FULL-W2V: Fully Exploiting Data Reuse for Word2Vec on GPU-Accelerated Systems

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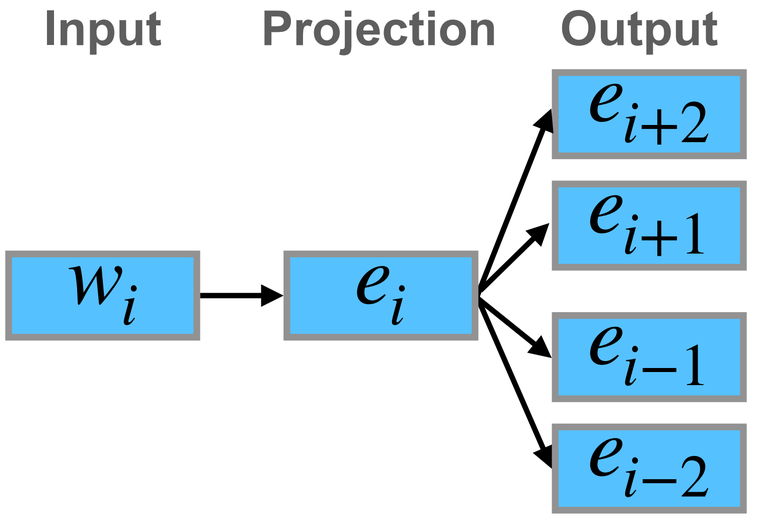
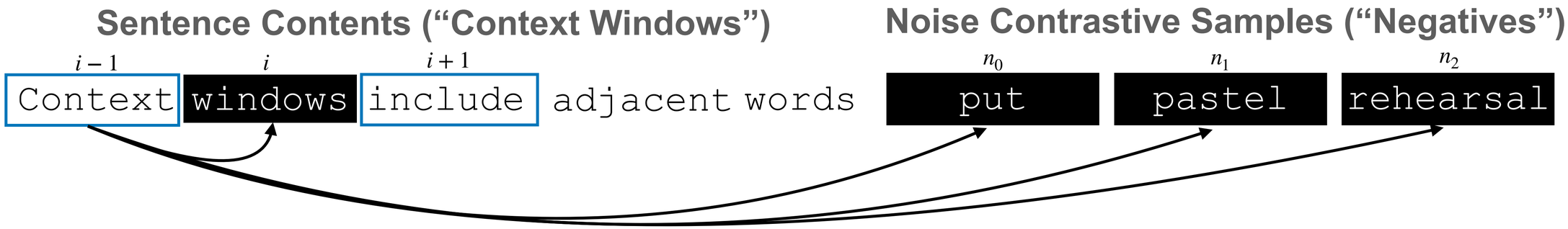
GPU W2V Not Faster than CPU

- 3-layer ANN
  - Words $w \rightarrow d$-dimensional embeddings e
- Prior ports based on data-intensive implementation
  - Suboptimal usage of GPU memory hierarchy





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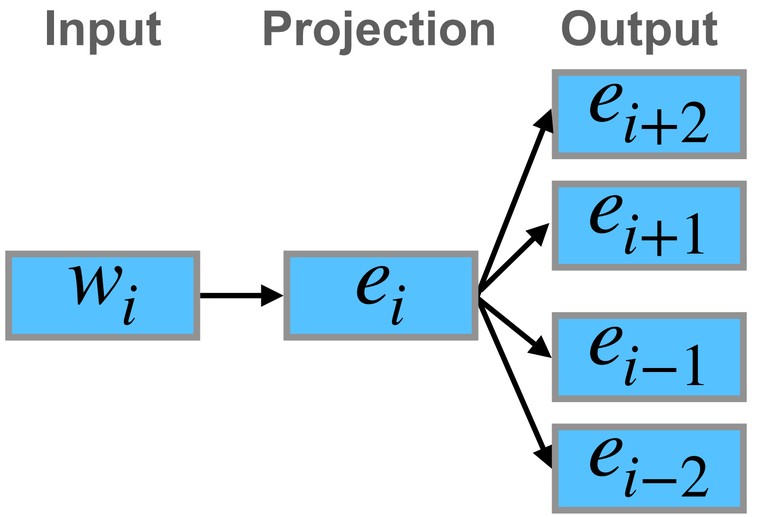

