HEAP EVOLUTION ANALYSIS USING TREE VISUALIZATIONS

SSP 2020

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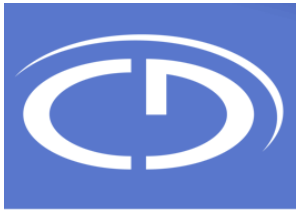
JOHANNES KEPLER
UNIVERSITY LINZ



dynatrace

MOTIVATION: MEMORY ANOMALIES

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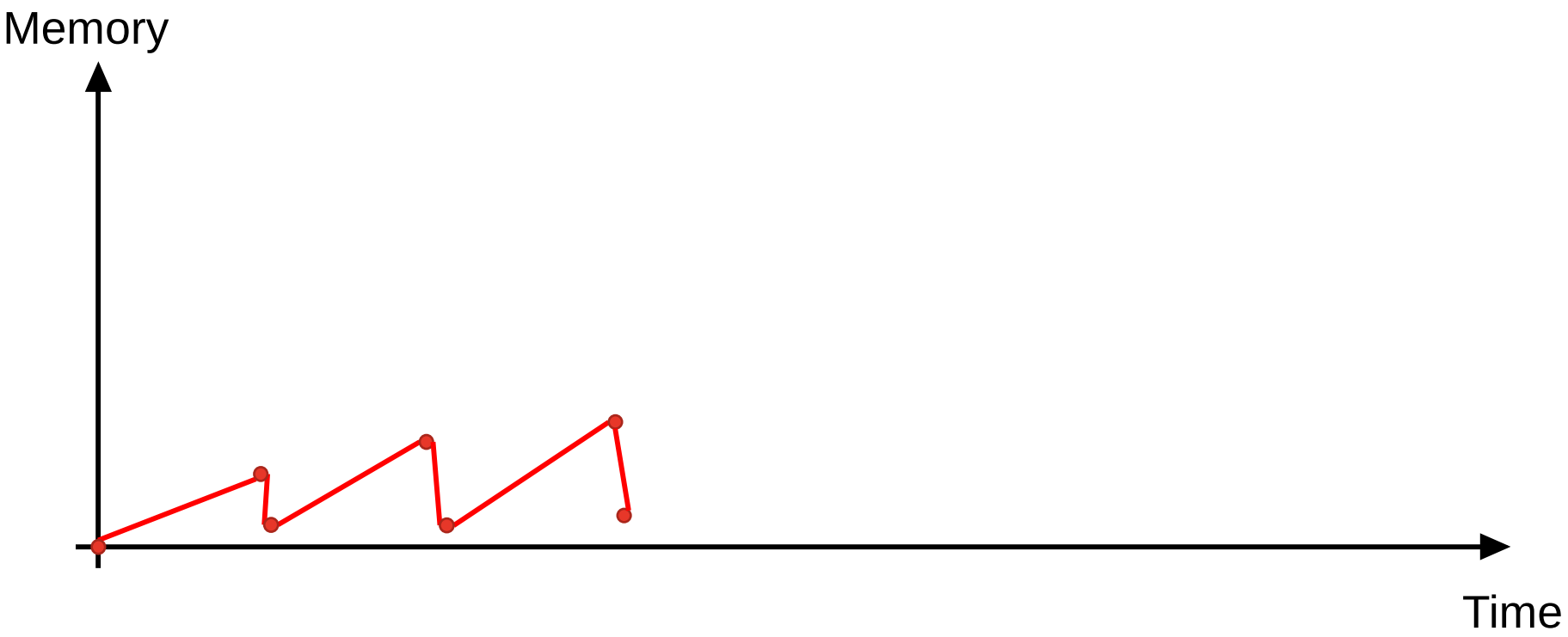

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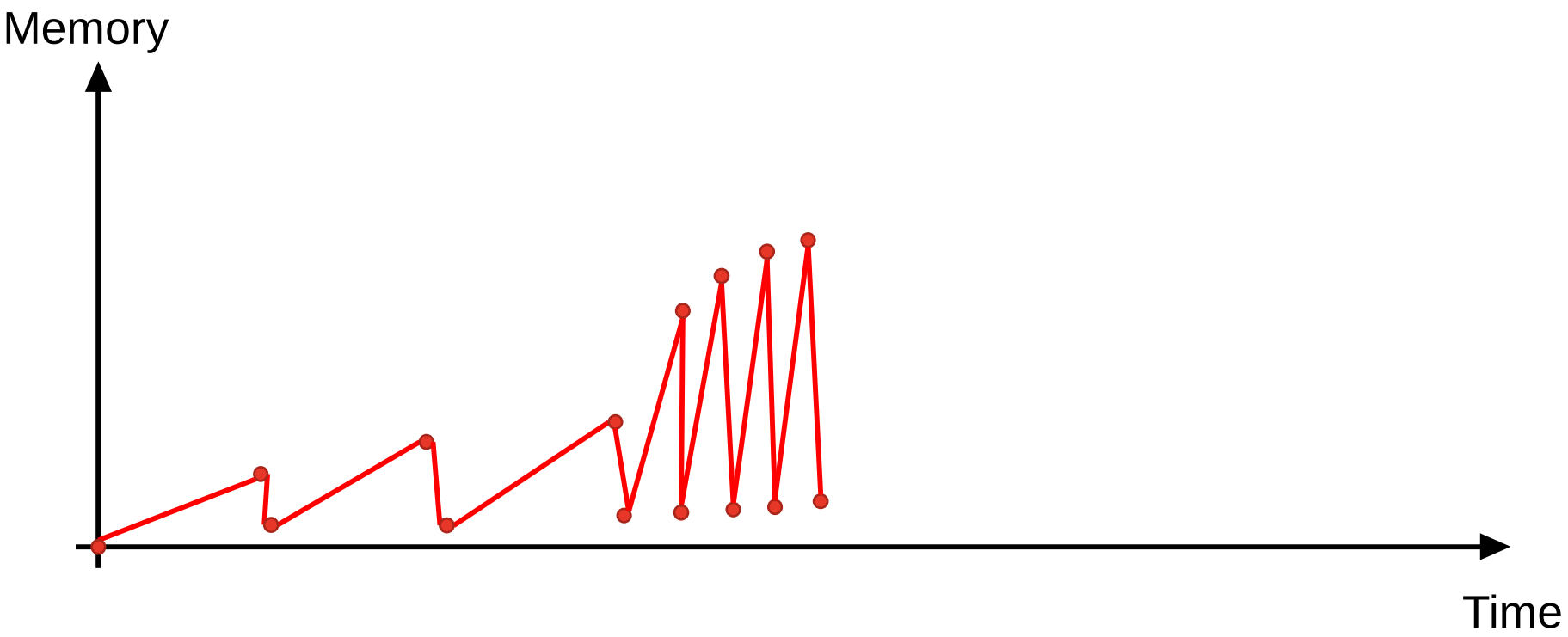

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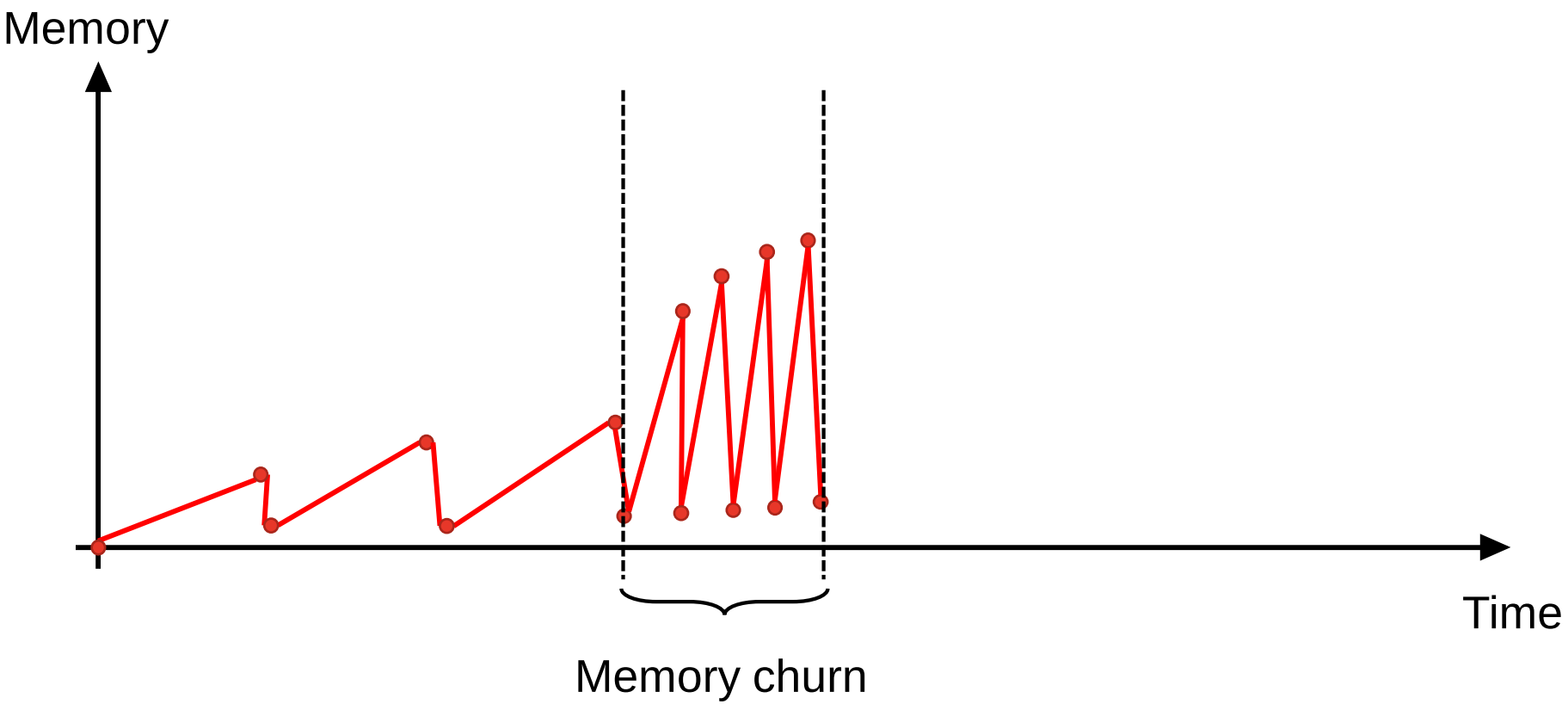

