Run Faster

Jeremy Clark

Parallel Programming in C#

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What?

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What?

CPU-bound Operations

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CPU-bound Operations

Data Processing

Complex Calculations

Data Manipulation

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Why?

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Why?

CPUs are getting Bigger

Not Faster

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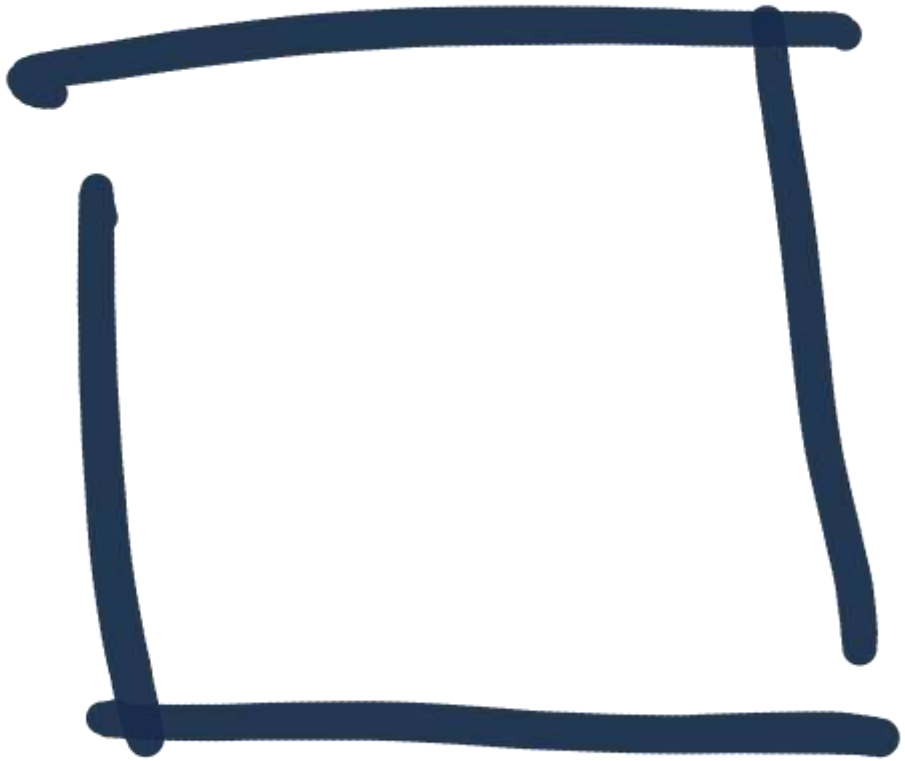

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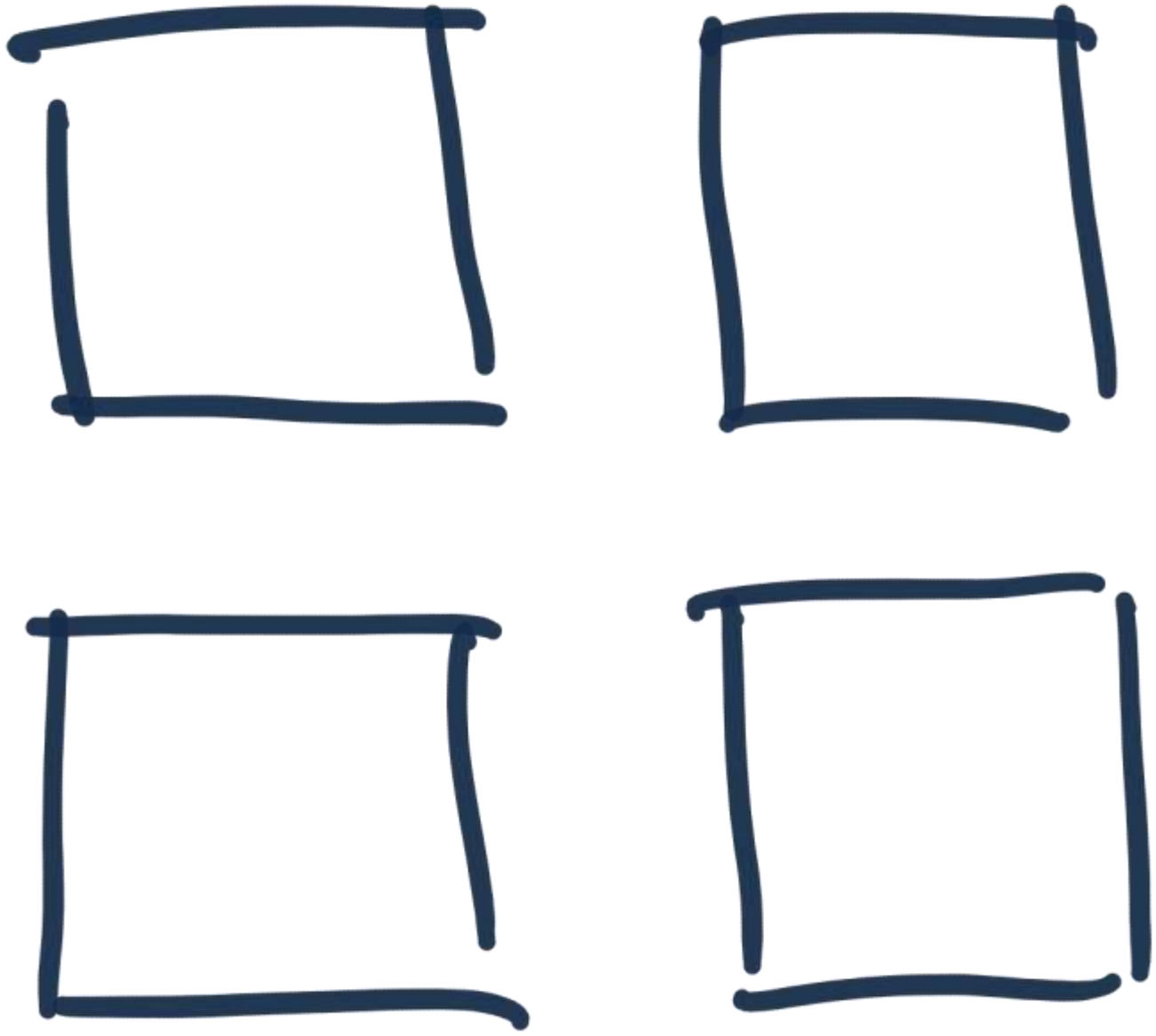