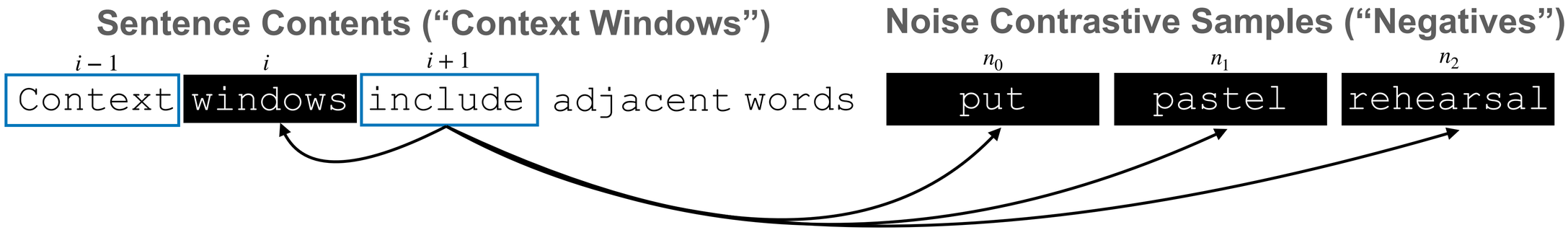

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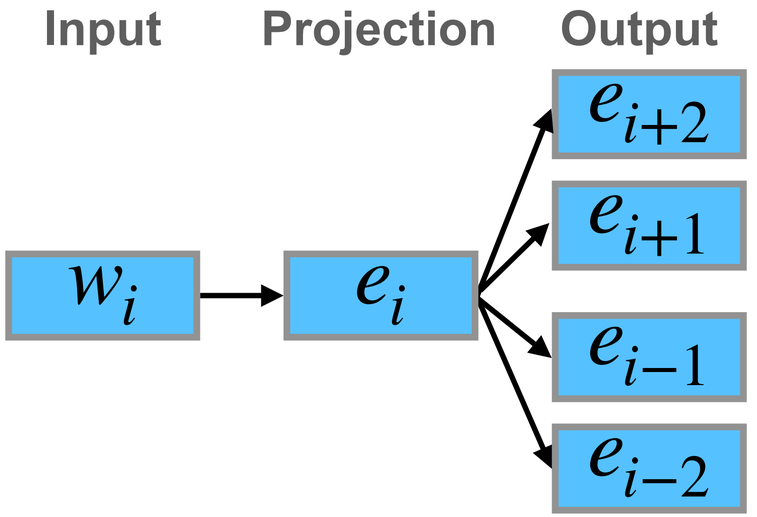