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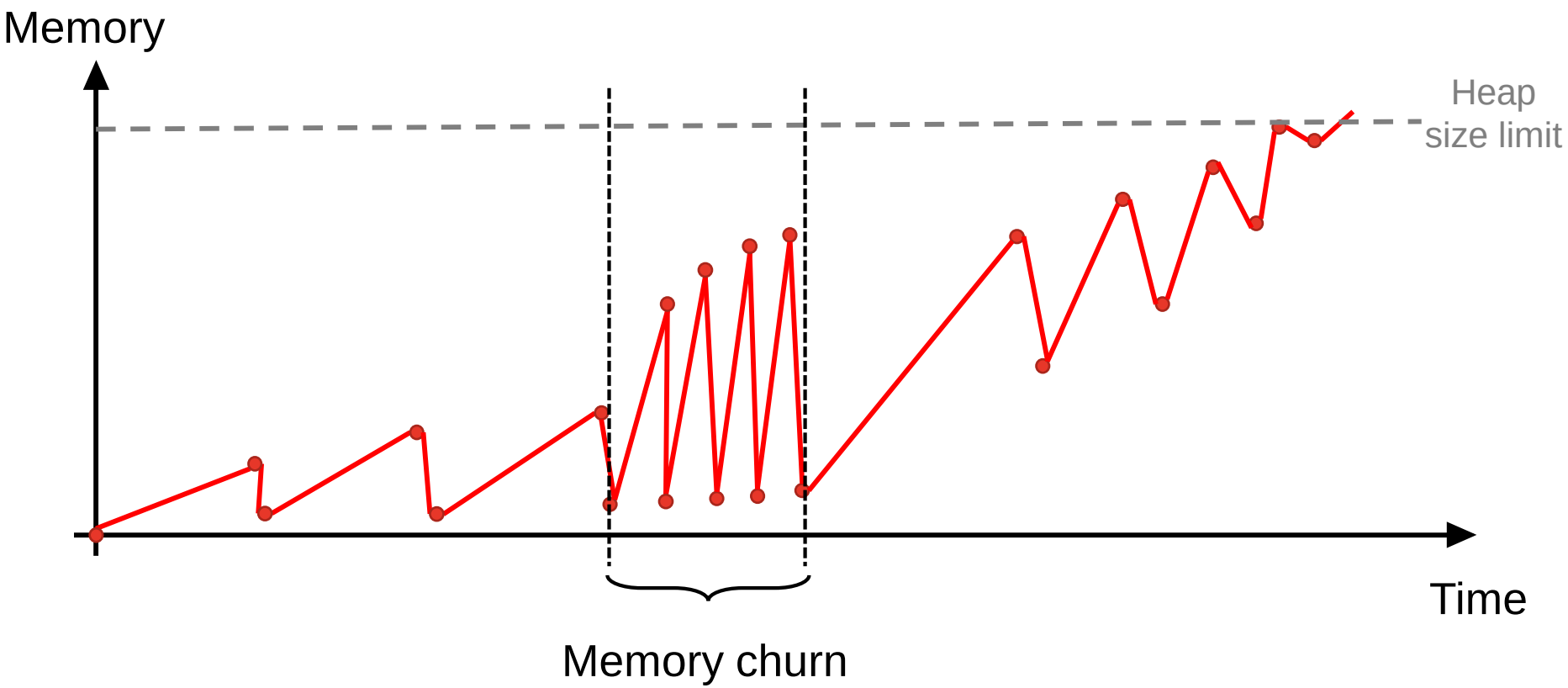

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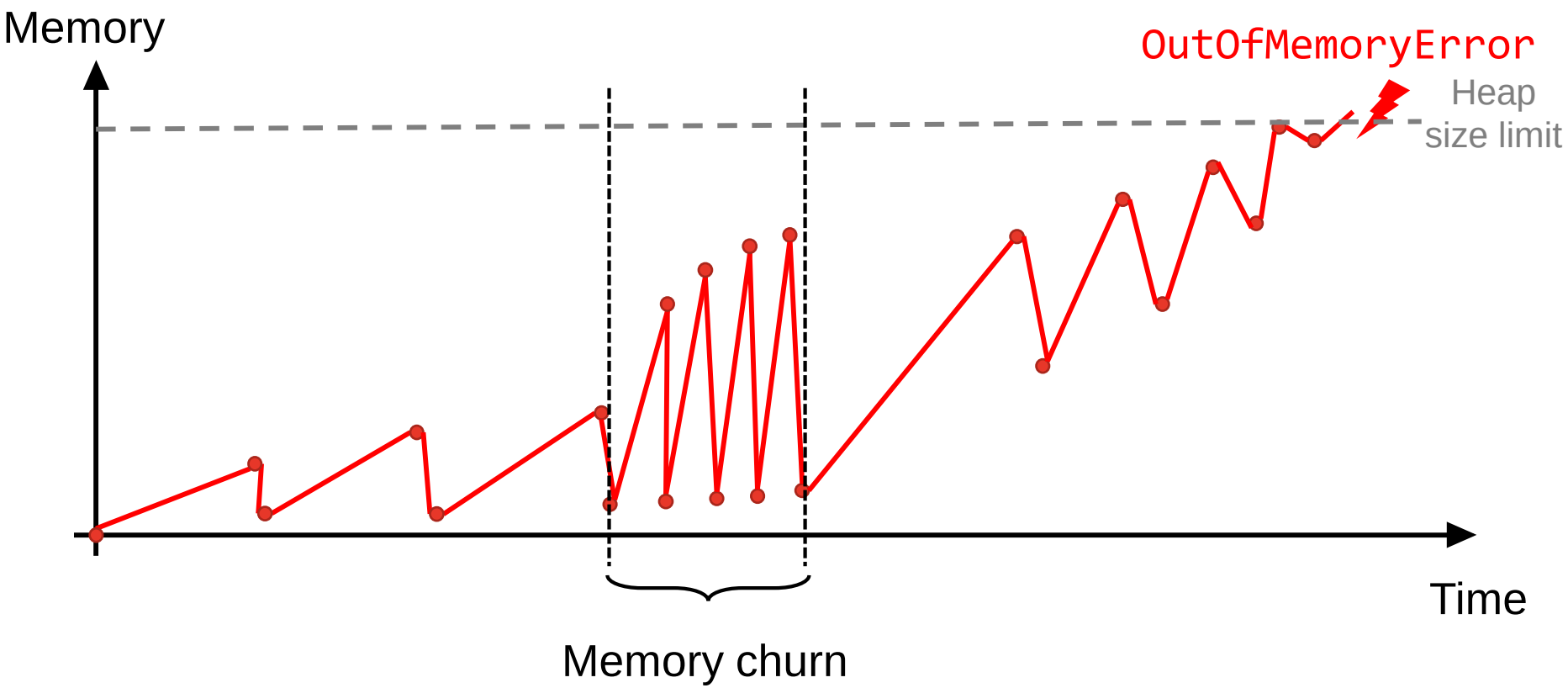

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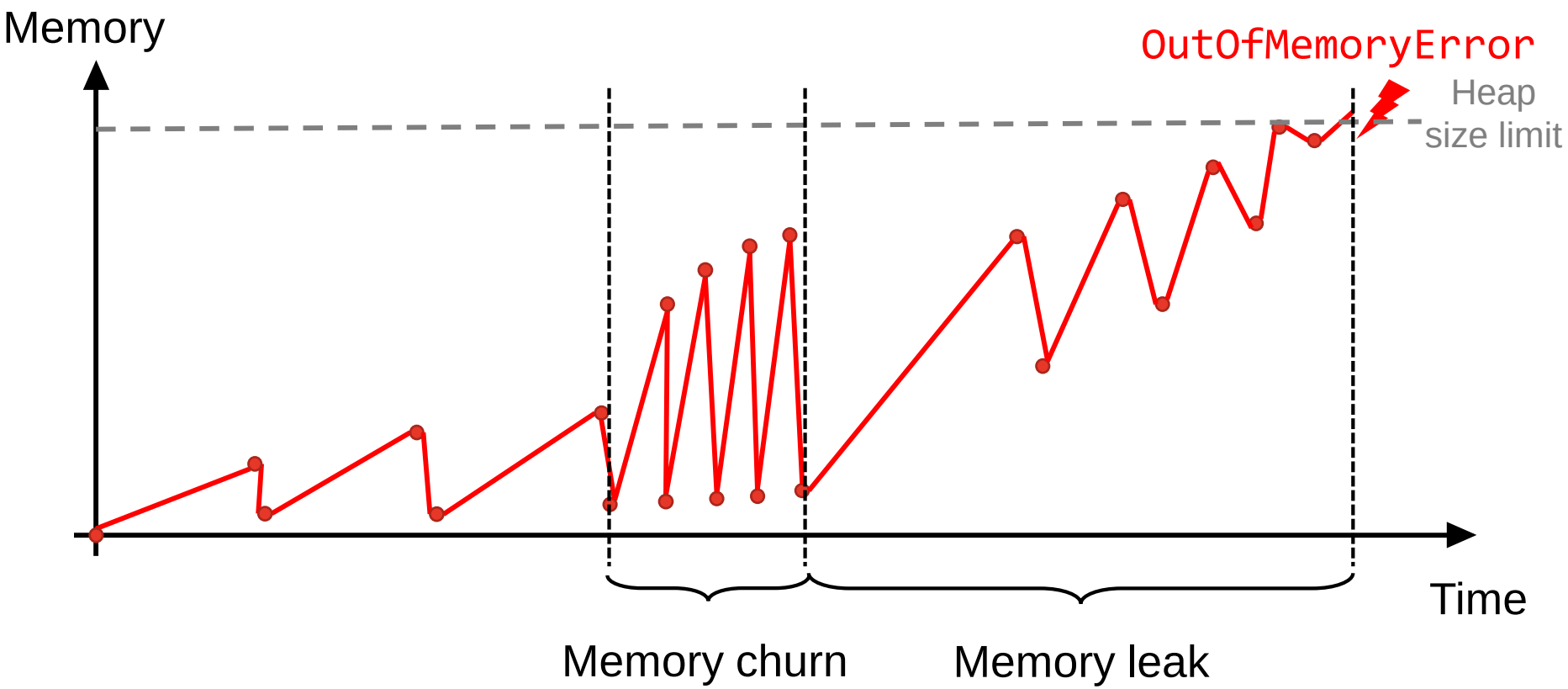

