CMSC 180:
Introduction to Parallel Computing

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Dichotomy of Parallel Computing Platforms

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Communication Model

Control Structure of Parallel Programs

- Parallelism can be expressed at various levels of granularity
  - per line of instruction
  - per block of instructions (e.g., within loops)
  - per subroutines (e.g., functions)
  - per process
- At these granularities, there exists a range of models, along with corresponding architectural support.

Control Structure of Parallel Programs

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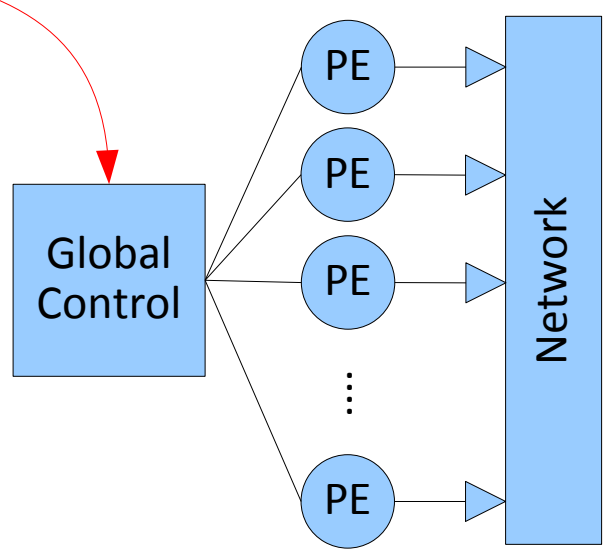

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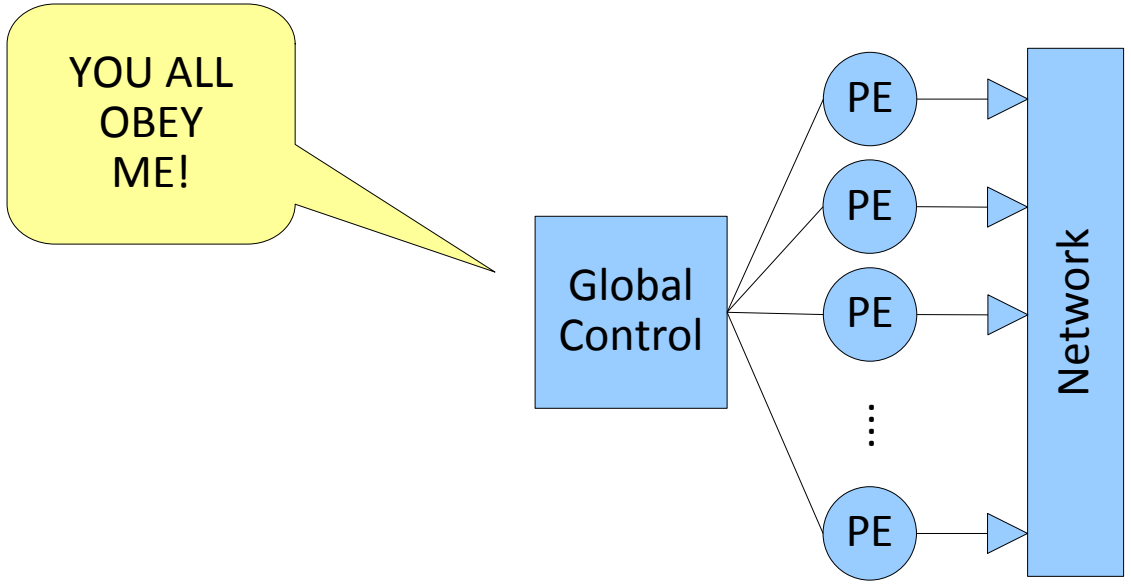

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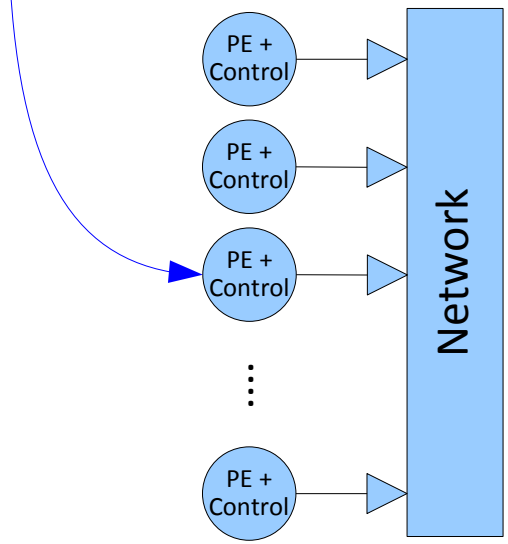