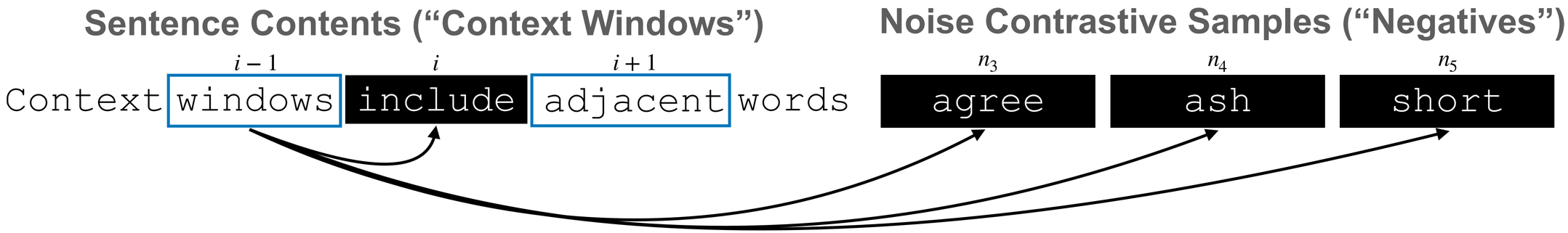

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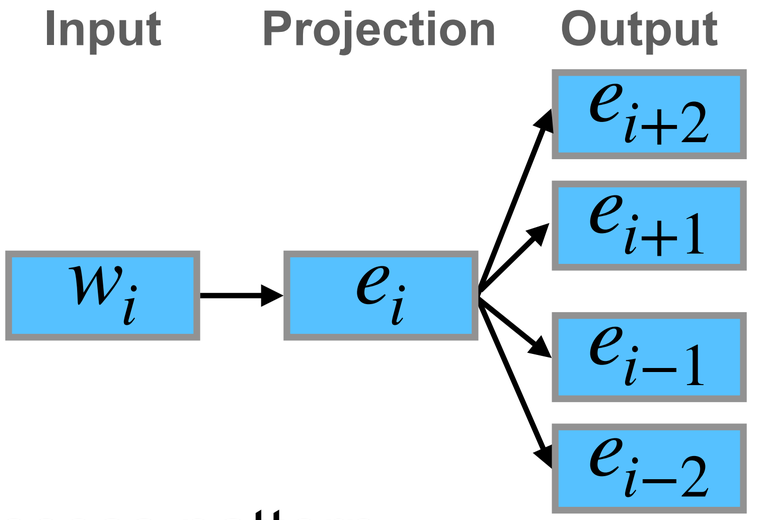
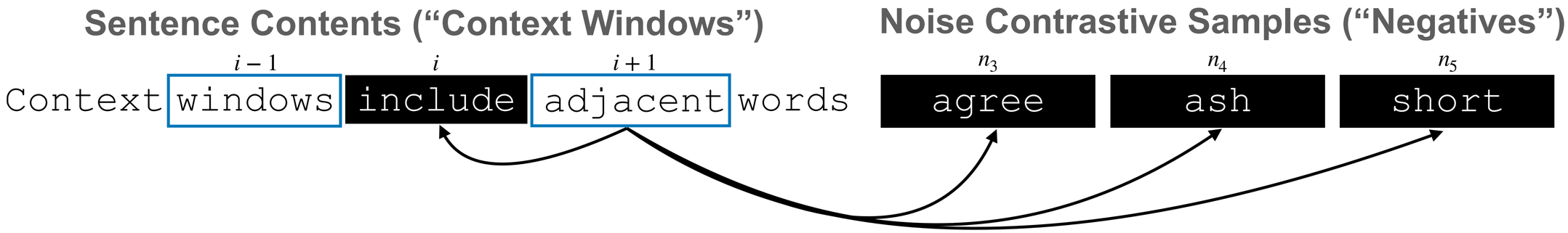
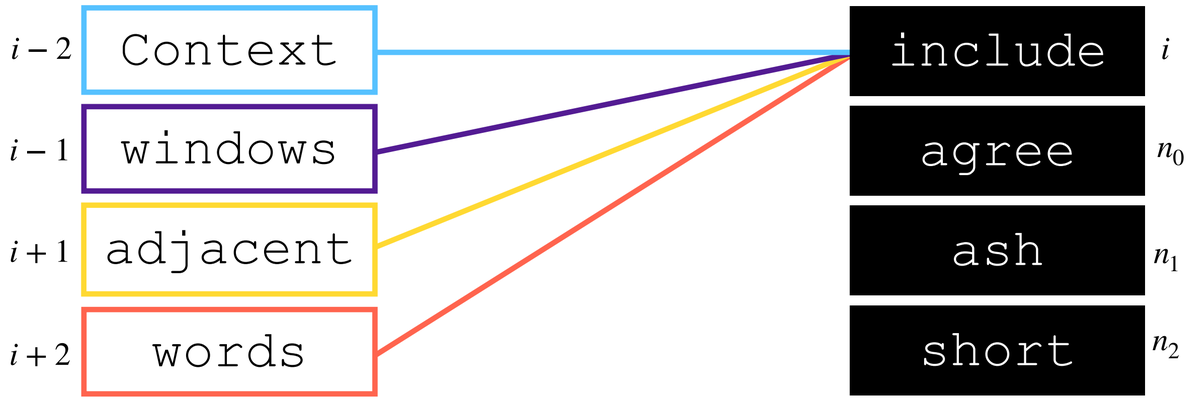
  - Suboptimal usage of GPU memory hierarchy
- FULL-W2V reduces access and improves locality
  - Leverage memory hierarchy based on algorithm's access pattern