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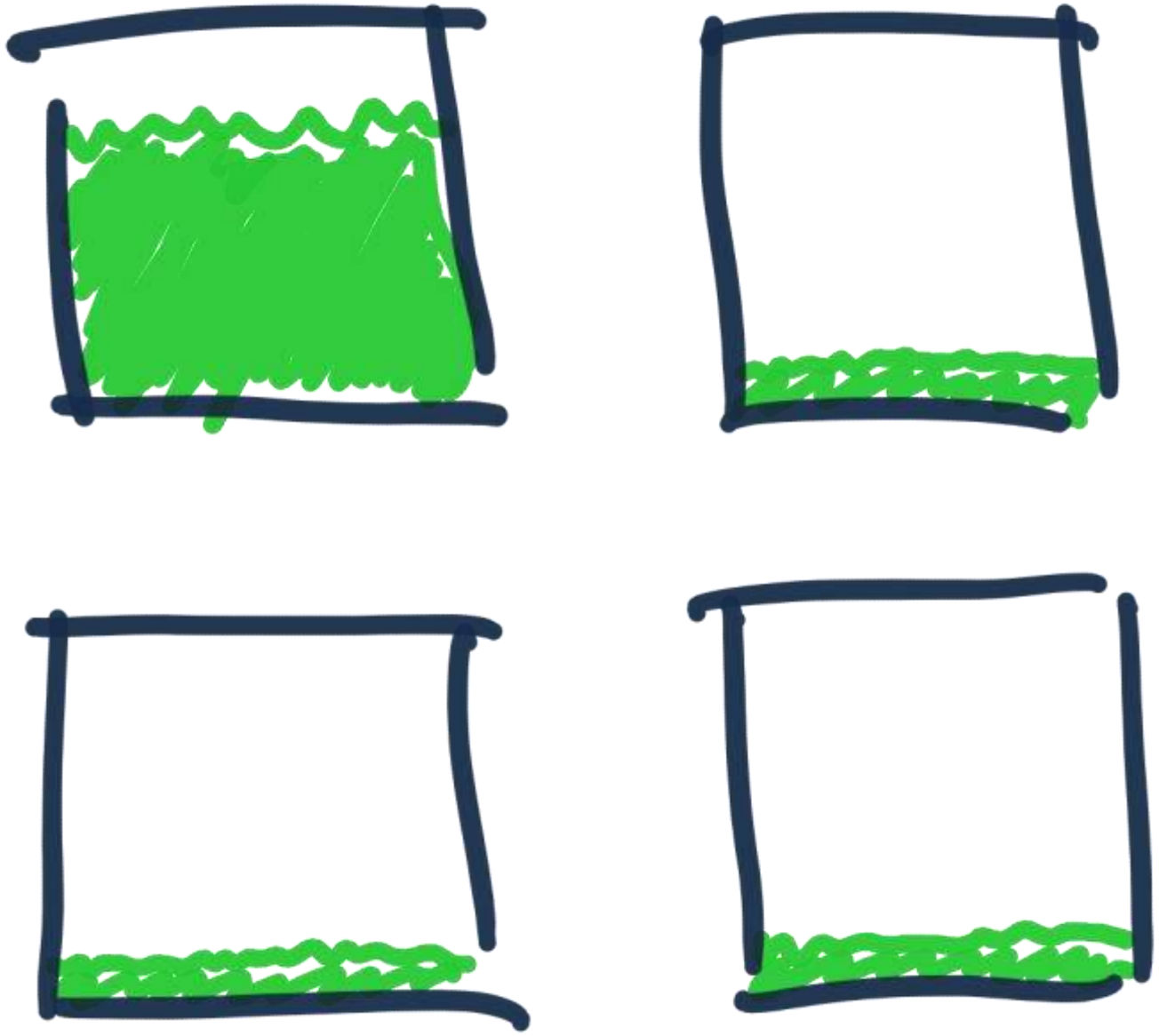