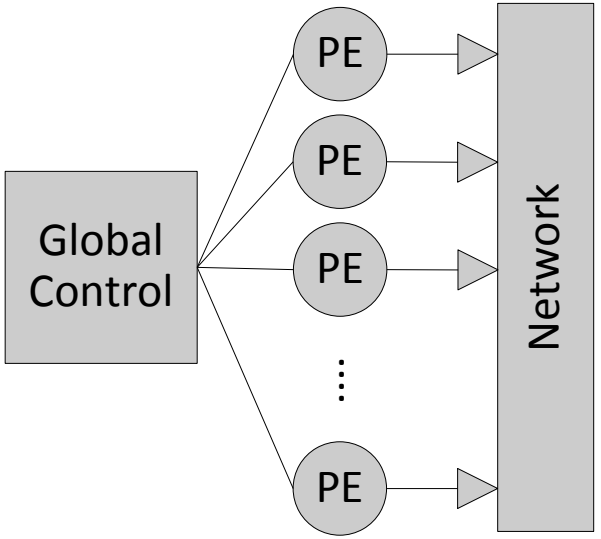

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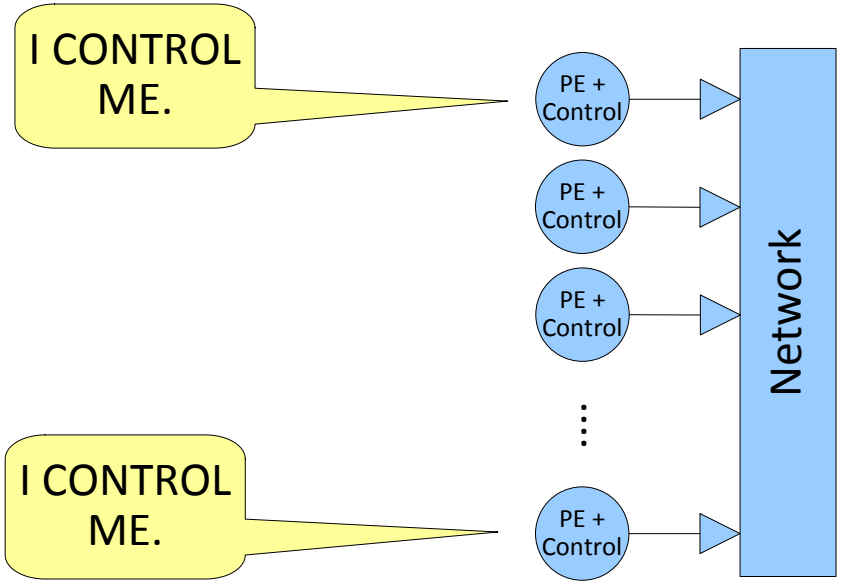
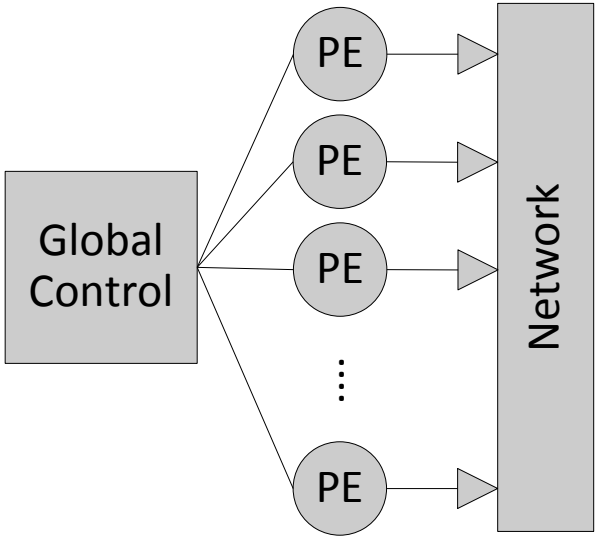
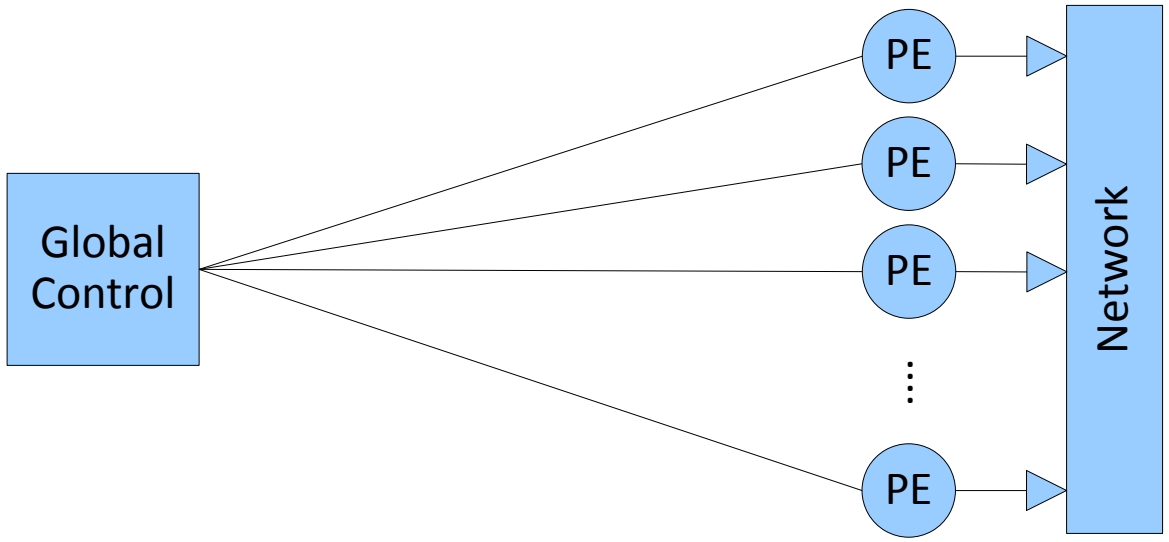




Control Structure of Parallel Programs

- If there is a single control unit that dispatches the same instruction to various processors (that work on different data), the model is referred to as single instruction, multiple data stream (SIMD).