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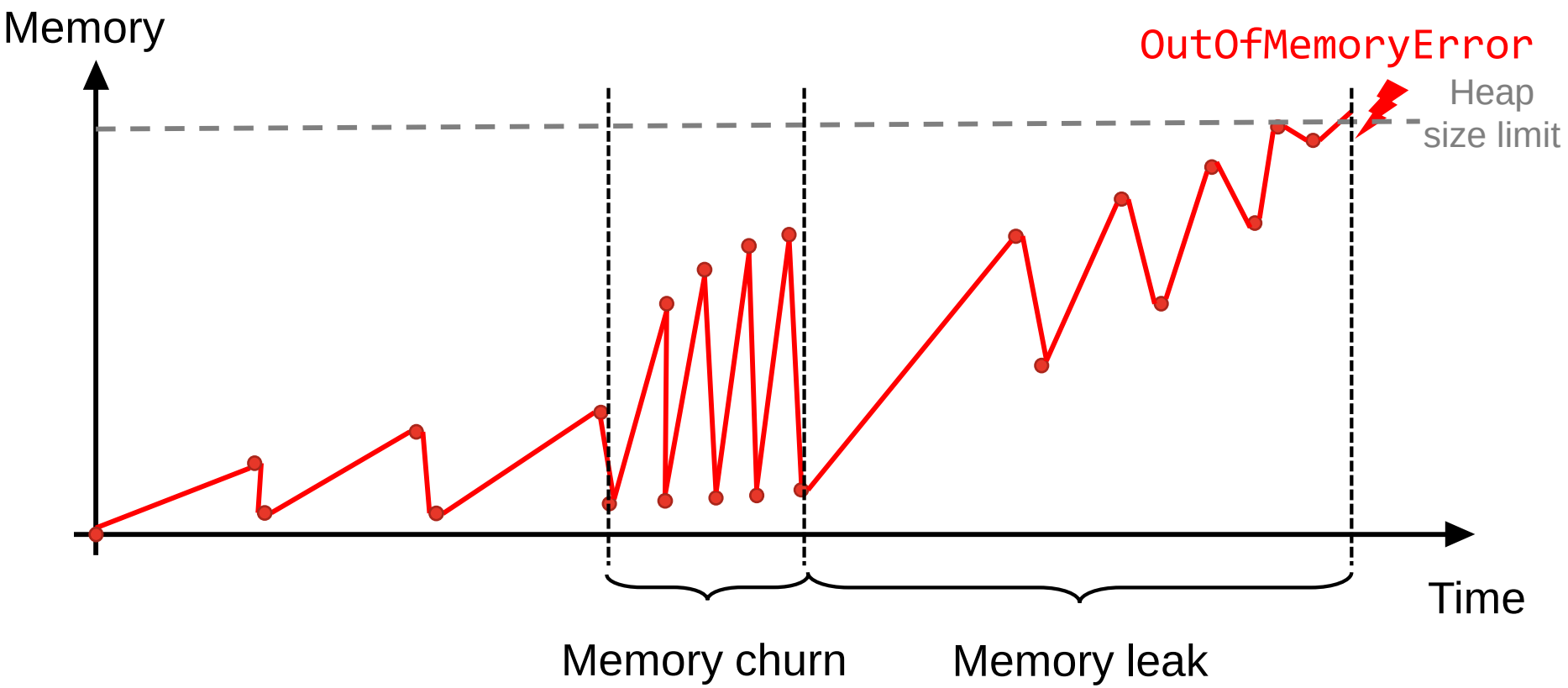

Investigate!

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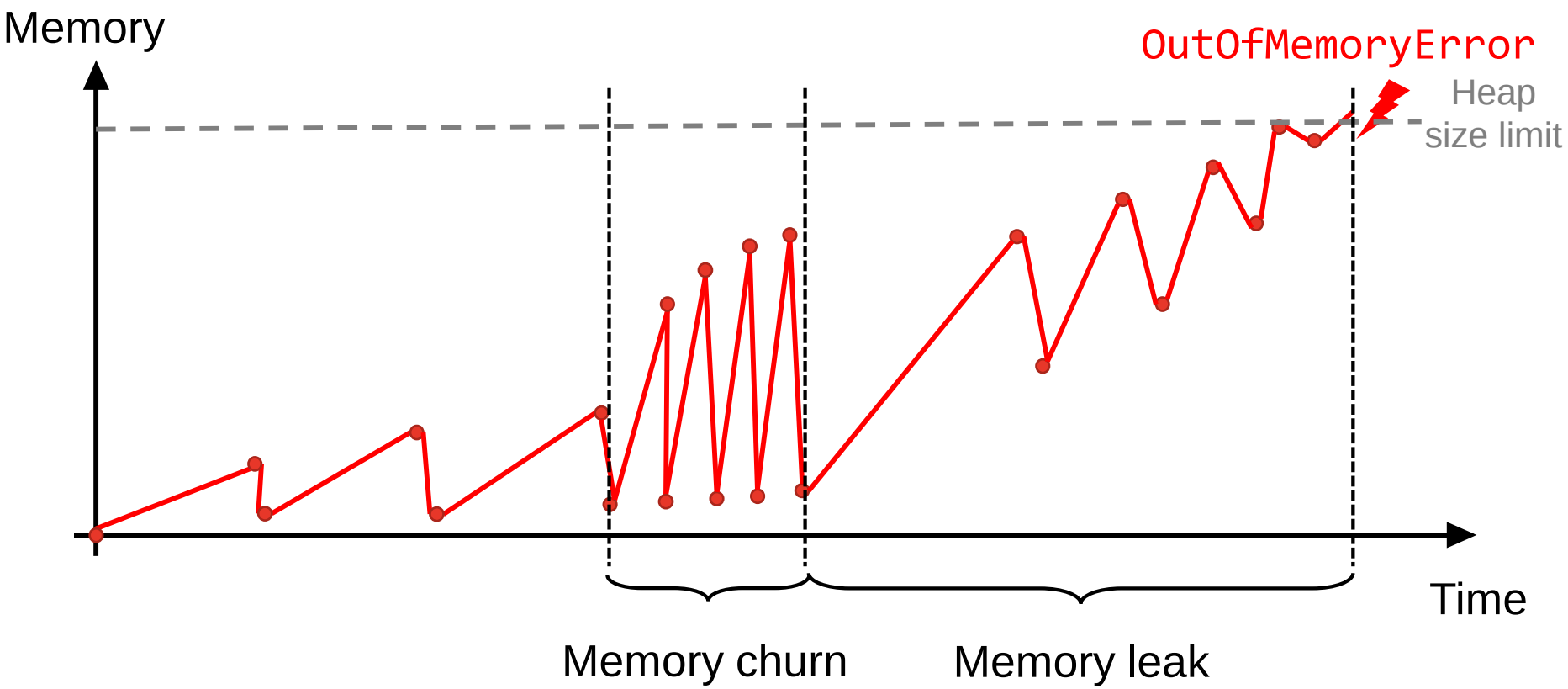

How?

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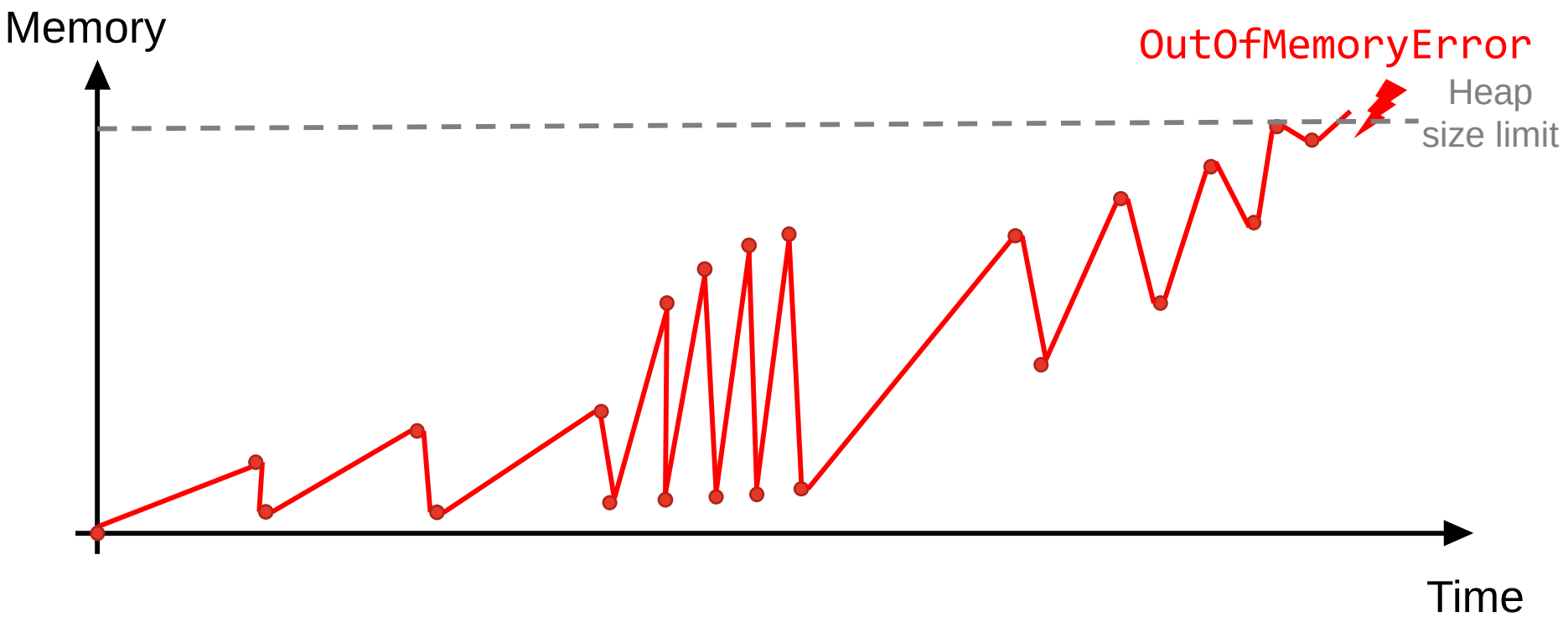