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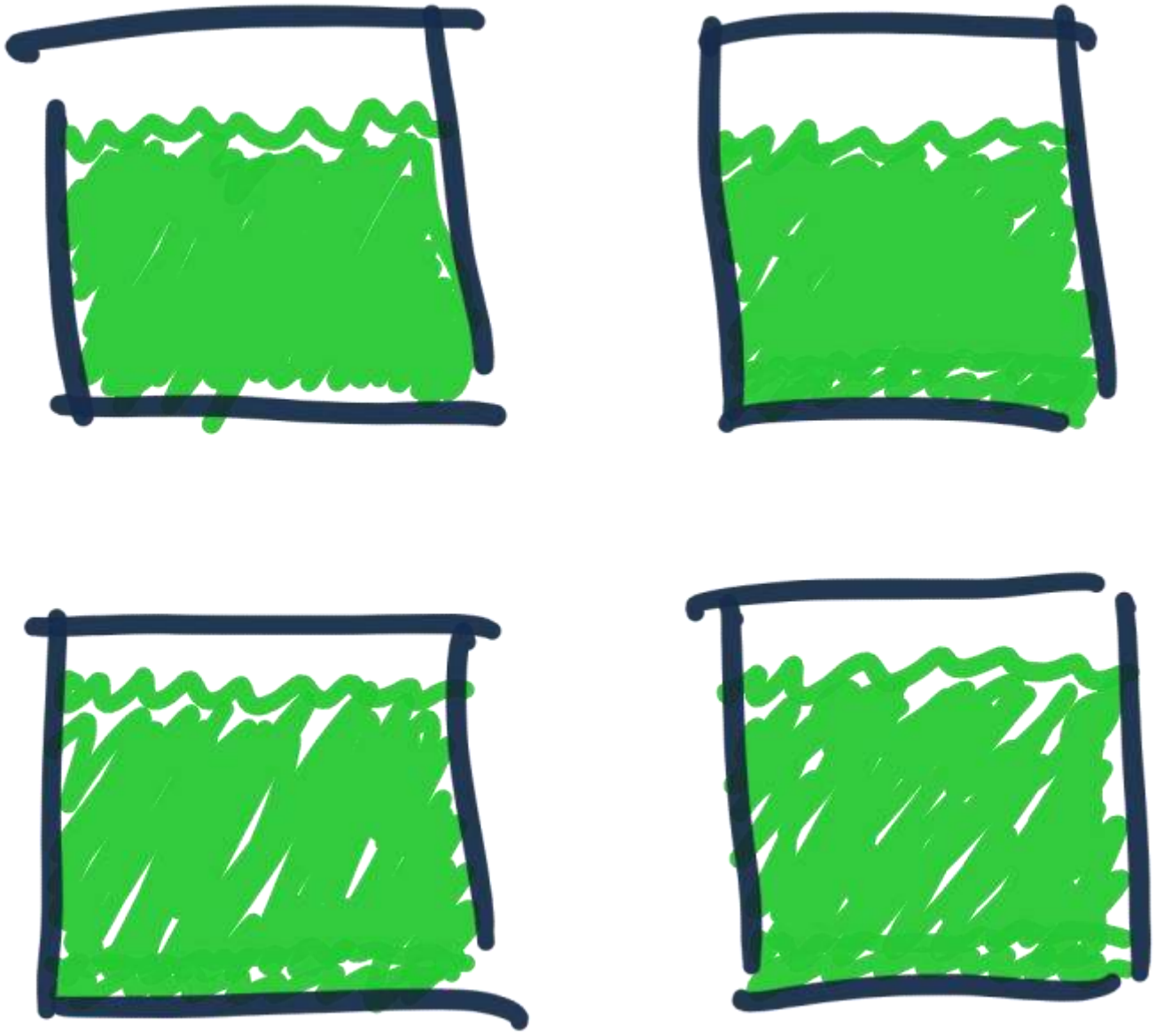