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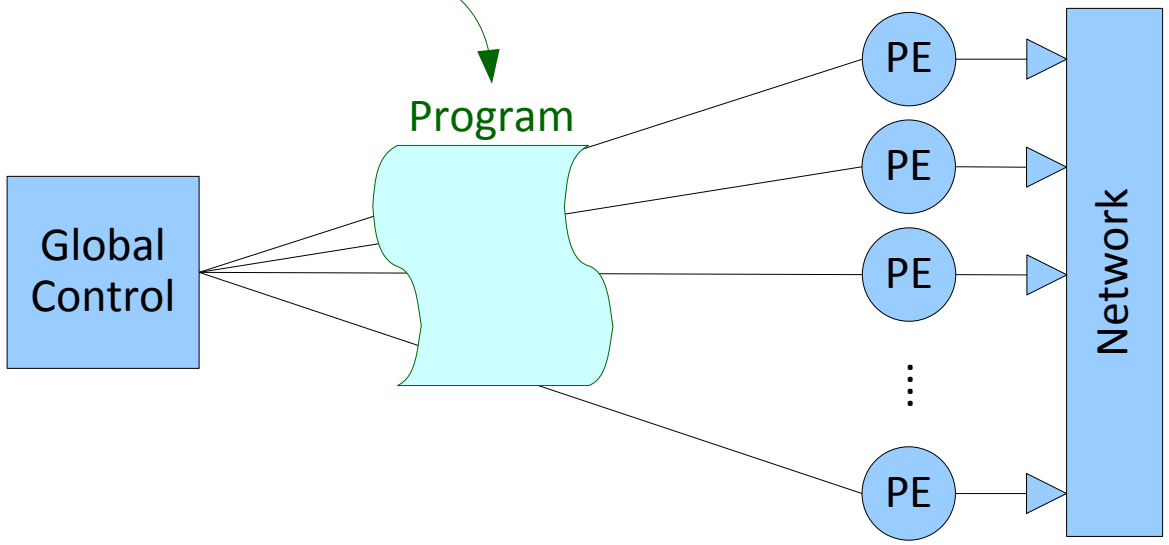

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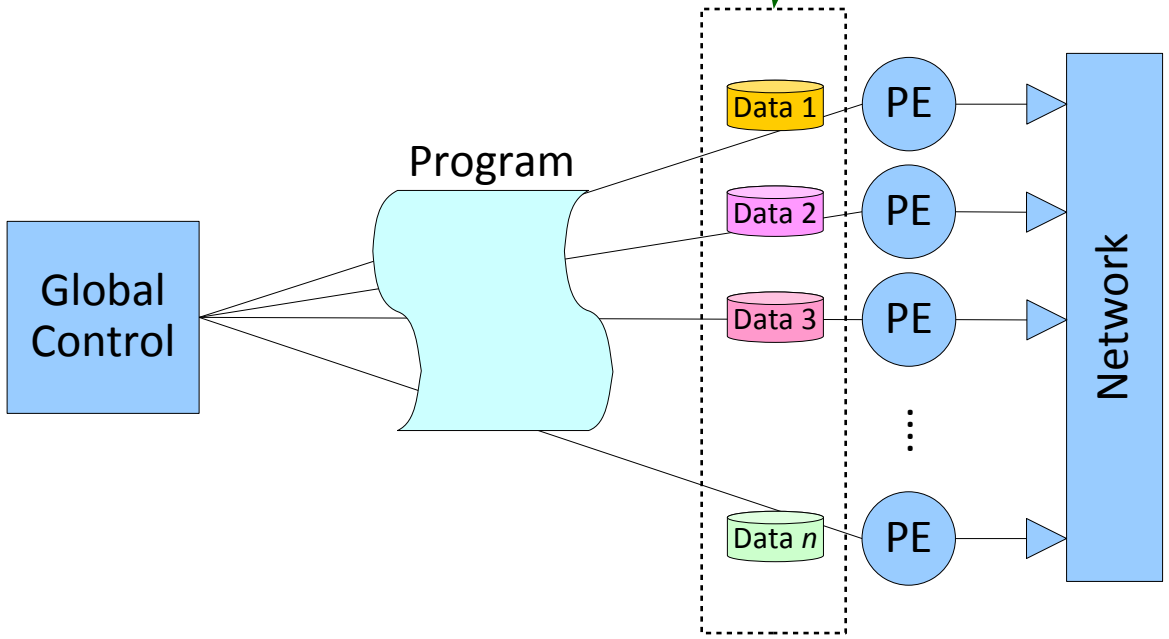

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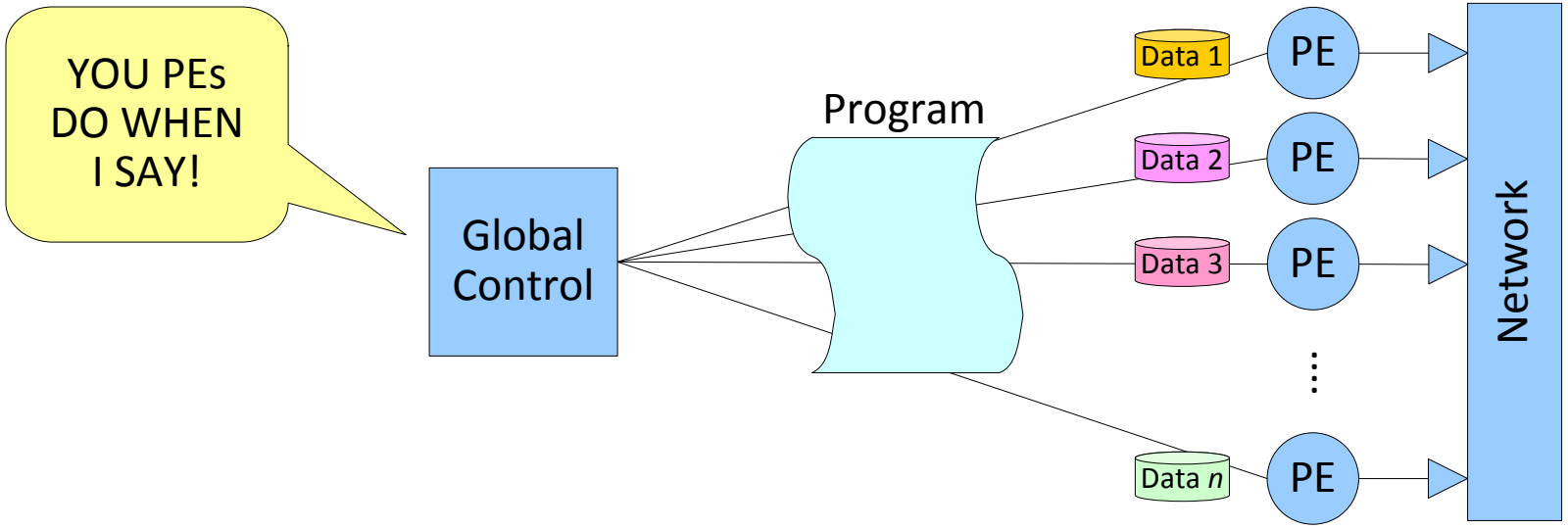