Negative Sample Reuse: Register-W2V

- Challenge: Negatives are **random** and have **lower reuse**



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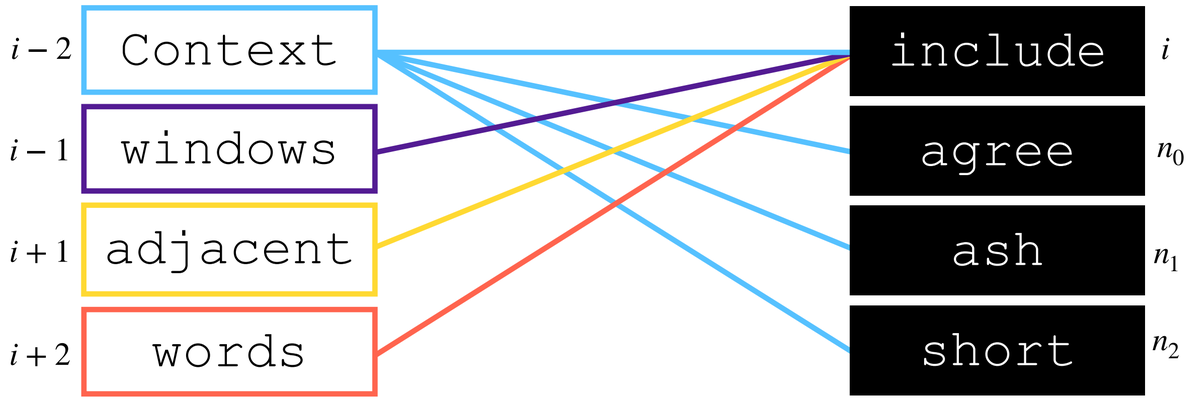

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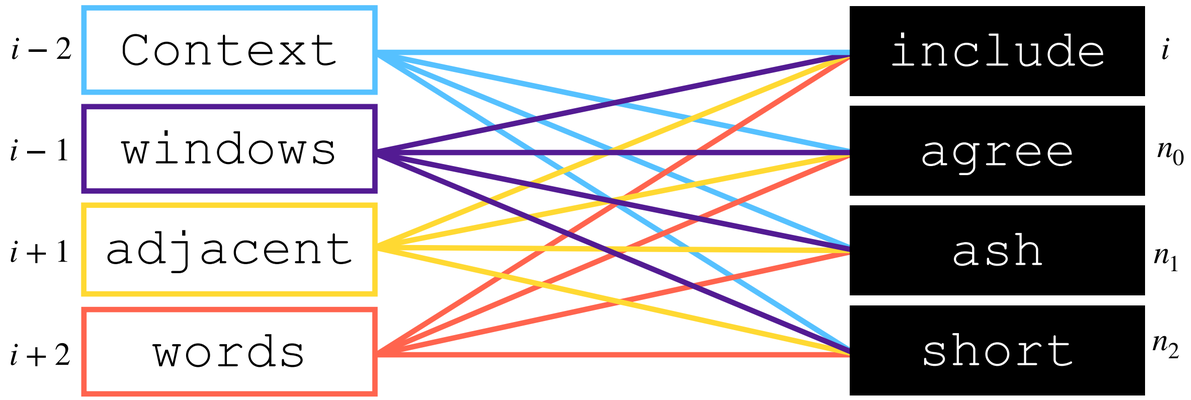

