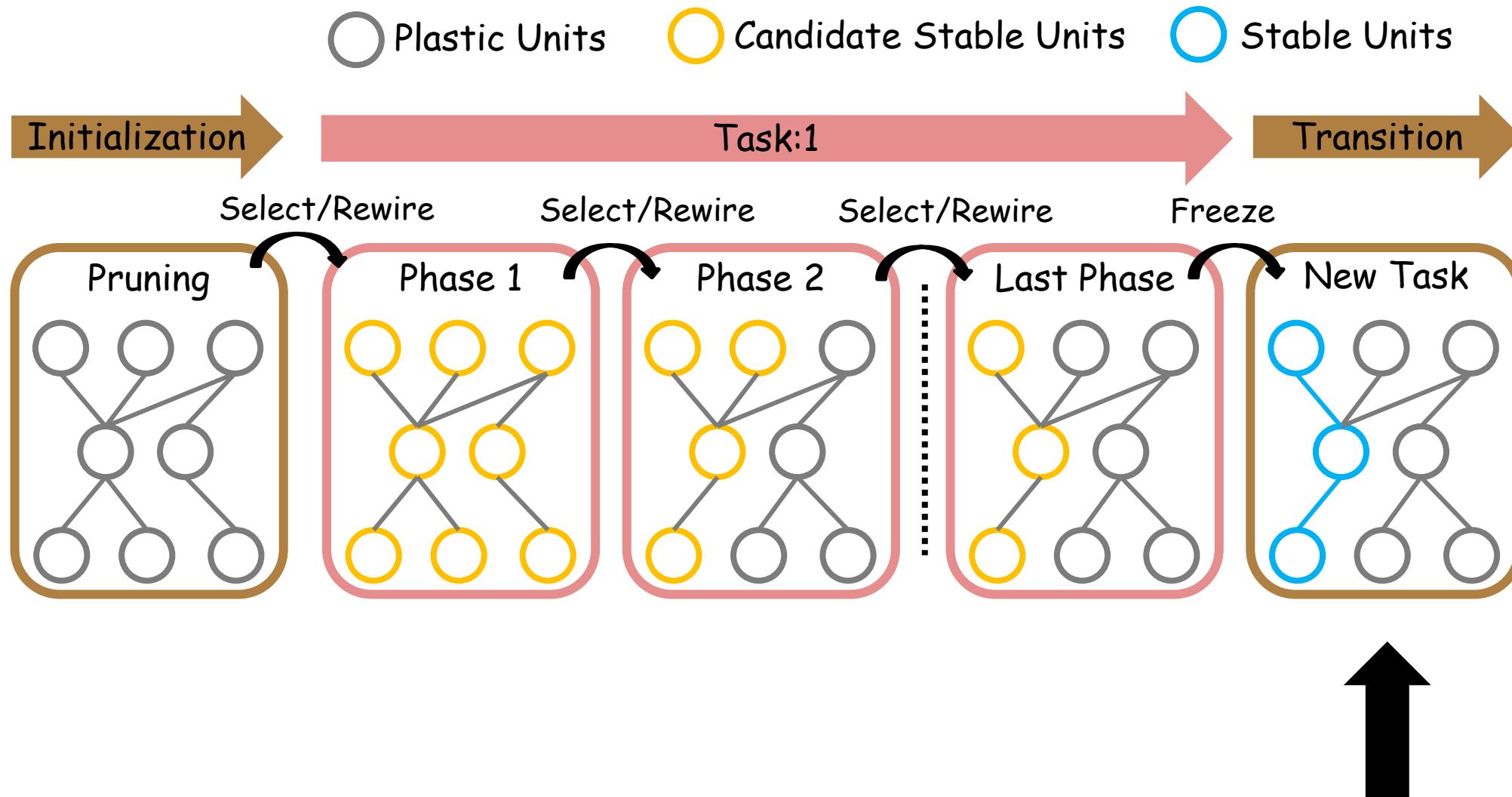
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