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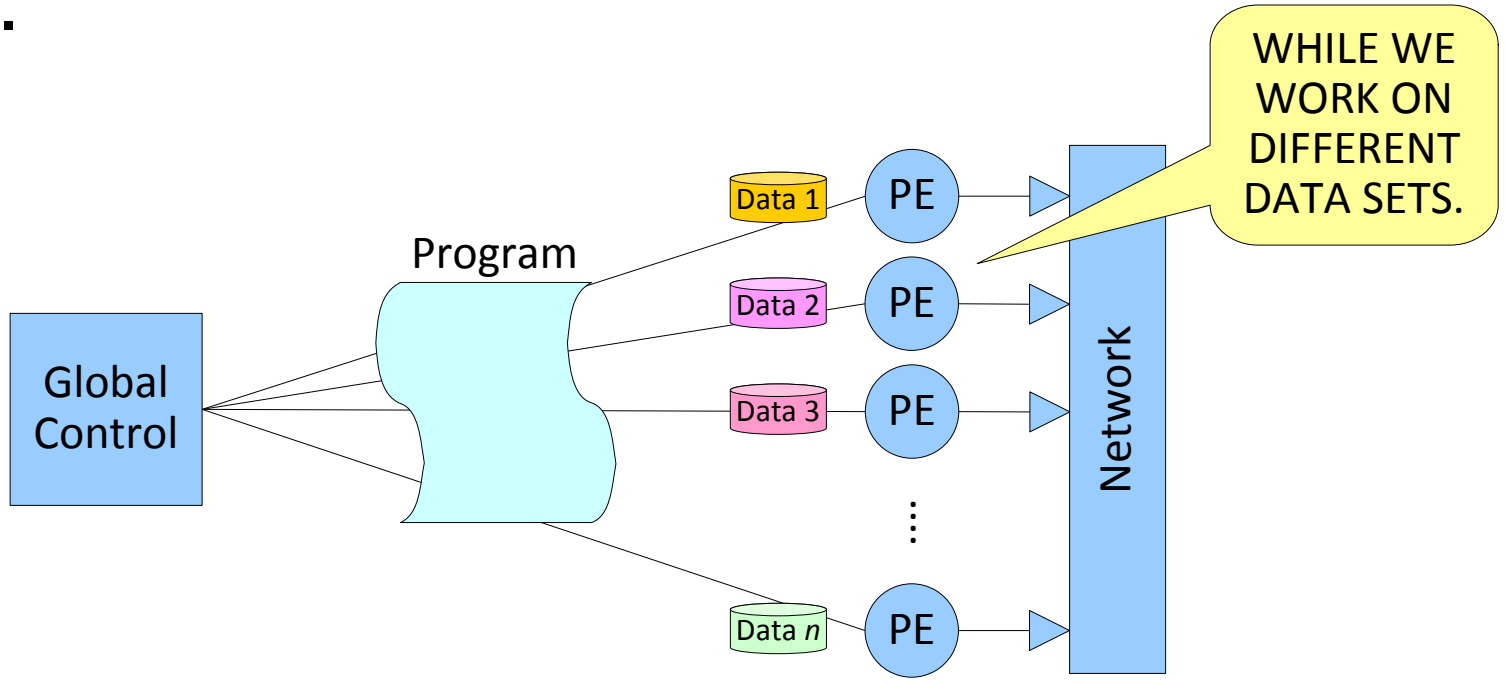

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	p_0	p_1	p_2	p_3
Initial values	a 5 b 0 c 0	a 4 b 2 c 0	a 1 b 1 c 0	a 0 b 0 c 0