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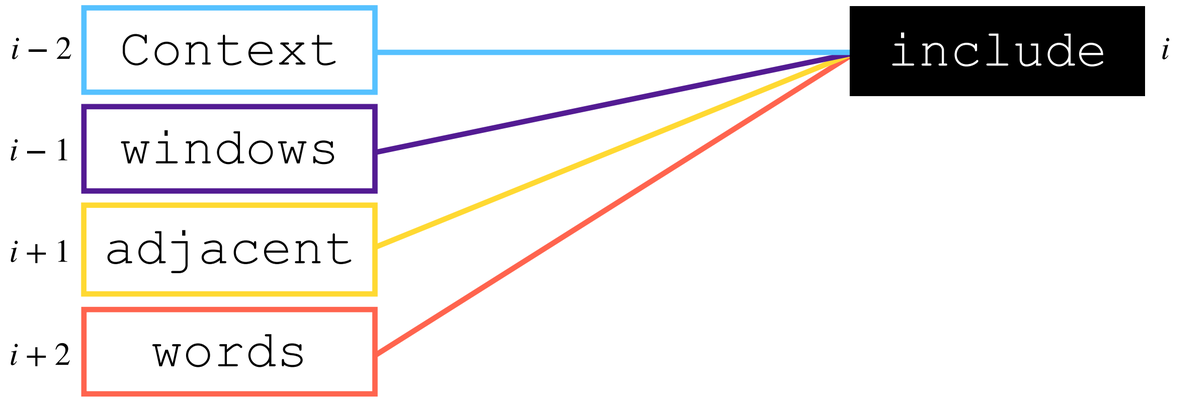
  - Maintain scheduling flexibility, reduce stress for Shared Memory



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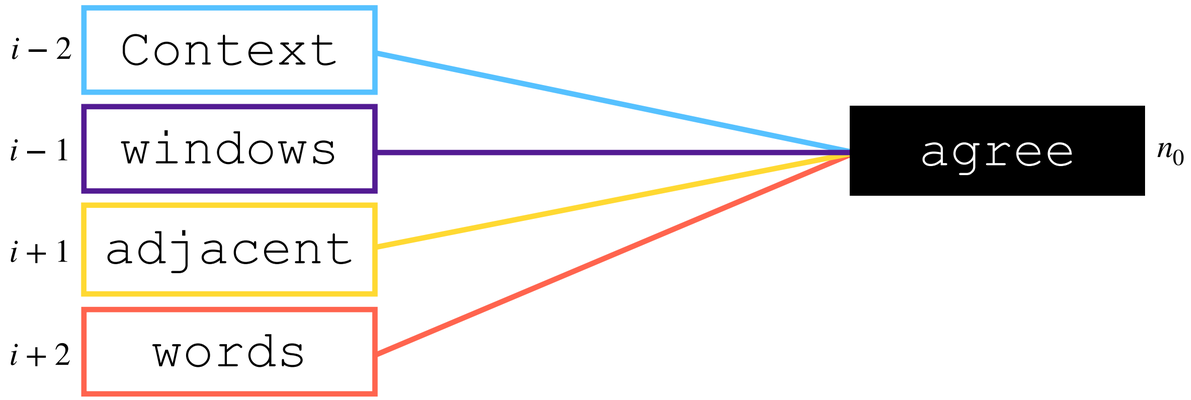
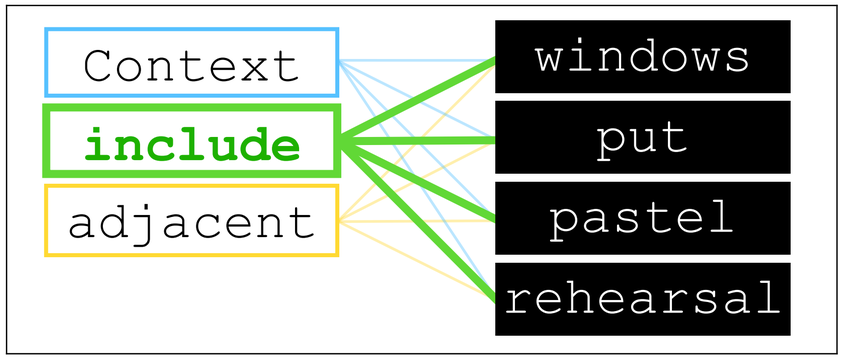