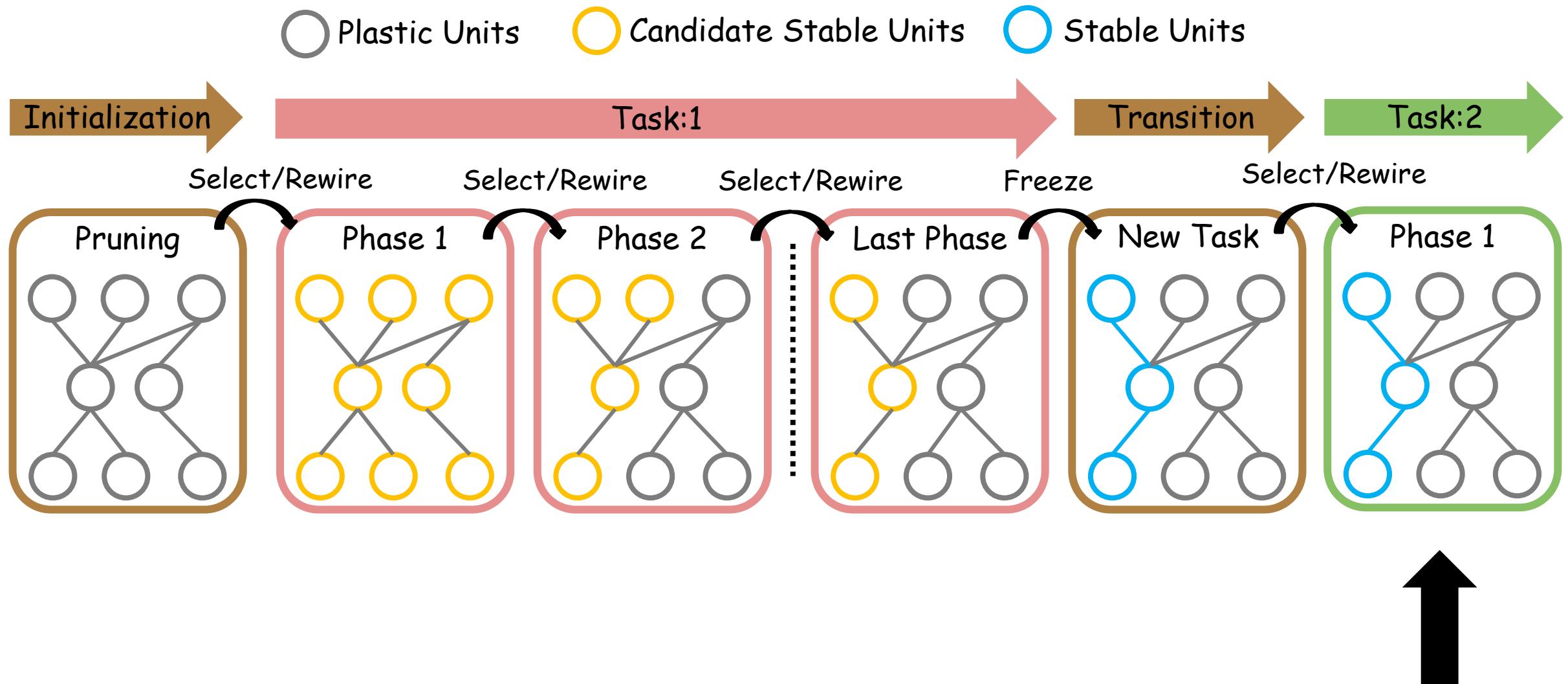
NISPA: Putting It All Together