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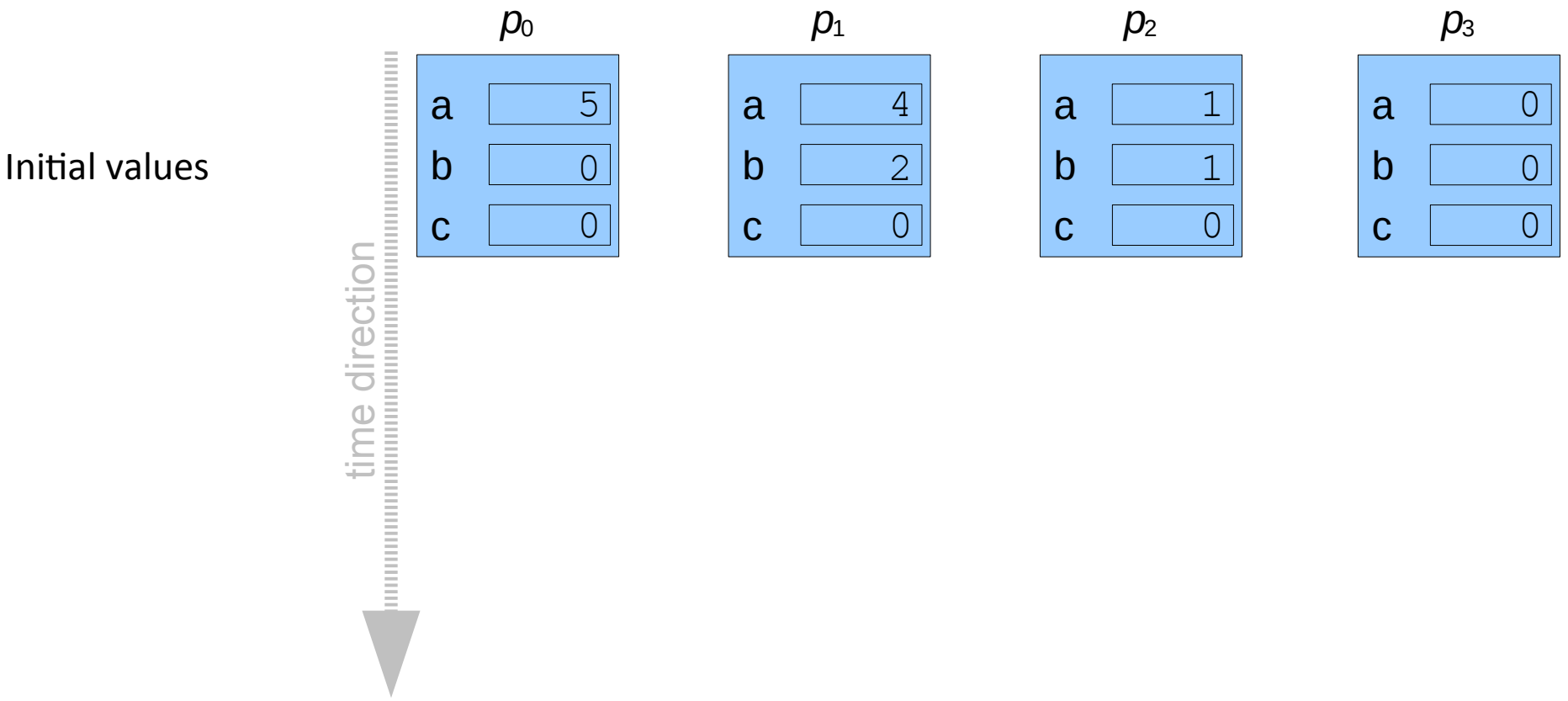

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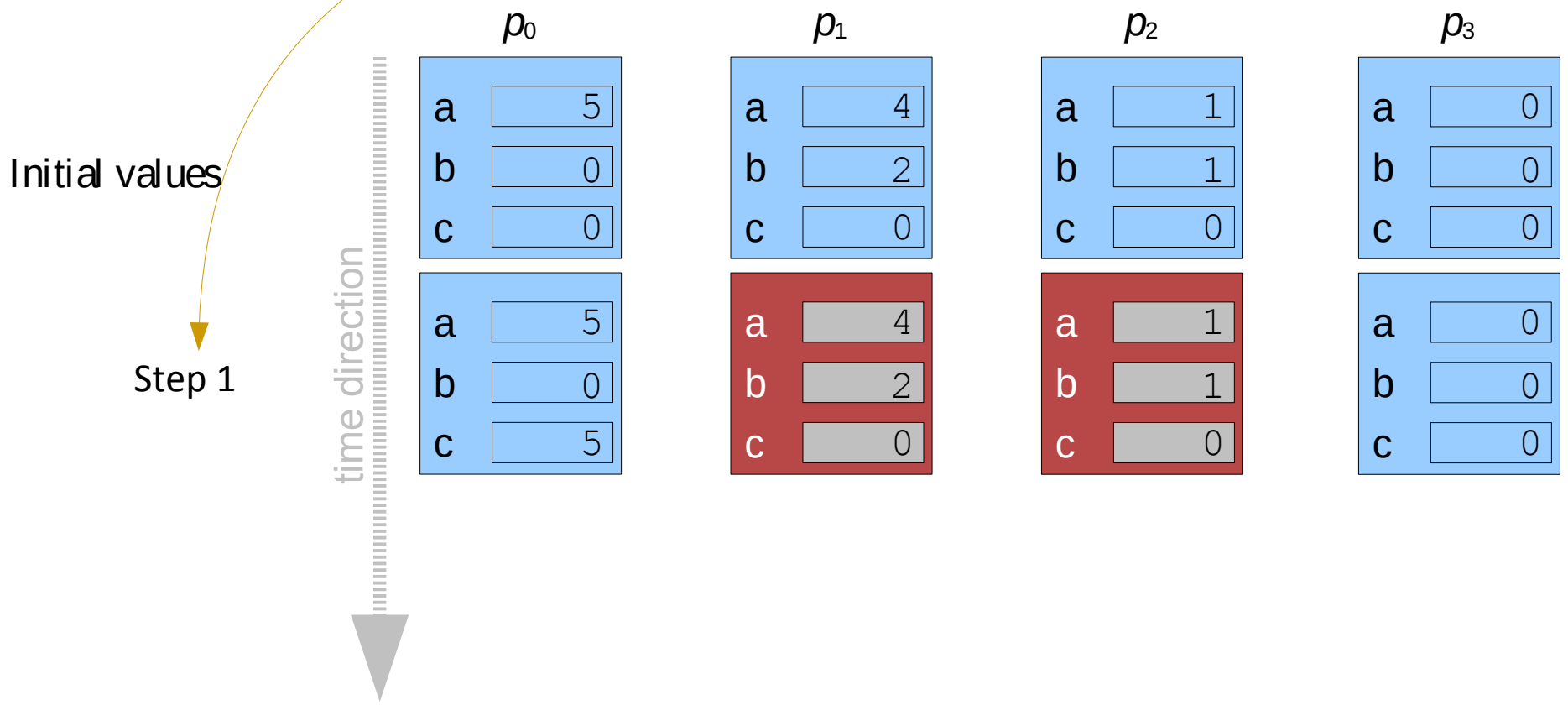