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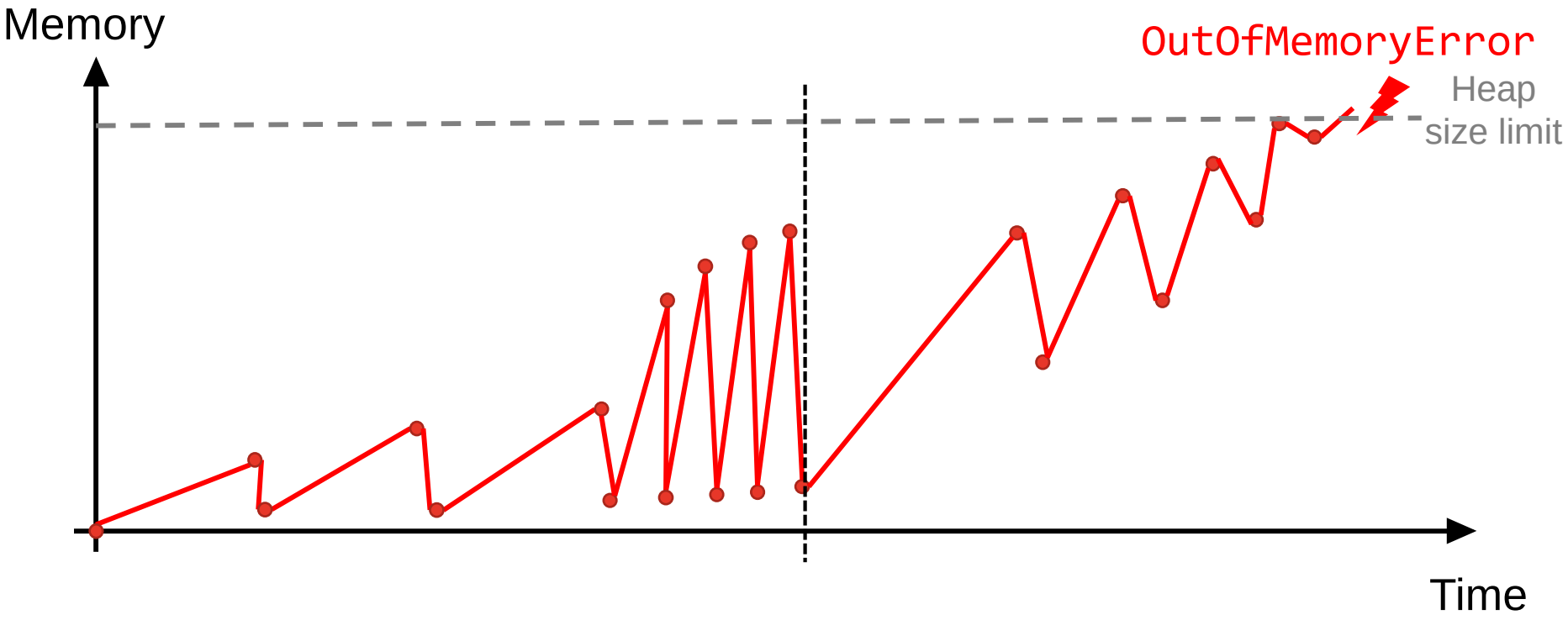

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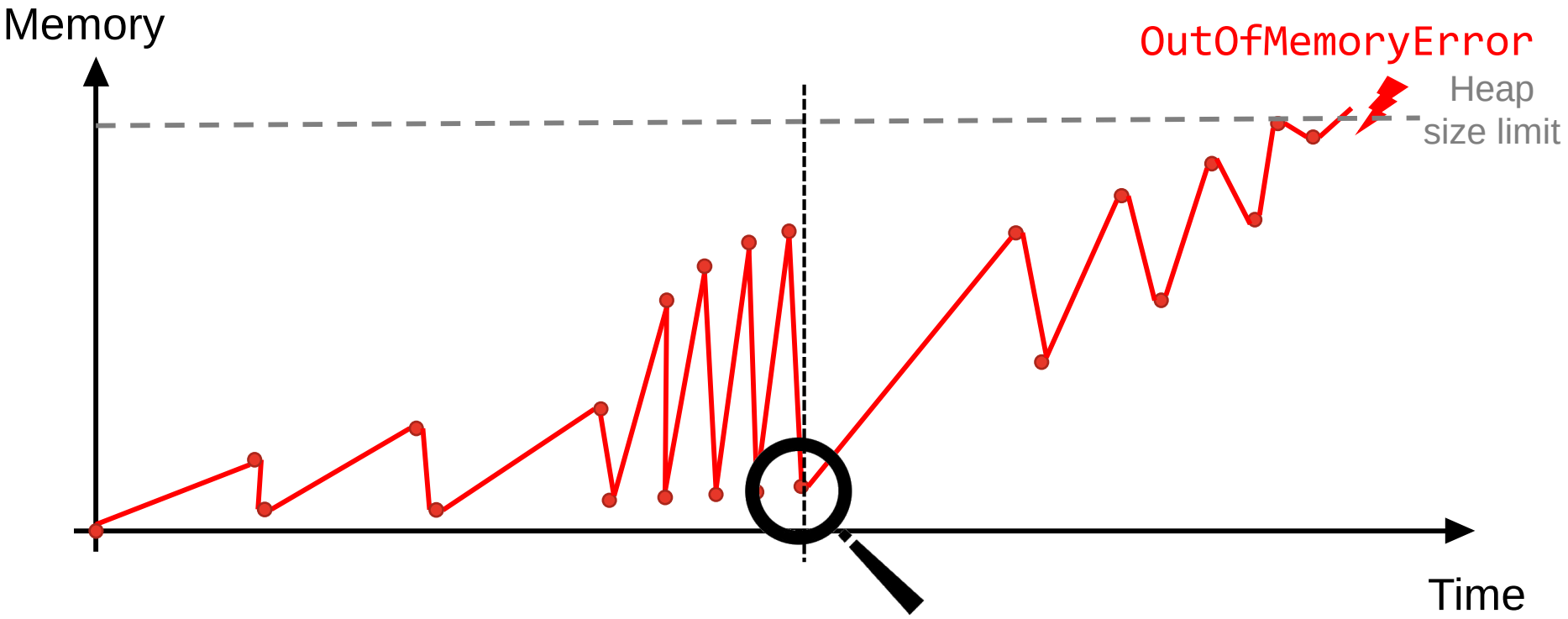

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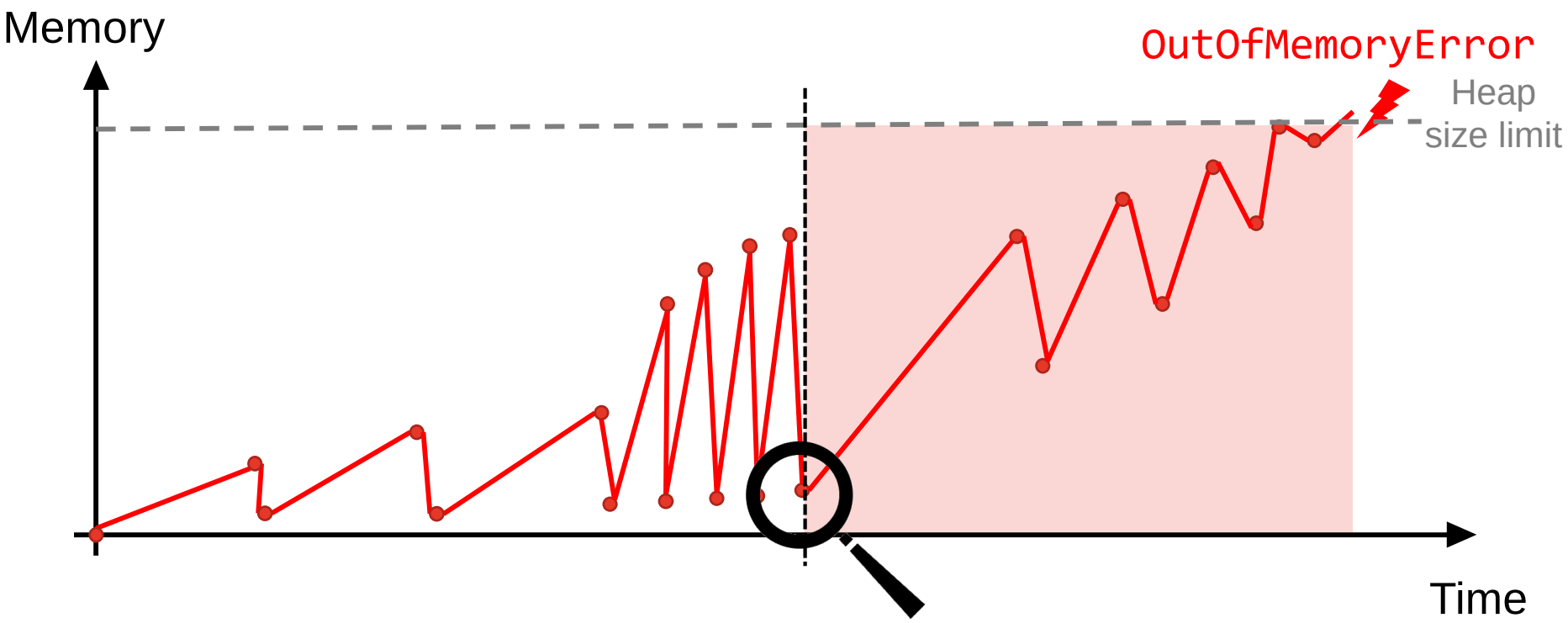