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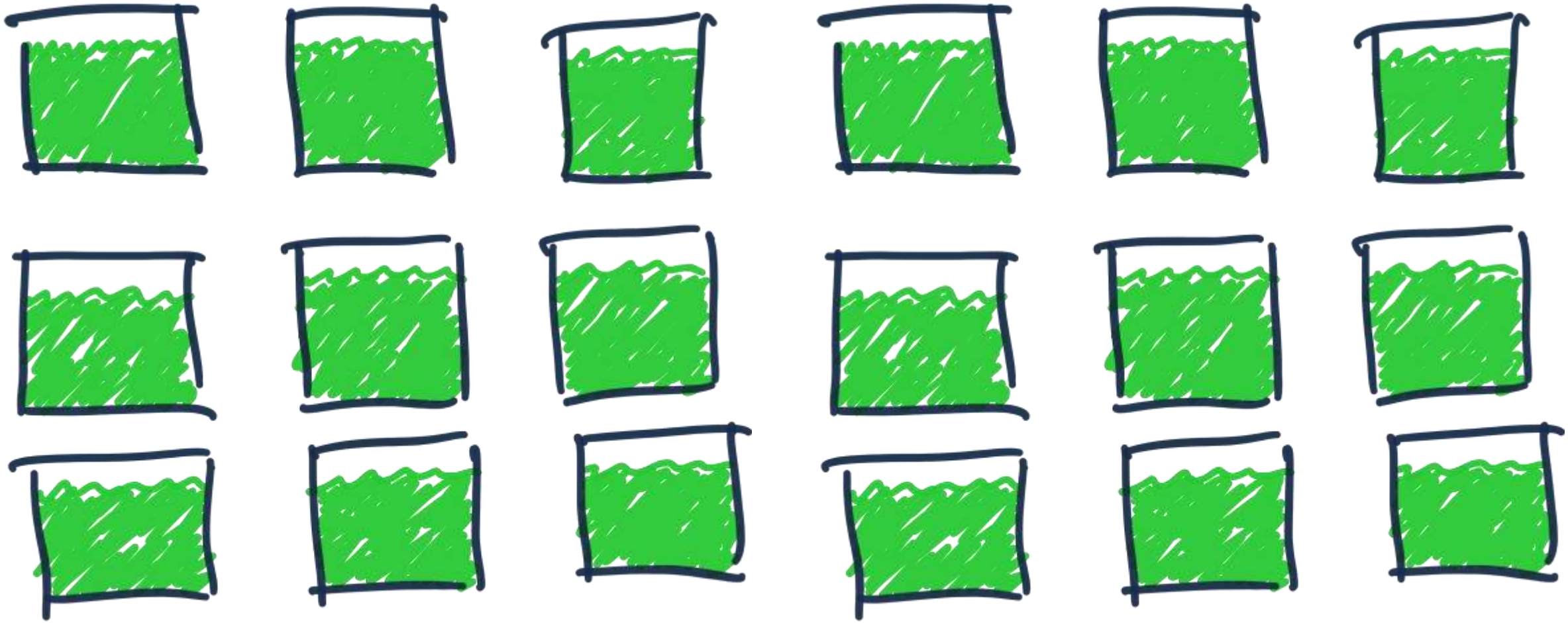

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Can I Run in Parallel?