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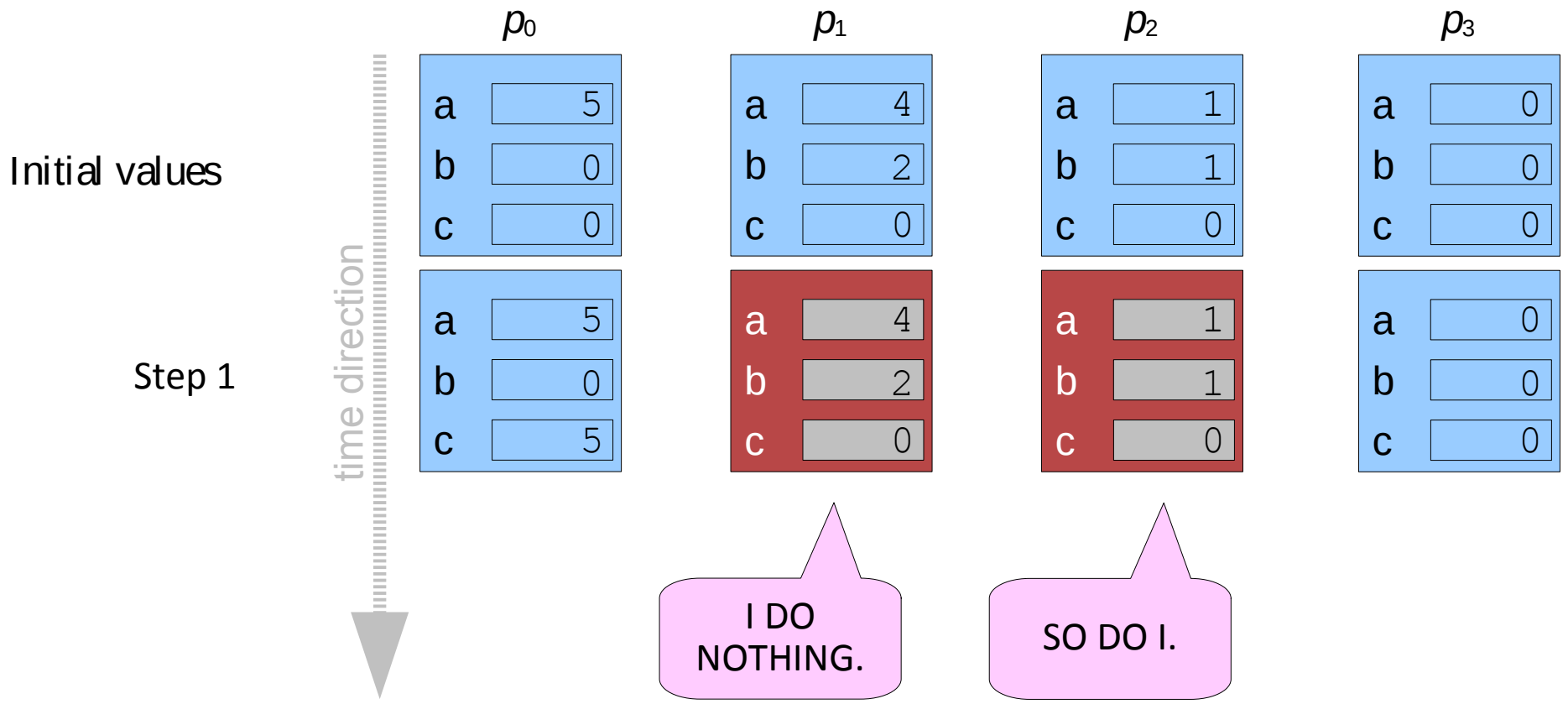