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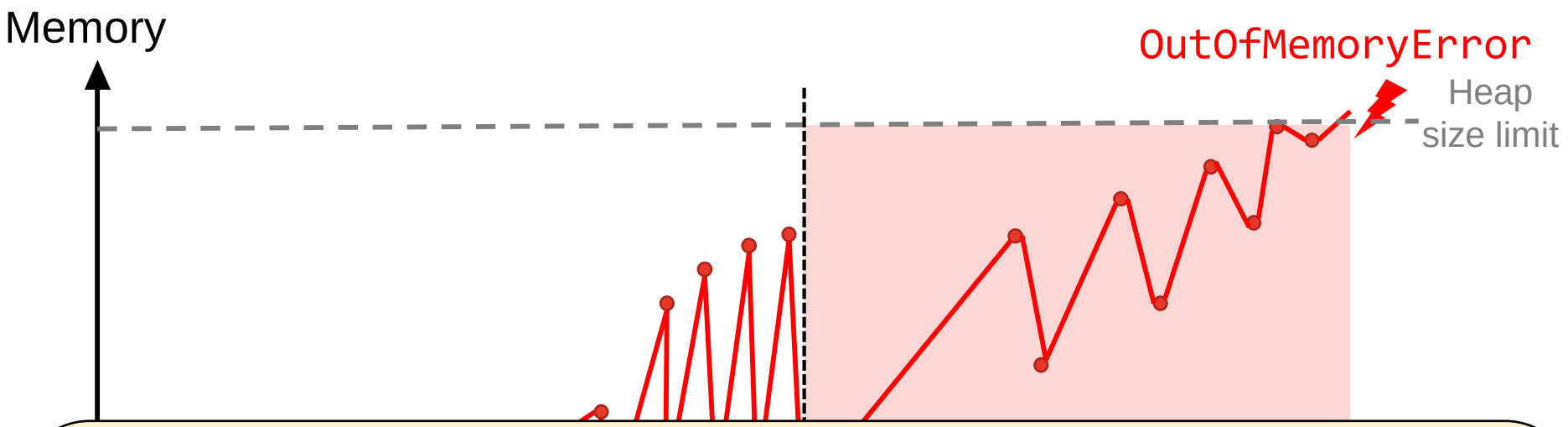
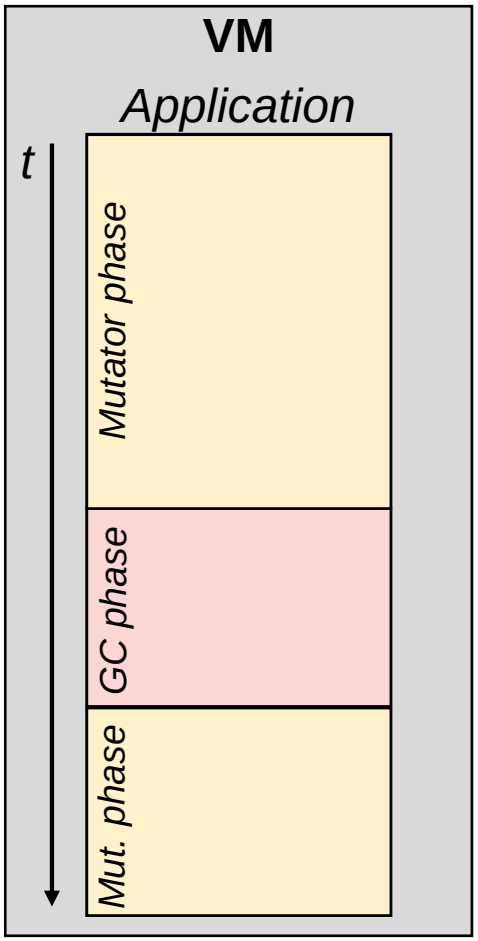


Idea: Help developers in ***understanding*** memory ***growth*** over time through the means of ***visualization***

DATA: MEMORY TRACES



Lengauer, Bitto, Mössenböck: Accurate and Efficient Object Tracing for Java Applications, ICPE 2015
Lengauer et al.: Efficient Memory Traces with Full Pointer Information, PPPJ 2016

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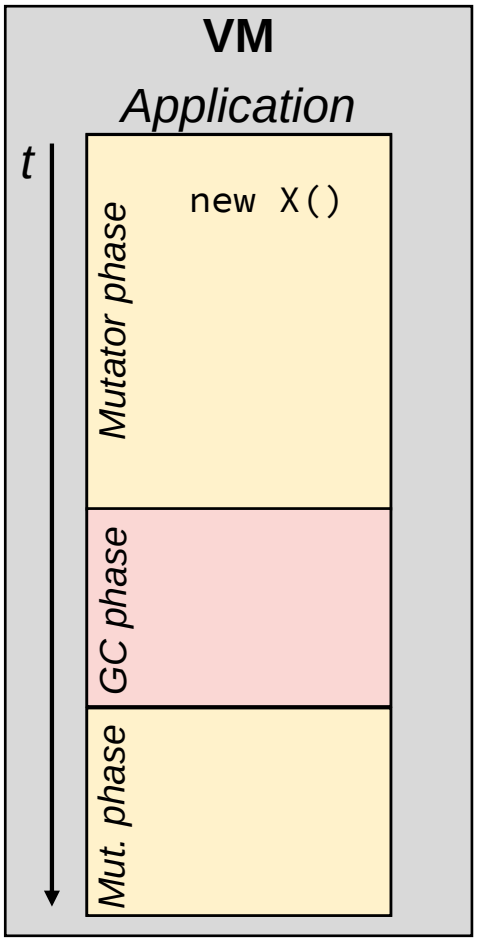

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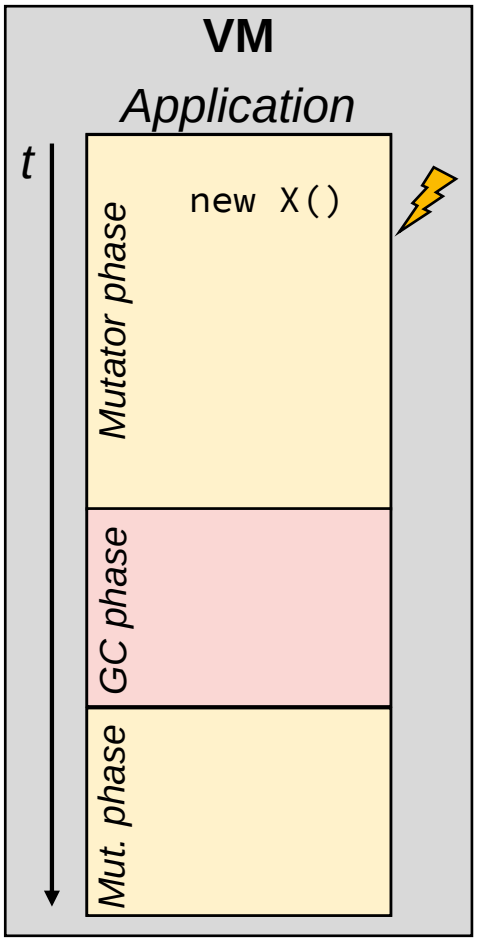

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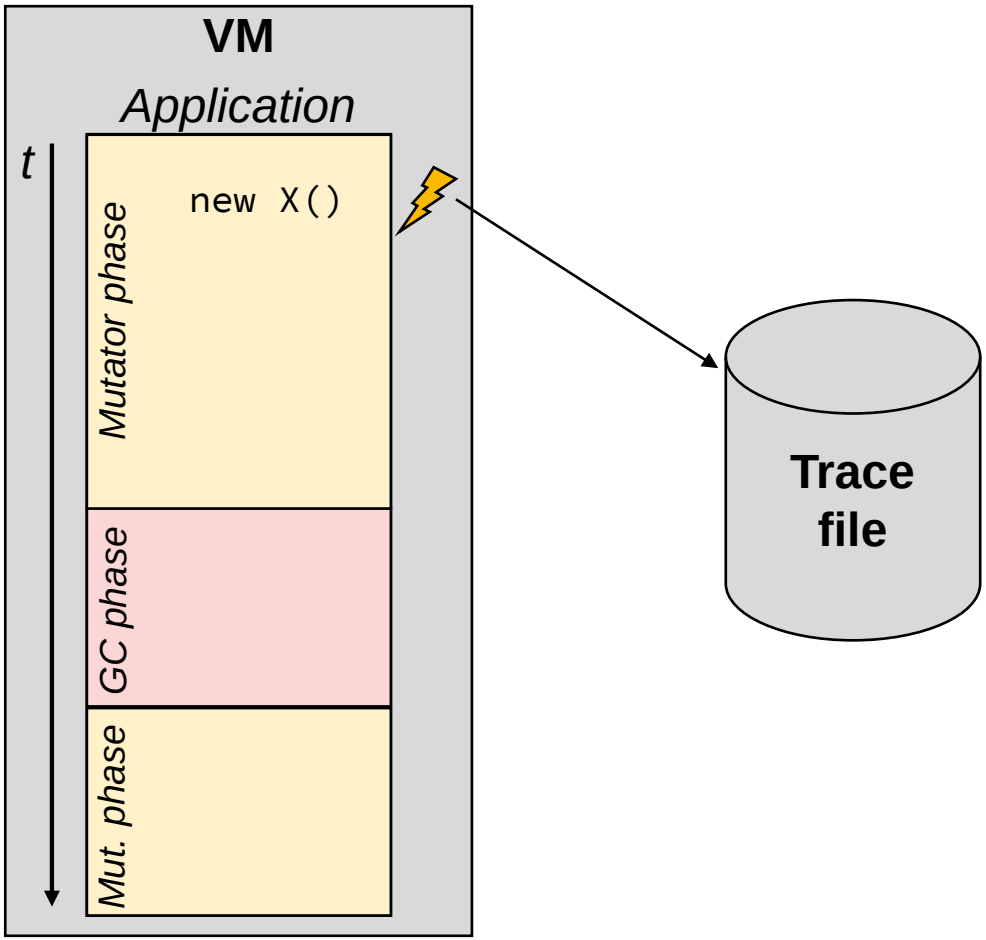