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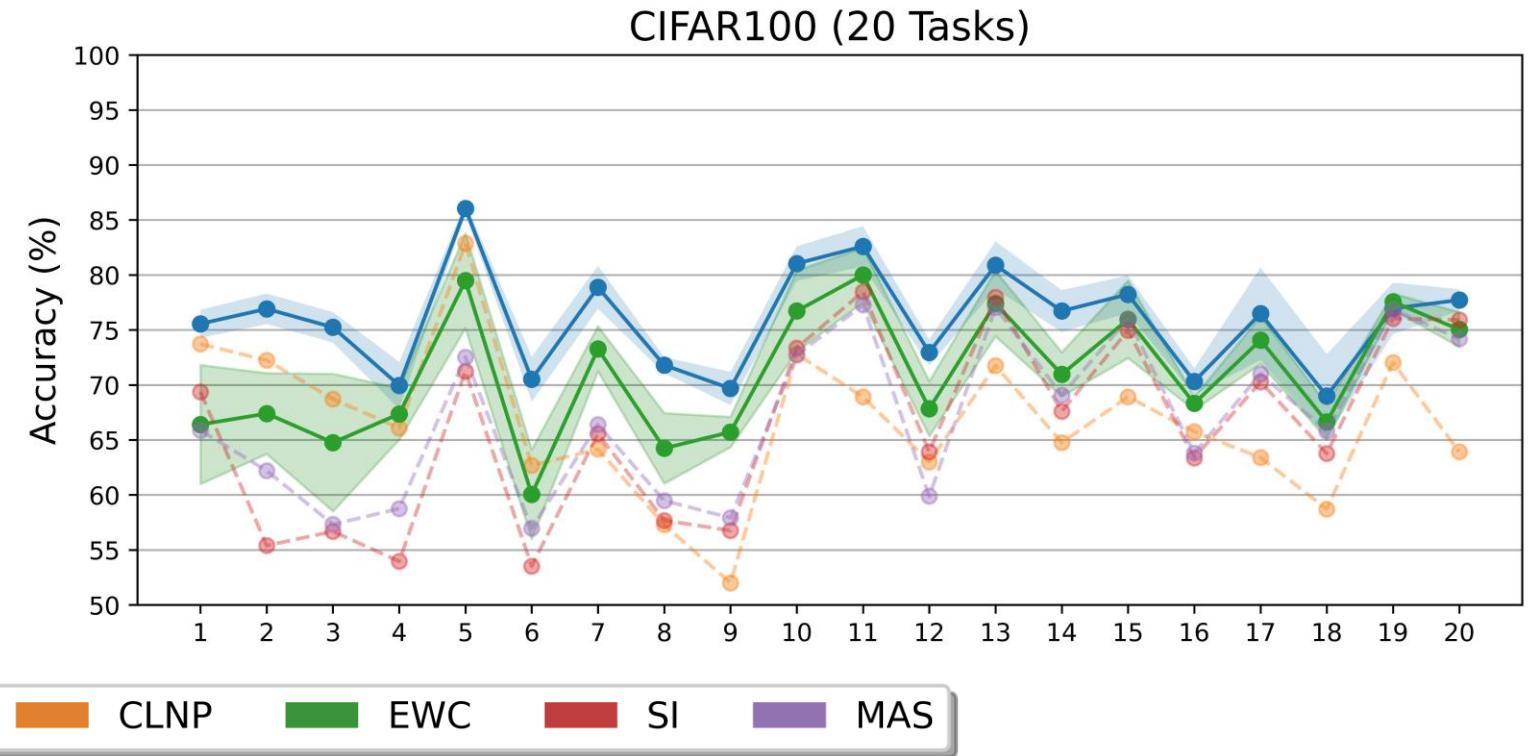
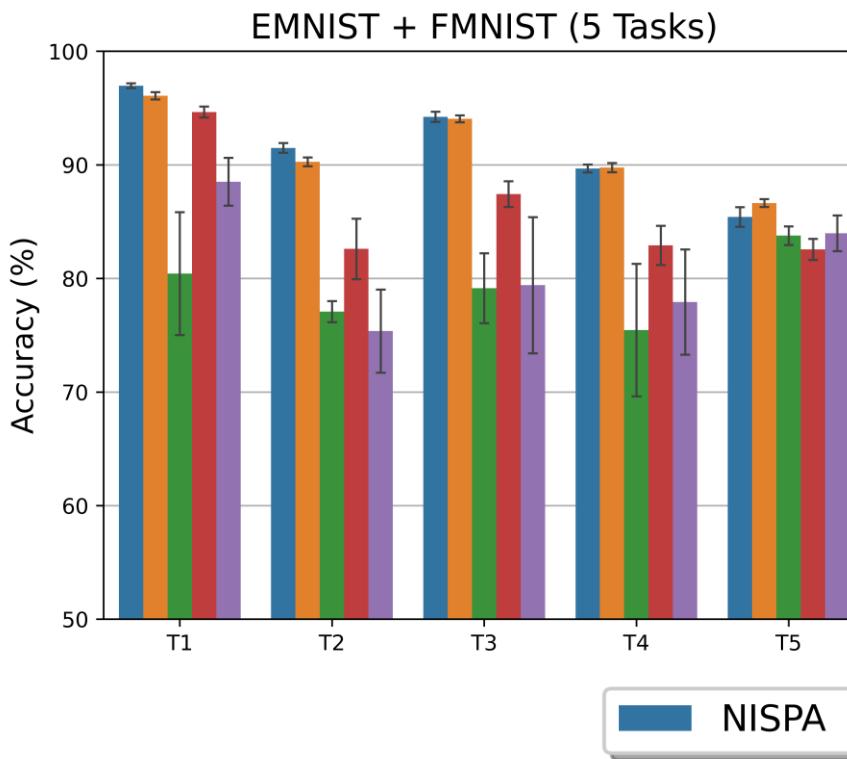