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Maybe

Maybe Not

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Atomic

Maybe

Deterministic

Discrete Input/Output

No Shared Data

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Maybe

Maybe Not

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Shared Data

Maybe Not

Shared Resources

External Dependencies

Ordered/Sequential

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Parallel.For

Parallel.ForEach

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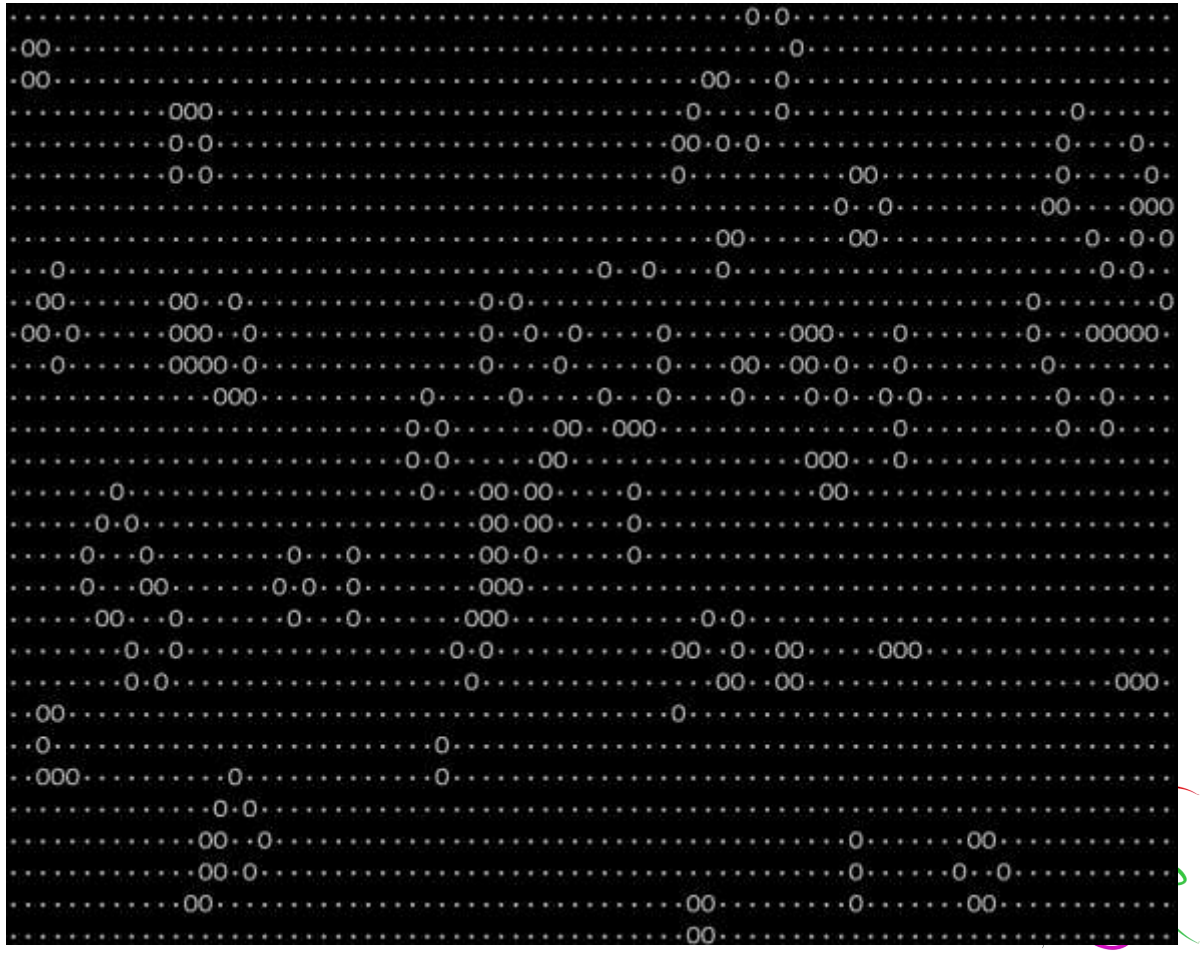
Conway's Game of Life