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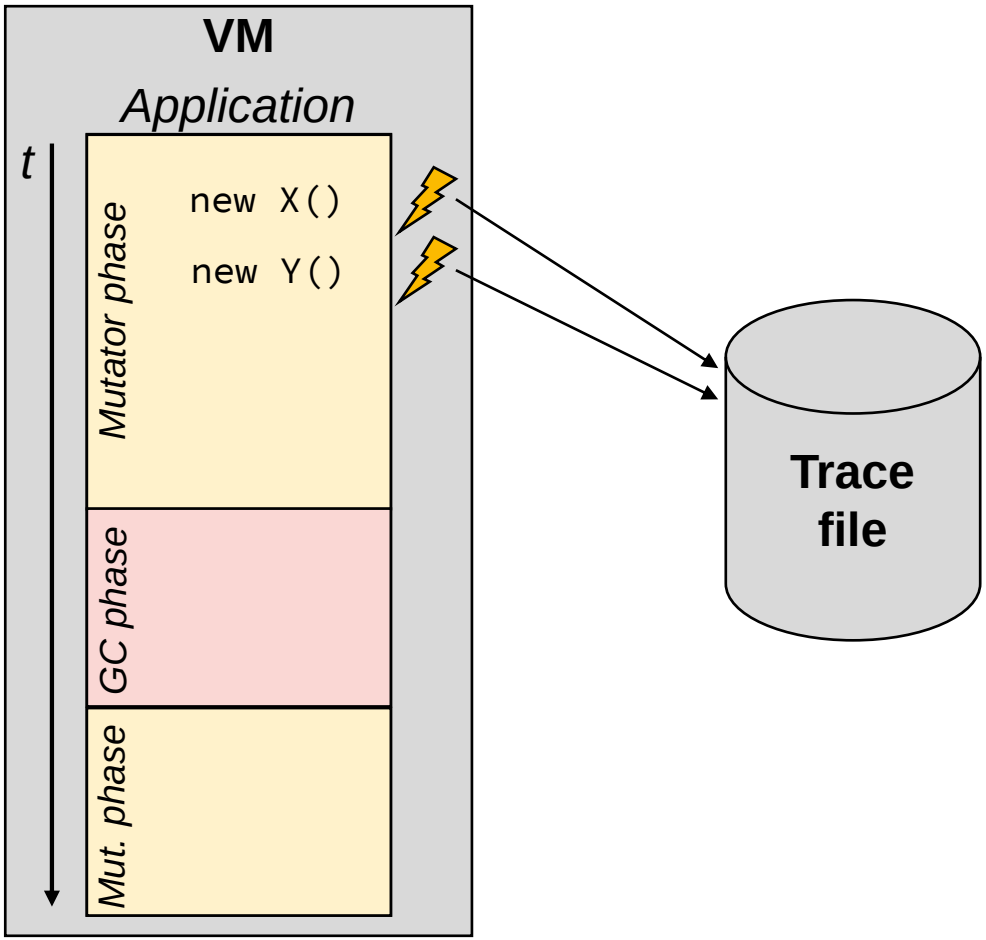

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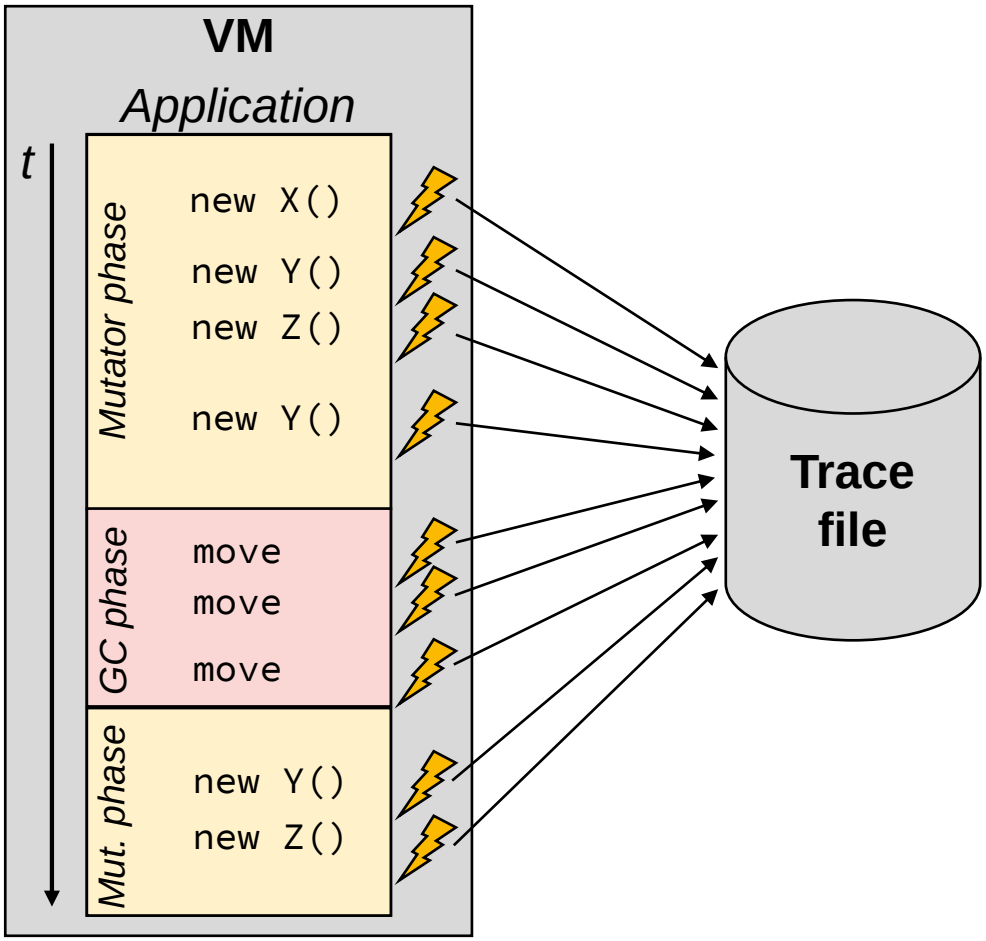

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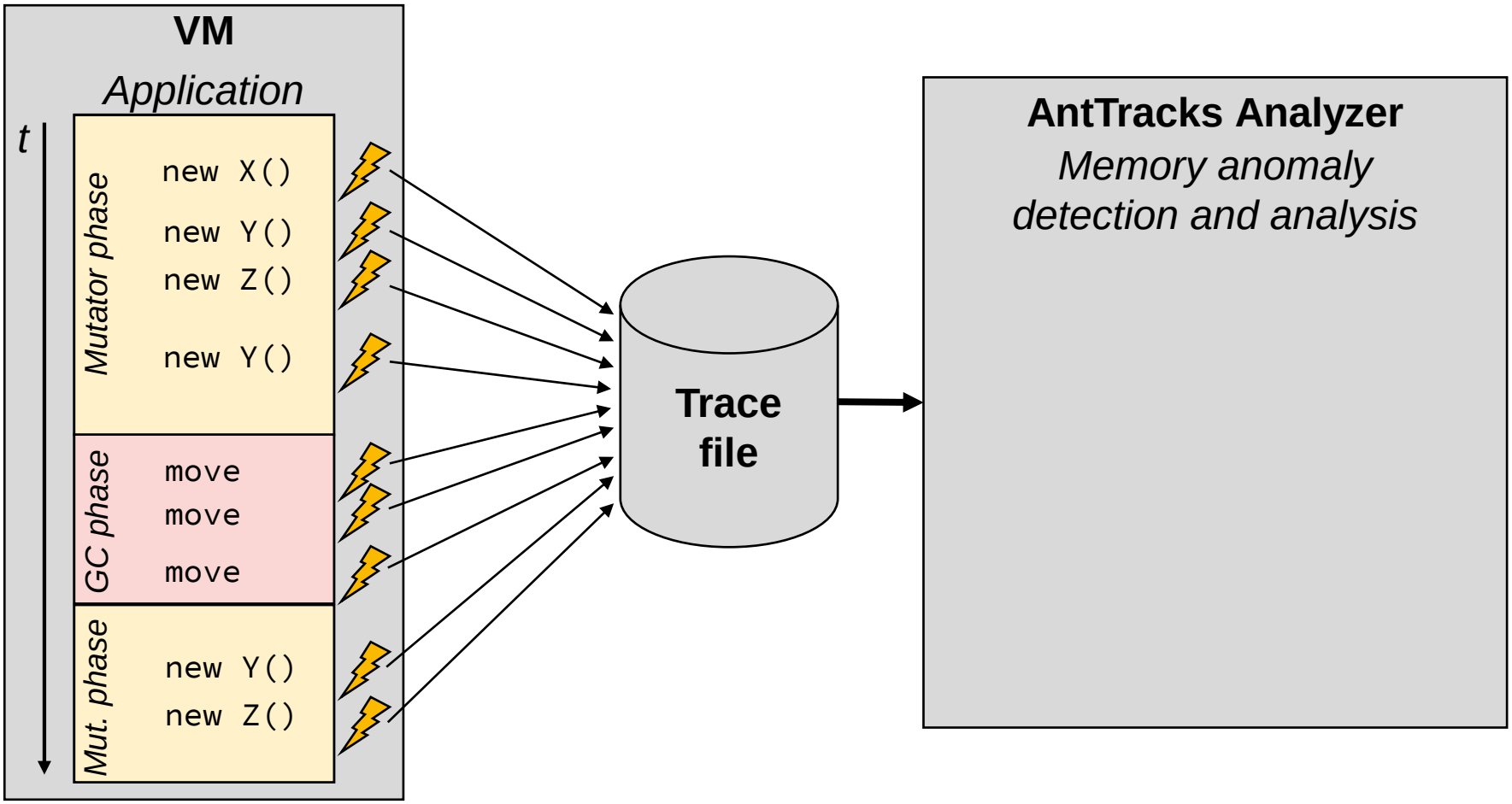