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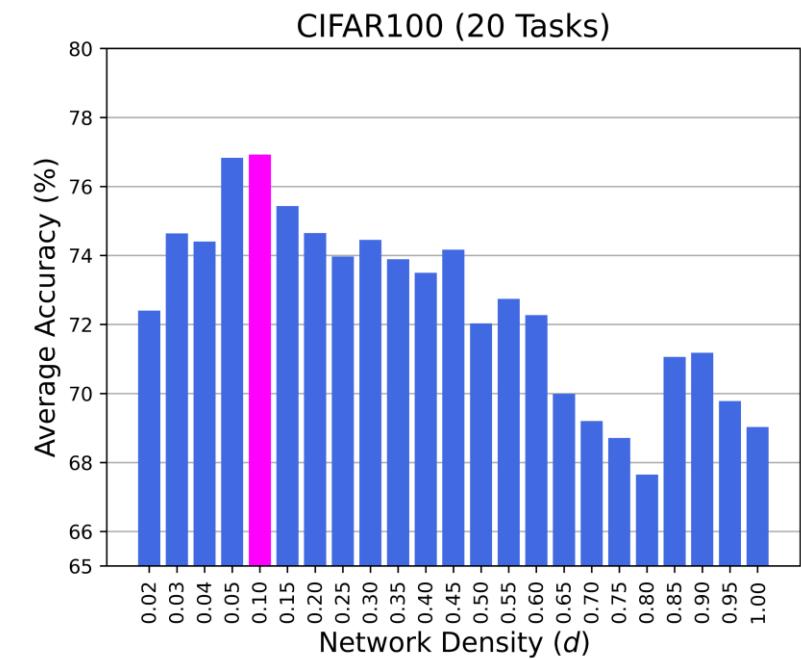
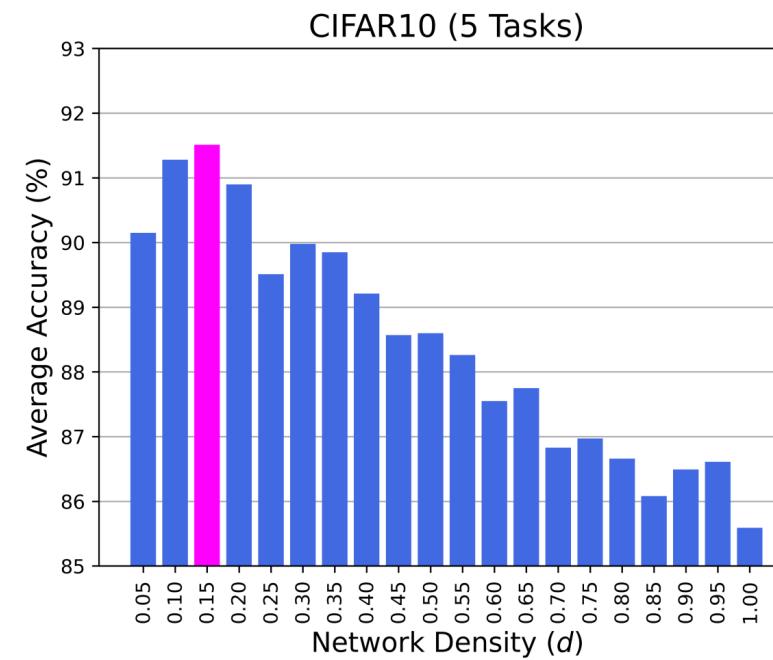
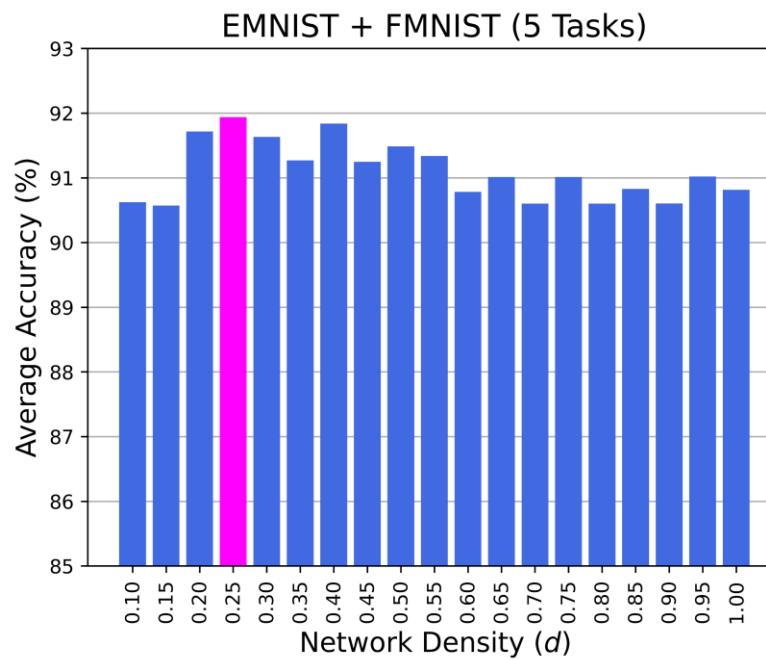
NISPA Outperforms State-of-the-Art Methods

