Approximate Flash Storage: A Feasibility Study

Amir Rahmati, Matthew Hicks, Atul Prakash
Introduction

Approximate computing
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Approximate computing

Approximate memory & storage
Introduction

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Rapid adoption of flash storage
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Rapid adoption of flash storage

Energy Saving / Performance Gain
Previous Work
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• **Approximate Memory**: SRAM, DRAM, PCM

  Decreasing input voltage, refresh rate, number of writes
Previous Work

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  Decreasing input voltage, refresh rate, number of writes

- **Under powering Flash:**
  
  - Find minimum operable voltage (Tseng’13, Half-Wits’11)
  
  - 34% - 45% Energy saving
  
  - Repeat writes to correct error to low cases (Half-Wits’11)
Overview
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• **Hypothesis:** By allowing imprecision, it is possible to achieve additional energy saving.
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• **Summary of Findings:**
  - Spatial locality in cell volatility
  - Large effect of temperature
Build an Open Platform

- Power Supply
- Voltage Amplifier
- Dev Board
- Flash Memory

Connections:
- VDD
- VFlash
- Address & control lines
- Data lines
Build an Open Platform

Part #, codes, and blueprints are available at
http://amir.rahmati.com
Memory cells are successfully written at a voltage well below their minimum recommended of 4.5V.
Groups of cells in a sector behave similarly to write iterations.
Minimum write voltage of cells in a sector are closely related.
Temperature increase caused by continuous experiments reduce minimum write voltage variations.
Approximate Flash Storage
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- Partition memory into sectors with different volatility level.
Approximate Flash Storage

• **Partition memory** into sectors with different volatility level.

• Adjust input voltage based on *partition volatility*, *temperature*, and *precision requirement*. 
Approximate Flash Storage

- **Partition memory** into sectors with different volatility level.

- Adjust input voltage based on **partition volatility**, **temperature**, and **precision requirement**.

- Choose write location based on **energy** and **storage availability**.
Conclusion
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• Is there potential for more energy saving? - Yes
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- Is approximate storage feasible? - Yes
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• Is approximate storage feasible? - Yes

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