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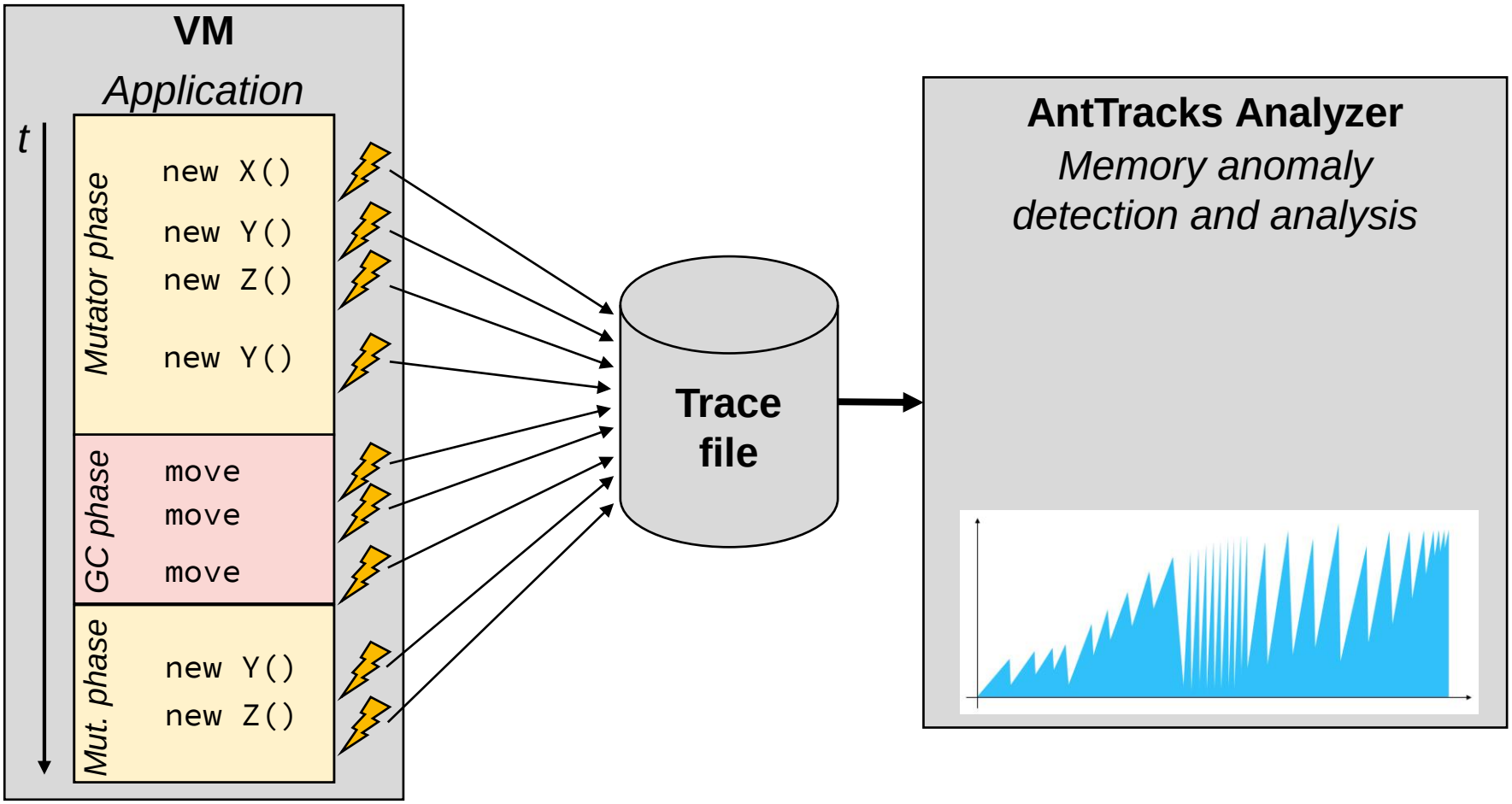

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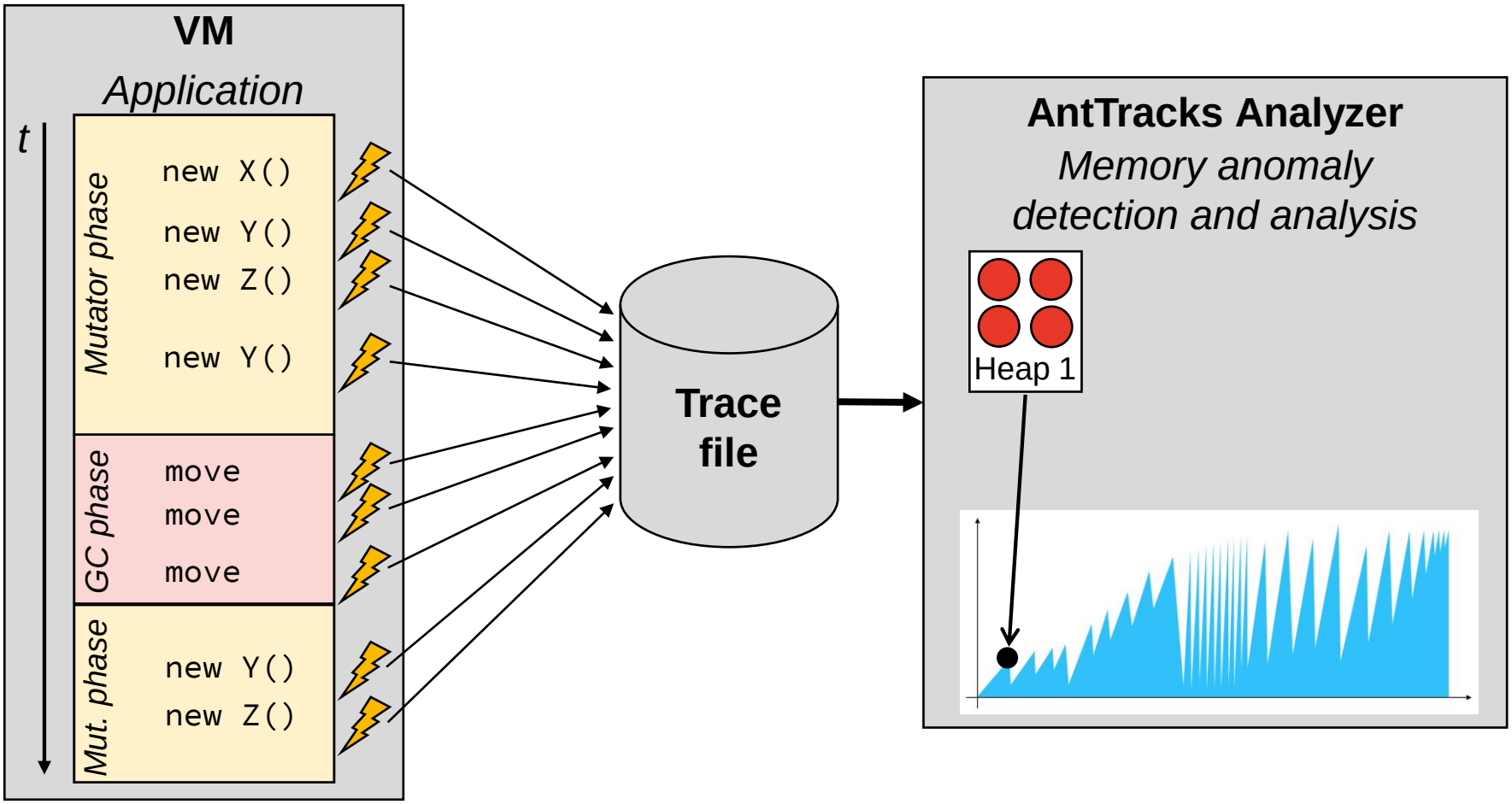

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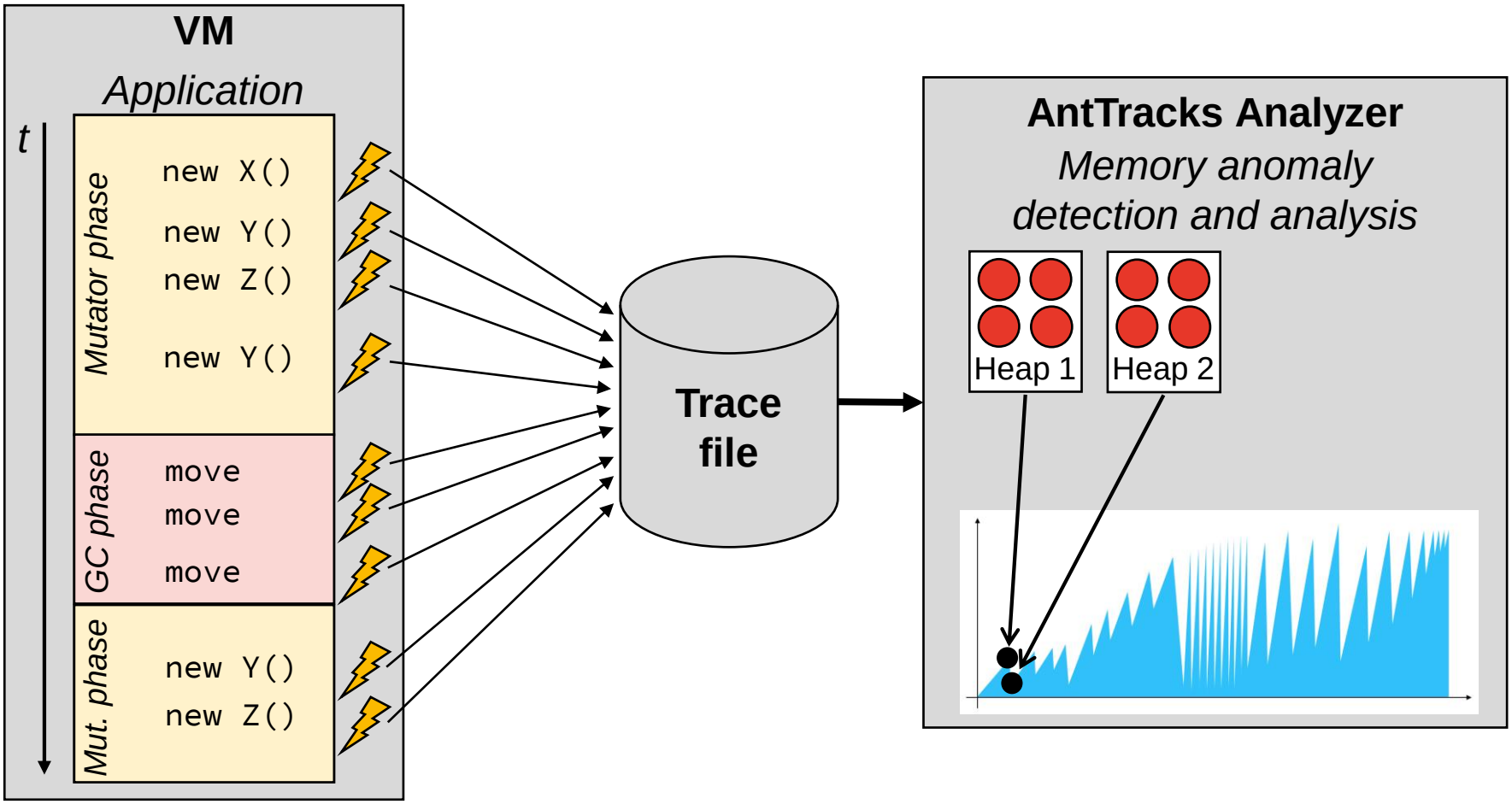