Context Word Reuse

- Different Pattern: Context Words have **more reuse**



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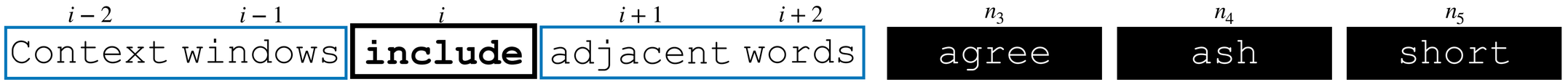

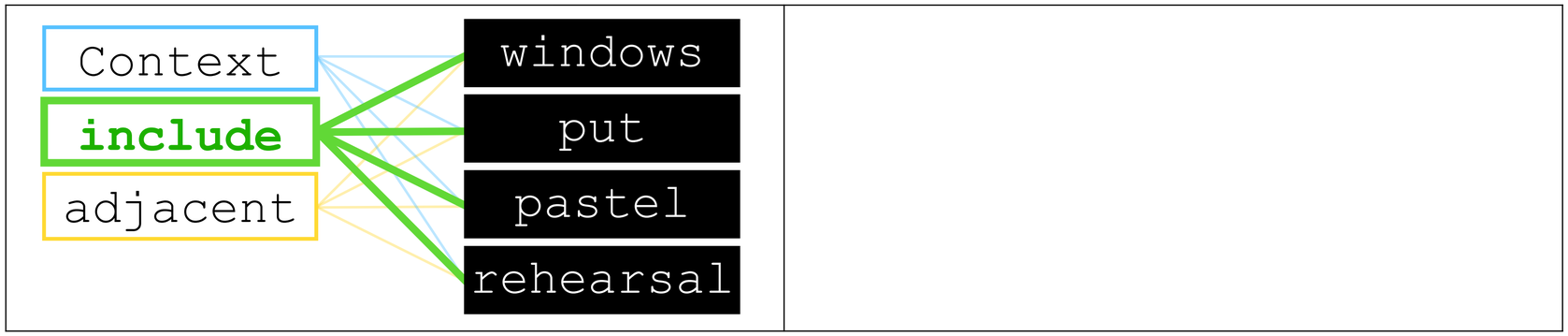

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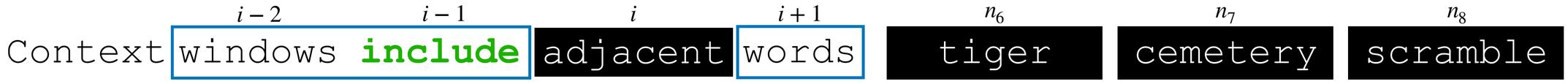
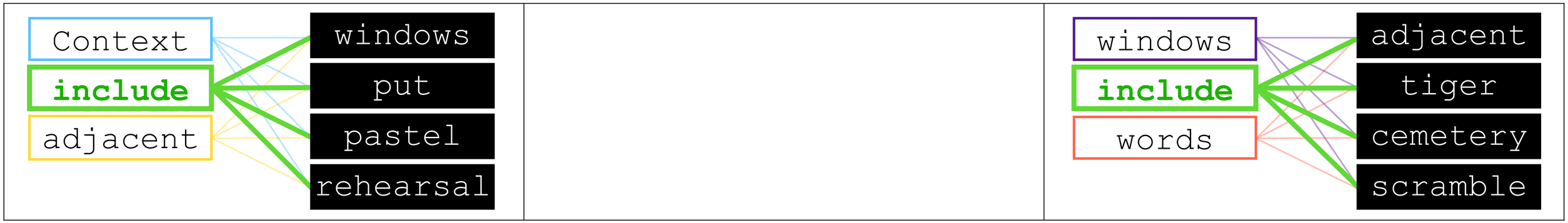
- Different Pattern: Context Words have **more reuse**
- Allocation: Shared Memory leverages longer-term reuse
  - High performance; Explicit control; Flexible scheduling
- Management: Ring buffer