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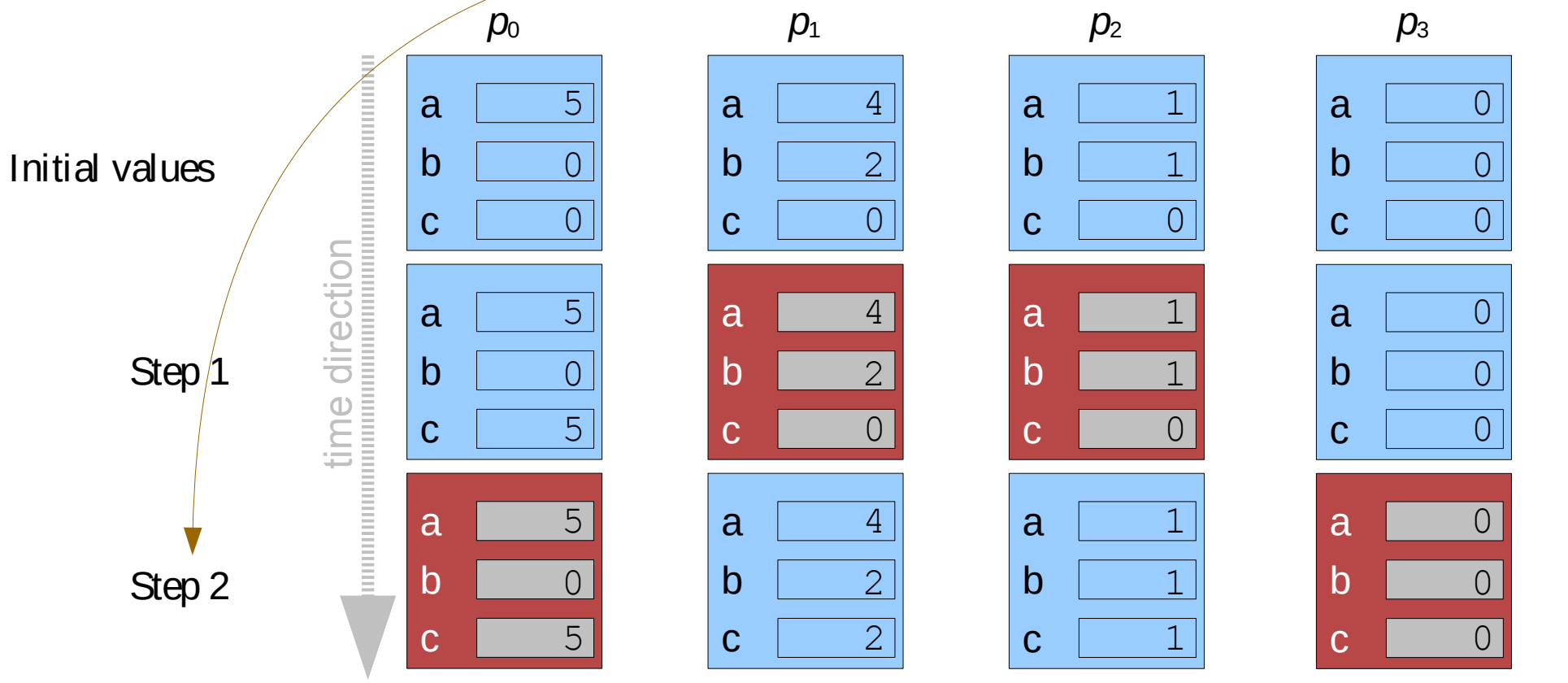

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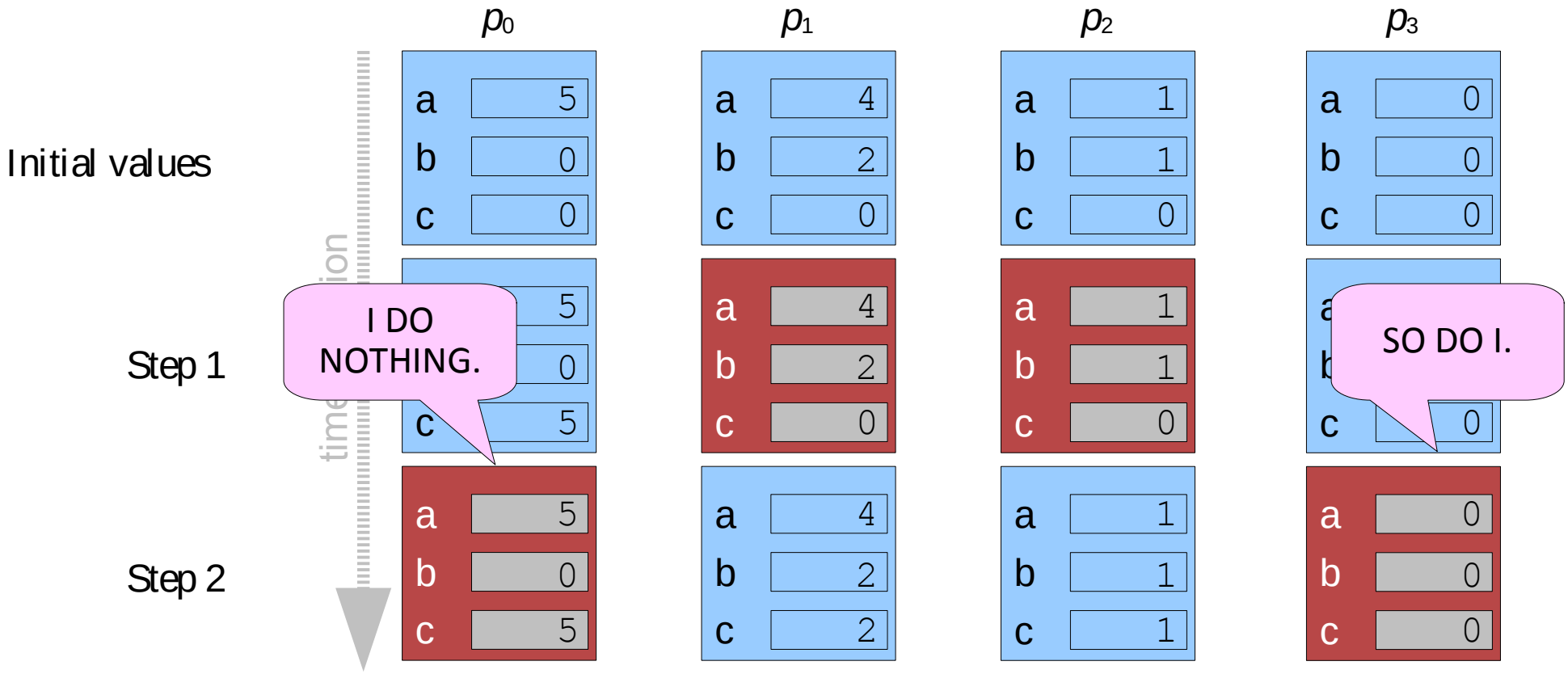