Parallel.For

Parallel.ForEach



Hard to Run Parallel

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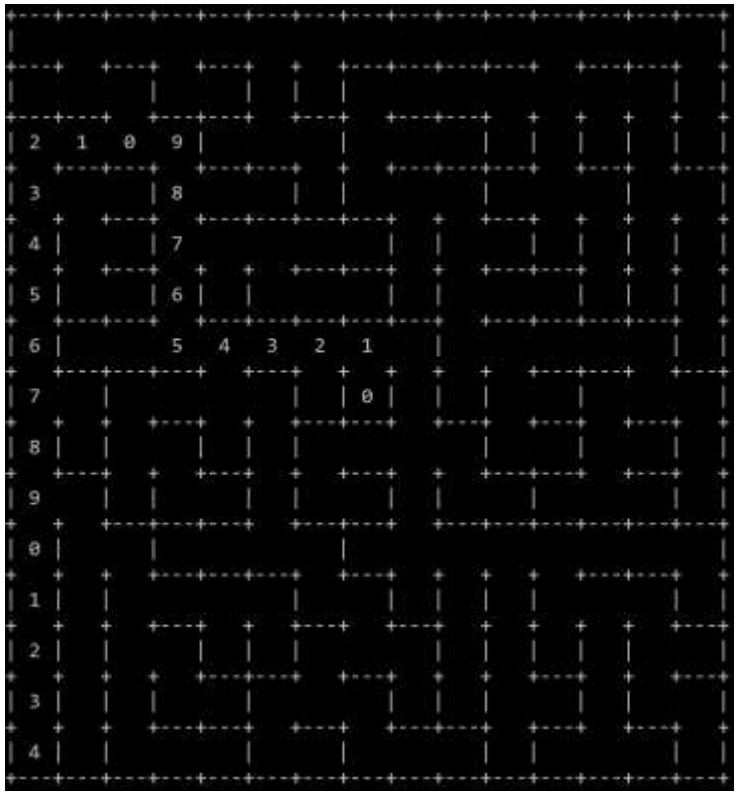
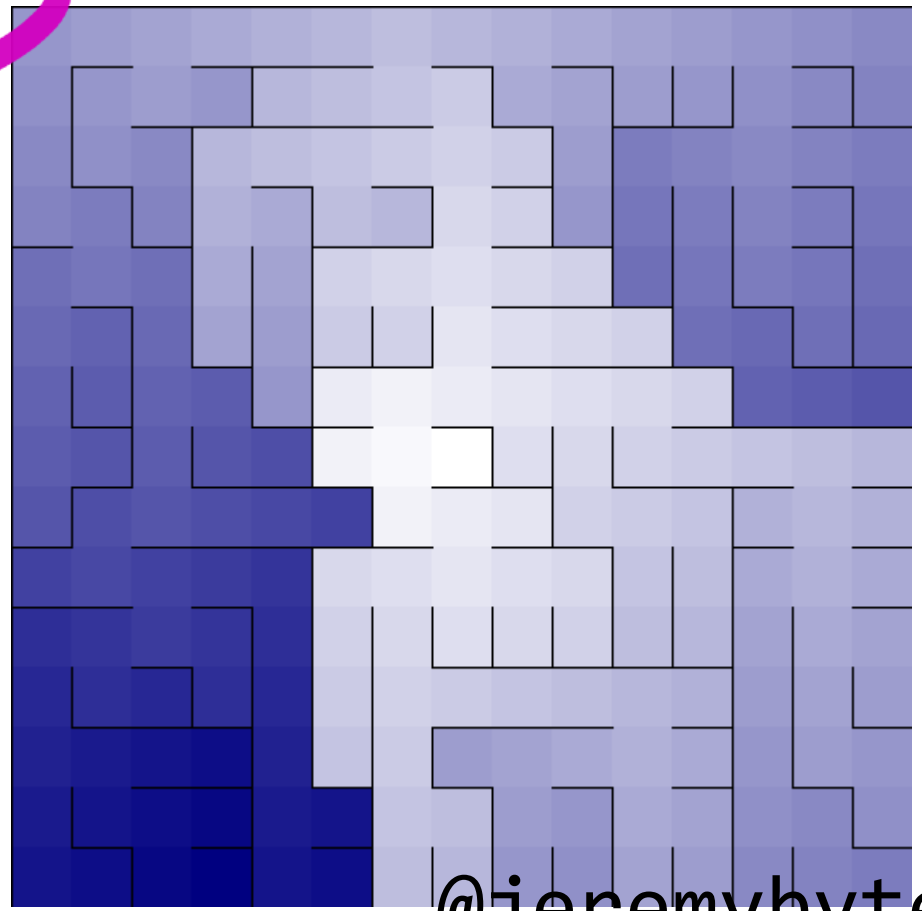
Mazes

Hard to Run Parallel





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Parallel Tasks

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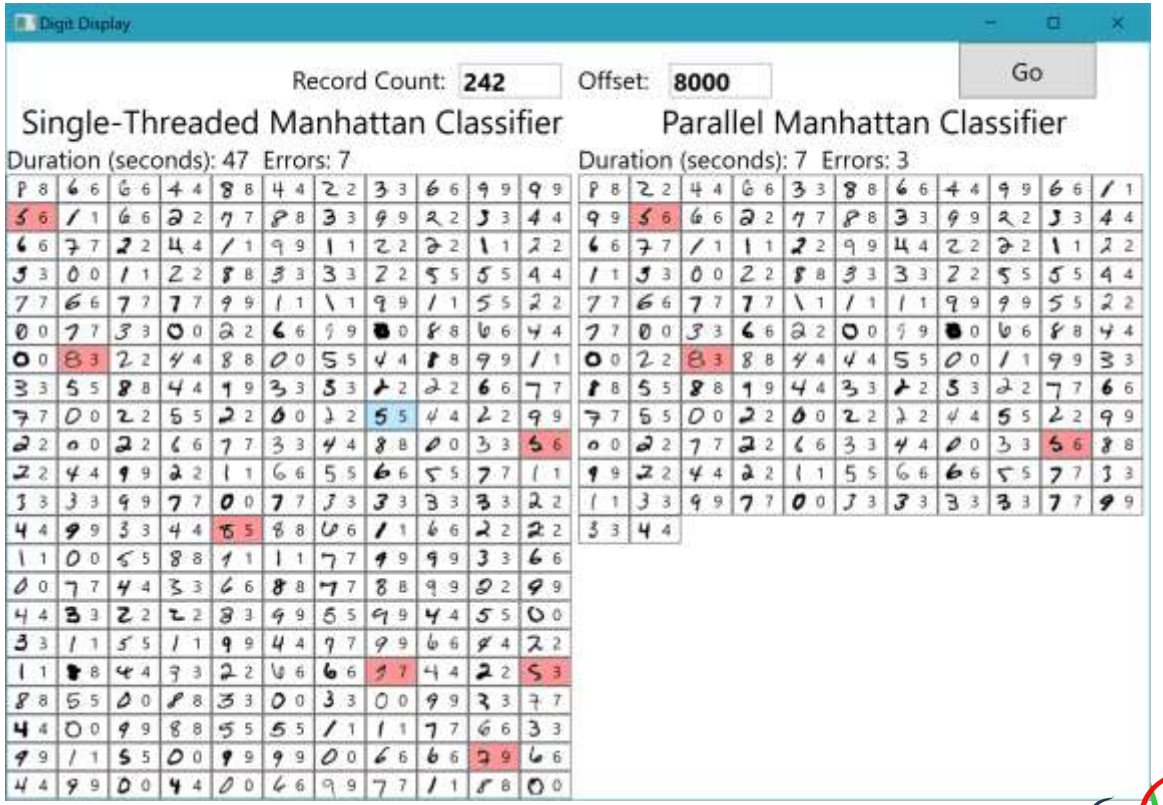
Parallel Tasks