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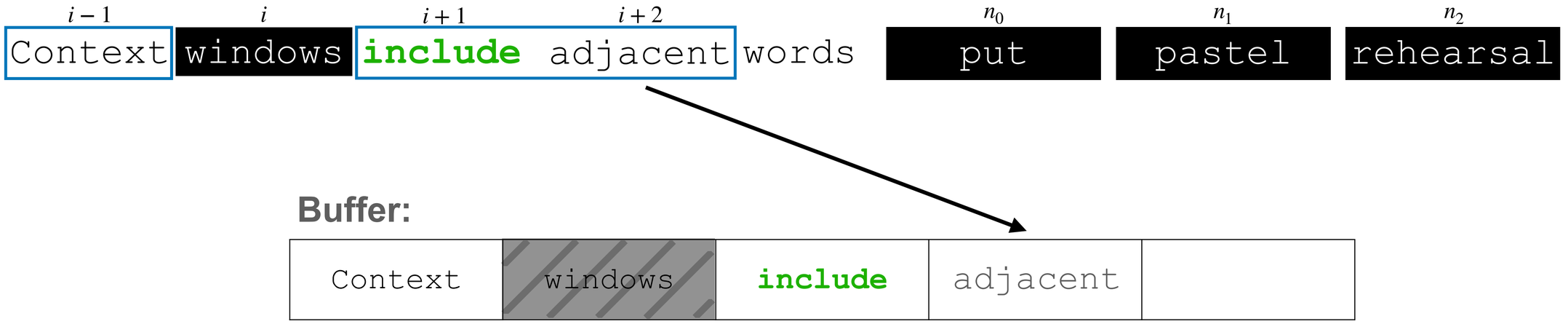

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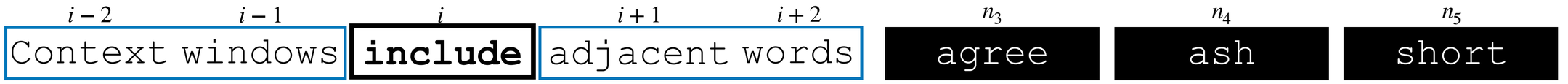

Buffer:

Context	windows	**include**	adjacent	words

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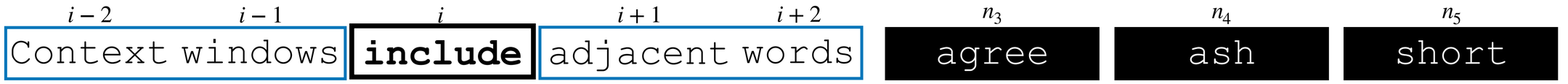

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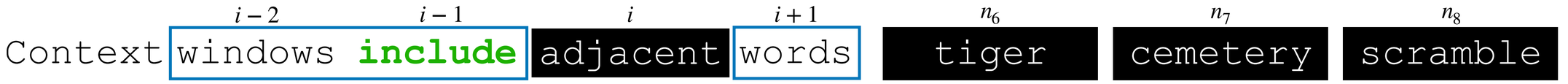