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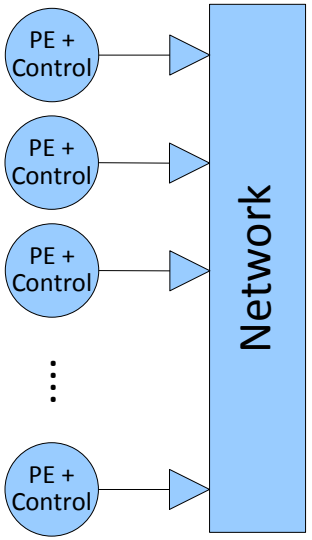
- In contrast to SIMD processor, MIMD processors can execute different programs on different processors.
- A special case of this, called single program multiple data stream (SPMD) executes the same program on different processors.



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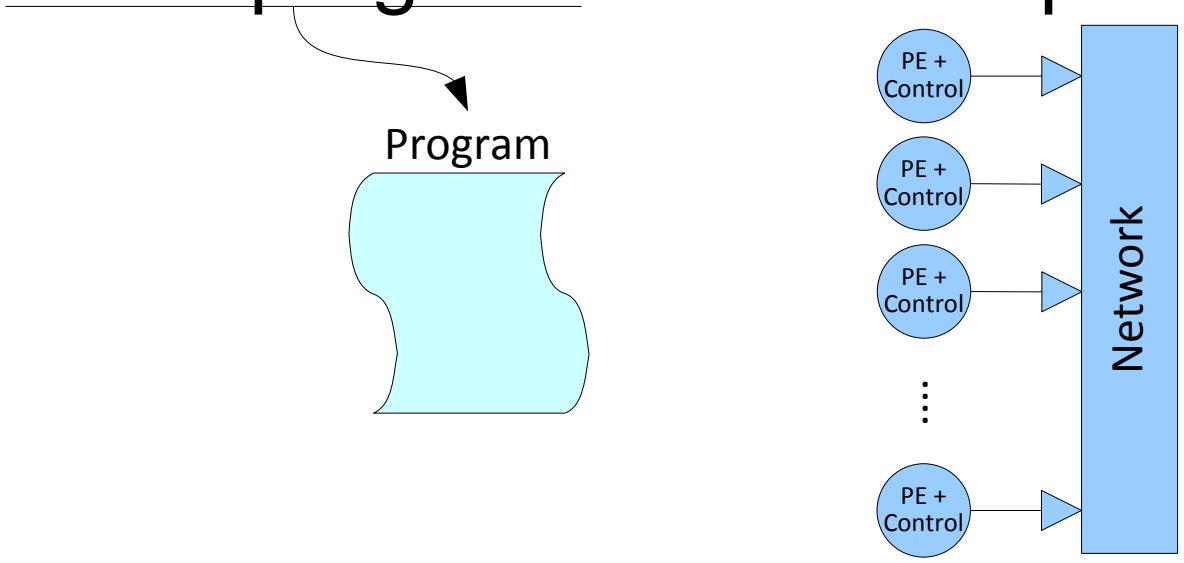

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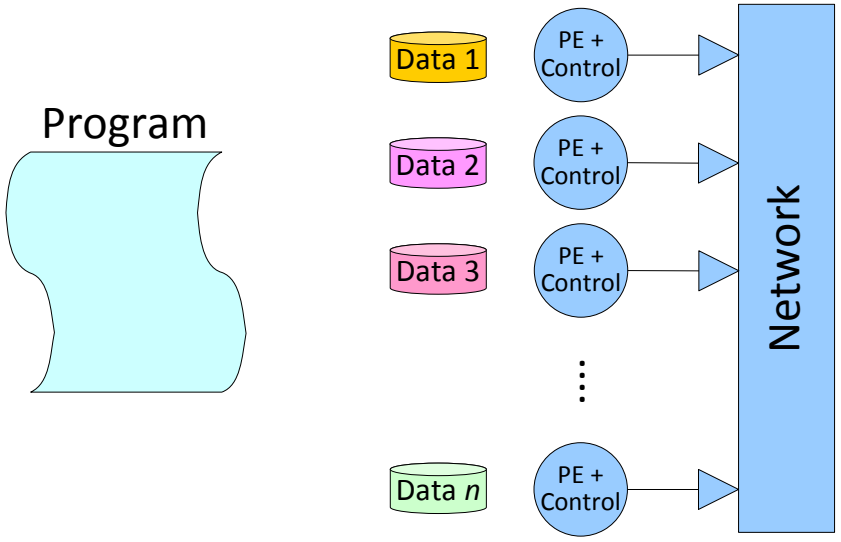

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- In contrast to SIMD processor, MIMD processors can execute different programs on different processors.
- A special case of this, called single program multiple data stream (SPMD) executes the same program on different processors.
- SPMD and MIMD are closely related in terms of programming flexibility and underlying architectural support.

SIMD vs. MIMD

- SIMD require less hardware than MIMD (hint: single control unit)
- However, since SIMD are specially designed, they tend to be expensive and have long design cycles.
- Not all applications are naturally suited to SIMDs.
- In contrast, platforms supporting the SPMD model can be built from inexpensive off-the-shelf components with relatively little effort in a short amount of time.
  - Example: commodity clusters

Next Discussion

- Implicit parallelism
- Limitations of the performance of memory systems
- Dichotomy of platforms
- Communication model
- Physical organization
- Communication costs
- Messaging cost models and routing
- Mapping techniques