Digit Recognition



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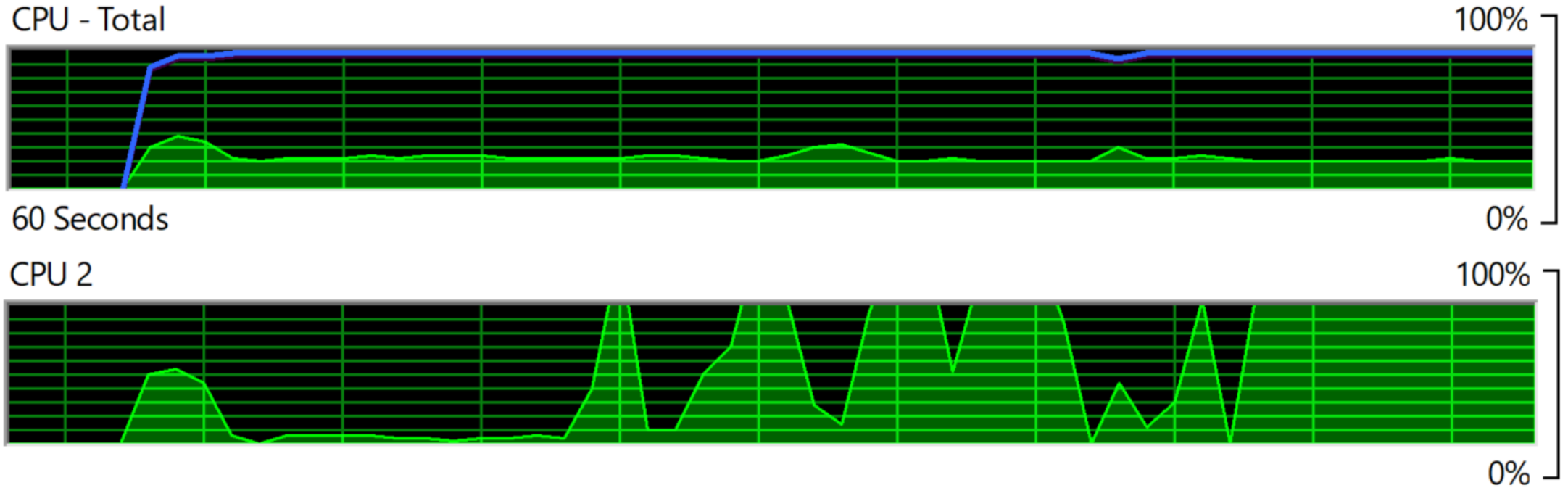