- NISPA outperforms baselines, using up to ten times fewer parameters.



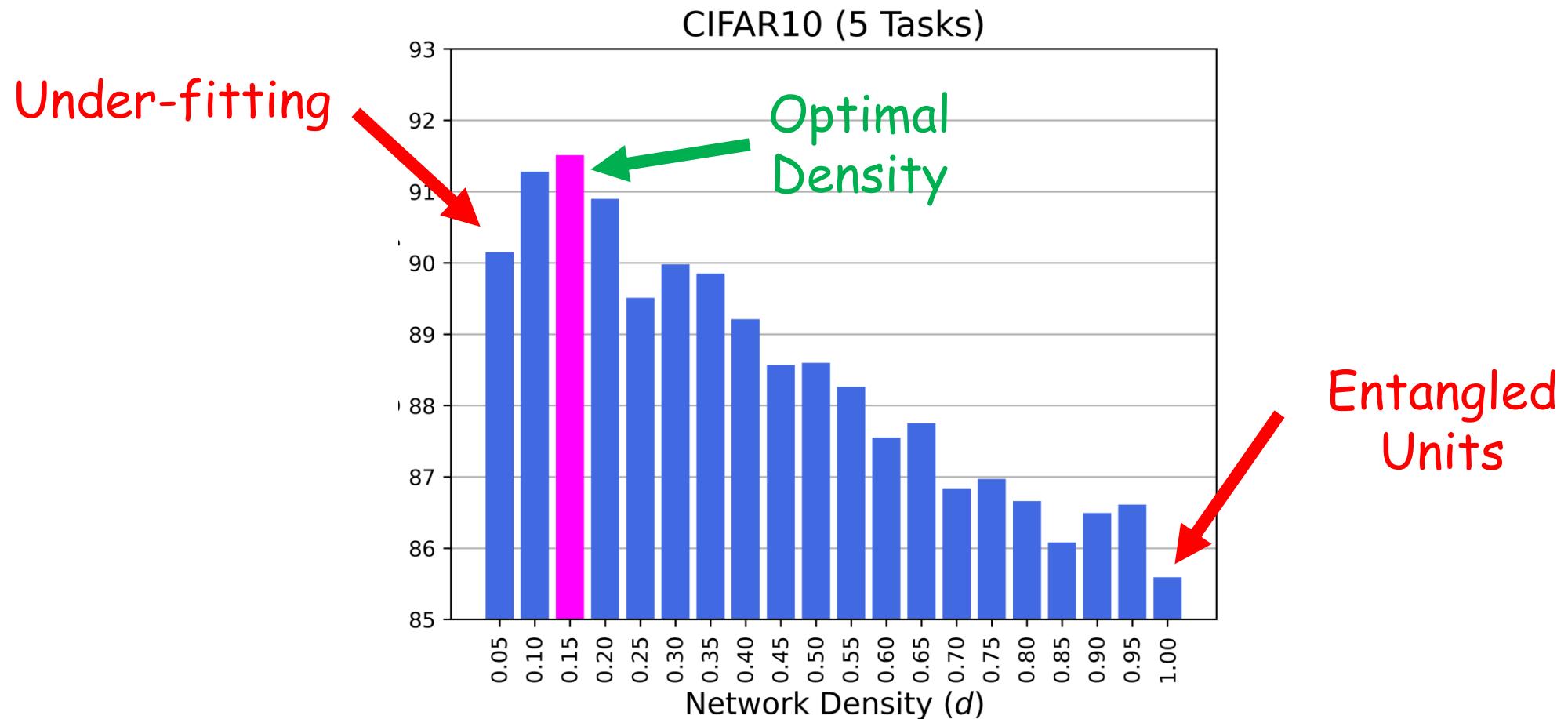
Sparsity is Necessary

- Sparsity is an essential ingredient for continual learning.



Sparsity is Necessary

- Sparsity is an essential ingredient for continual learning.



Conclusion and Future Work

- Conclusion
 - NISPA is a neuro-inspired continual learning approach.
 - It uses sparsity and dynamic connectivity to avoid catastrophic forgetting.
 - Outperforms baselines using up to ten times fewer parameters.
- Future Work
 - Selective unfreezing strategies
 - Using network-theoretic metrics for connection rewiring.