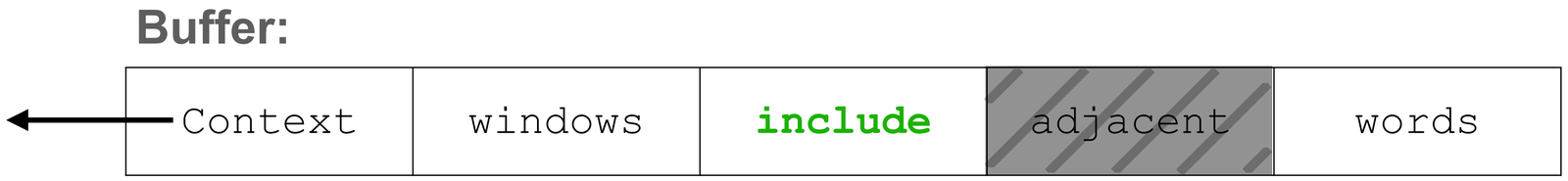

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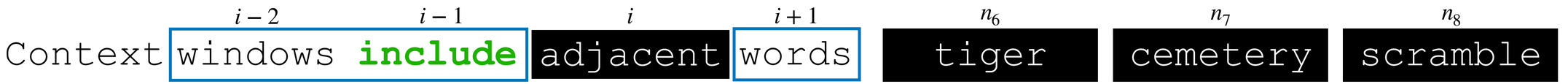


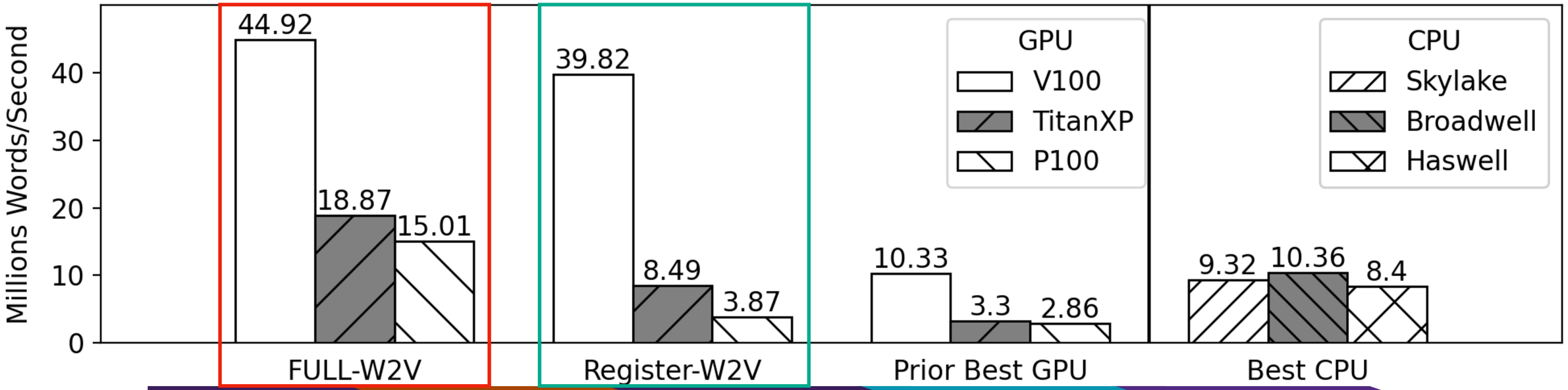
Buffer:

Results

Demand in GB/Epoch

Implementation	L1/TEX	L2	DRAM	%
Closest Prior	1,134.448	493.614	226.578	100.0%
Register-W2V	885.065	781.576	66.555	78.02%
FULL-W2V	**94.760**	**88.723**	**41.851**	**8.35%**

- FULL-W2V: Register-W2V + Context Word Reuse
  - **4.35X** total speedup previous best on V100
  - **3.85X** speedup from Register-W2V only
  - Sum data demand reduced by **91.65%**



Insights and Conclusion

- We present FULL-W2V
  - **4.35X** prior SOTA on V100
  - **2.99X** scaling from P100 to V100
- Different storage for different data
  - Register-W2V: maximize short term reuse in register
  - FULL-W2V: maximize long term reuse in shared memory
- Looking for more?
  - Our code is open source: https://github.com/tlranda/FULL-W2V
  - See the extended presentation for additional details

Acknowledgements

- Thomas Randall
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    - https://www.researchgate.net/profile/Thomas-Randall-5
- Tyler Allen
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    - https://www.researchgate.net/profile/Tyler-Allen-2
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