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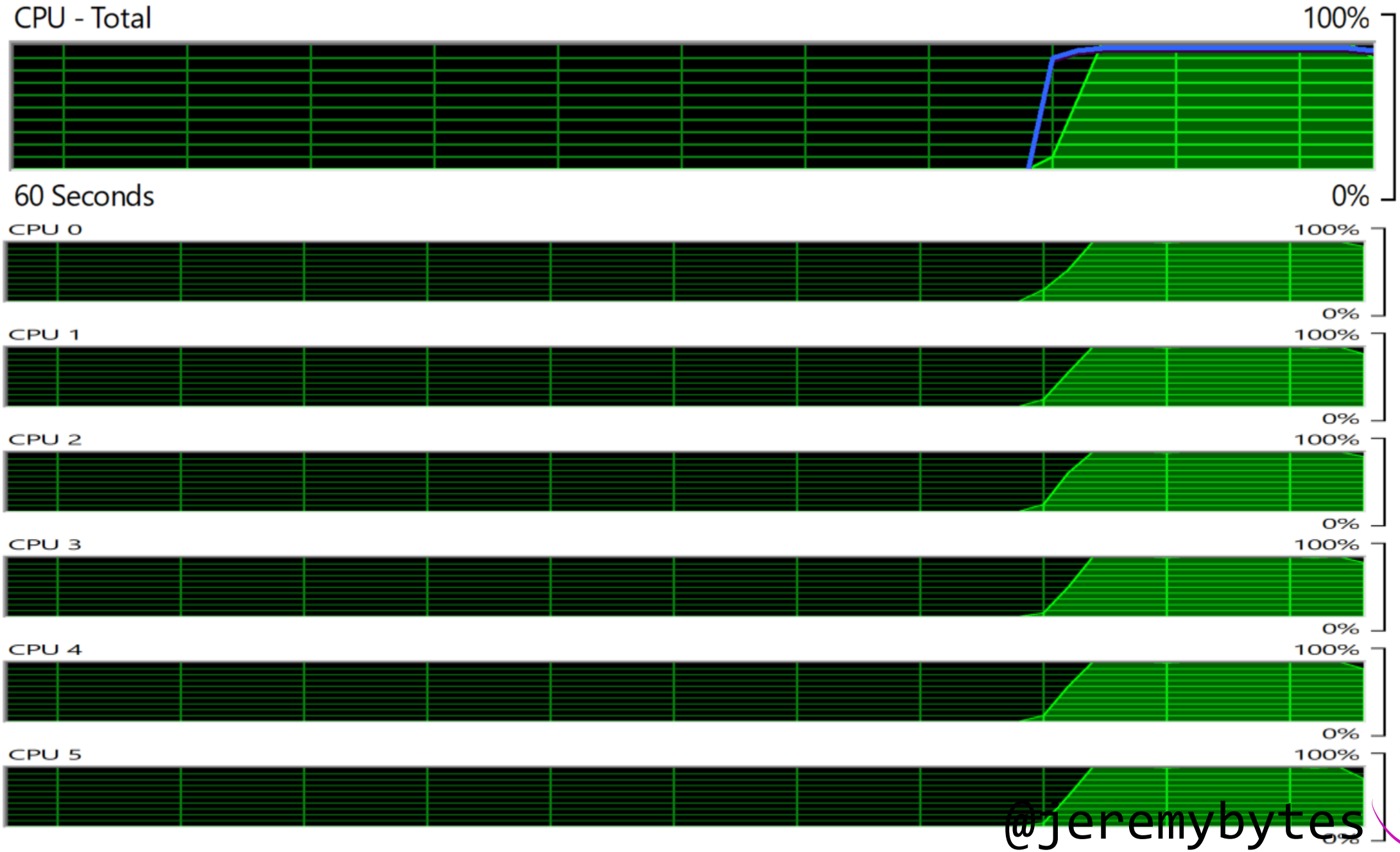
CPU - Total
100%
60 Seconds
0%
CPU 0
100%
0%
CPU 1
100%
0%
CPU 2
100%
0%
CPU 3
100%
0%
CPU 4
100%
0%
CPU 5
100%
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Measure
Measure
Measure

Resources

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Resources

Parallel Programming with Microsoft .NET

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Selecting the Right Pattern

To select the relevant pattern, use the following table.

Application characteristic	Relevant pattern
Do you have sequential loops where there's no communication among the steps of each iteration?	The Parallel Loop pattern (Chapter 2). Parallel loops apply an independent operation to multiple inputs simultaneously.
Do you have distinct operations with well-defined control dependencies? Are these operations largely free of serializing dependencies?	The Parallel Task pattern (Chapter 3) Parallel tasks allow you to establish parallel control flow in the style of fork and join.
Do you need to summarize data by applying some kind of combination operator? Do you have loops with steps that are not fully independent?	The Parallel Aggregation pattern (Chapter 4) Parallel aggregation introduces special steps in the algorithm for merging partial results. This pattern expresses a reduction operation and includes map/reduce as one of its variations.
Does the ordering of steps in your algorithm depend on data flow constraints?	The Futures pattern (Chapter 5) Futures make the data flow dependencies between tasks explicit. This pattern is also referred to as the Task Graph pattern.
Does your algorithm divide the problem domain dynamically during the run? Do you operate on recursive data structures such as graphs?	The Dynamic Task Parallelism pattern (Chapter 6) This pattern takes a divide-and-conquer approach and spawns new tasks on demand.
Does your application perform a sequence of operations repetitively? Does the input data have streaming characteristics? Does the order of processing matter?	The Pipelines pattern (Chapter 7) Pipelines consist of components that are connected by queues, in the style of producers and consumers. All the components run in parallel even though the order of inputs is respected.

Parallel Programming with Microsoft .NET

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Resources

- Parallel Programming w/ Microsoft .NET
  https://docs.microsoft.com/en-us/previous-versions/msp-n-p/ff963553(v=pandp.10)
- Task & Await
  http://www.jeremybytes.com/Demos.aspx#TaskAndAwait
- Presentation Links
  http://www.jeremybytes.com/Demos.aspx#RunFaster
- GitHub
  https://github.com/jeremybytes/parallel-programming

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Thank You

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