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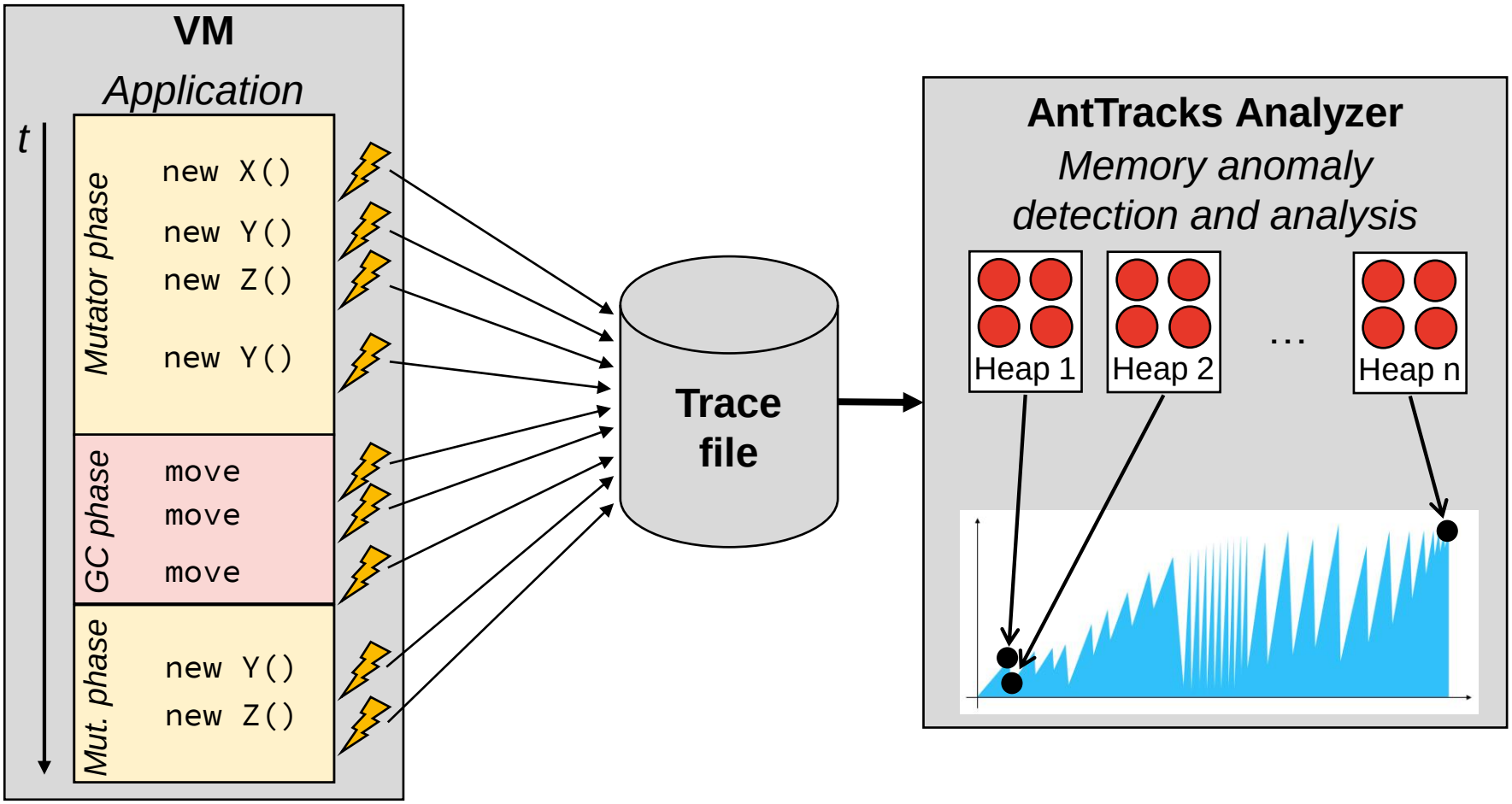

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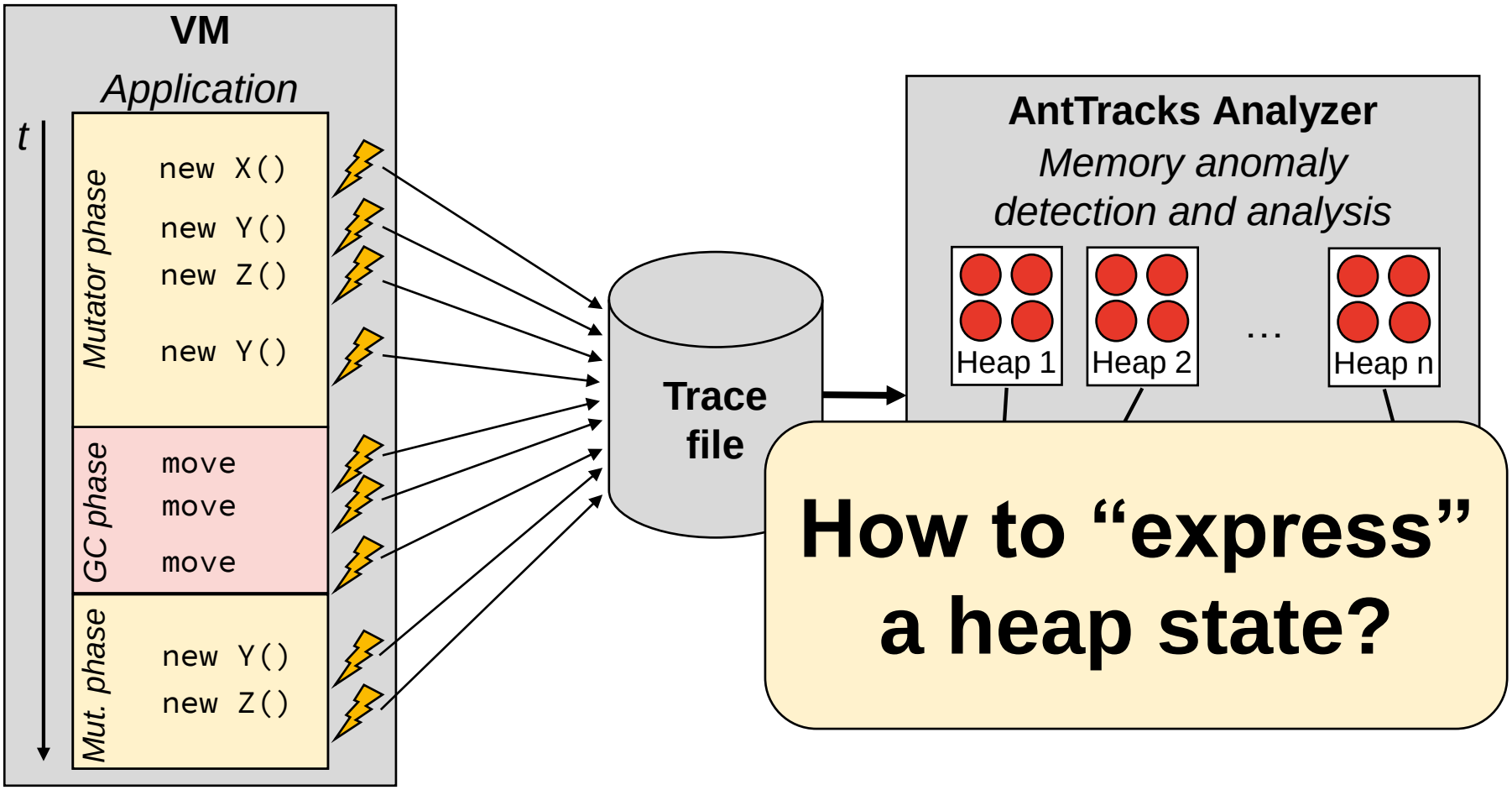

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OBJECT CLASSIFICATION

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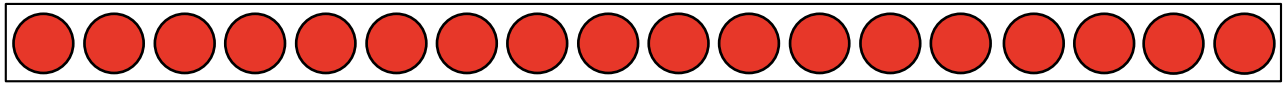

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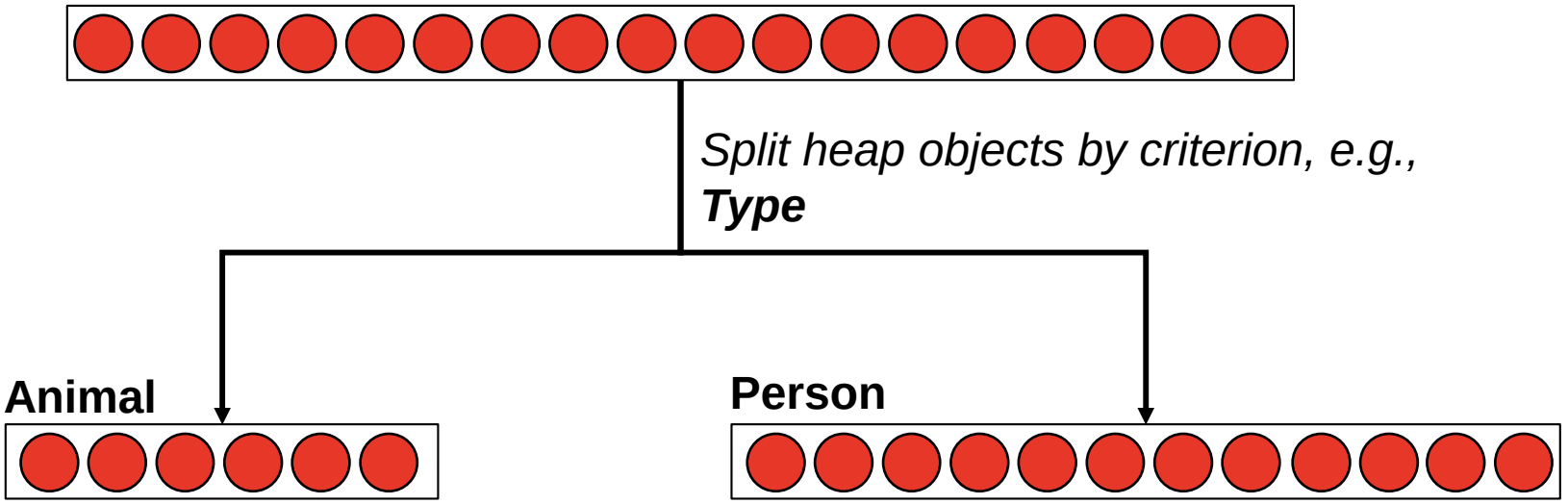

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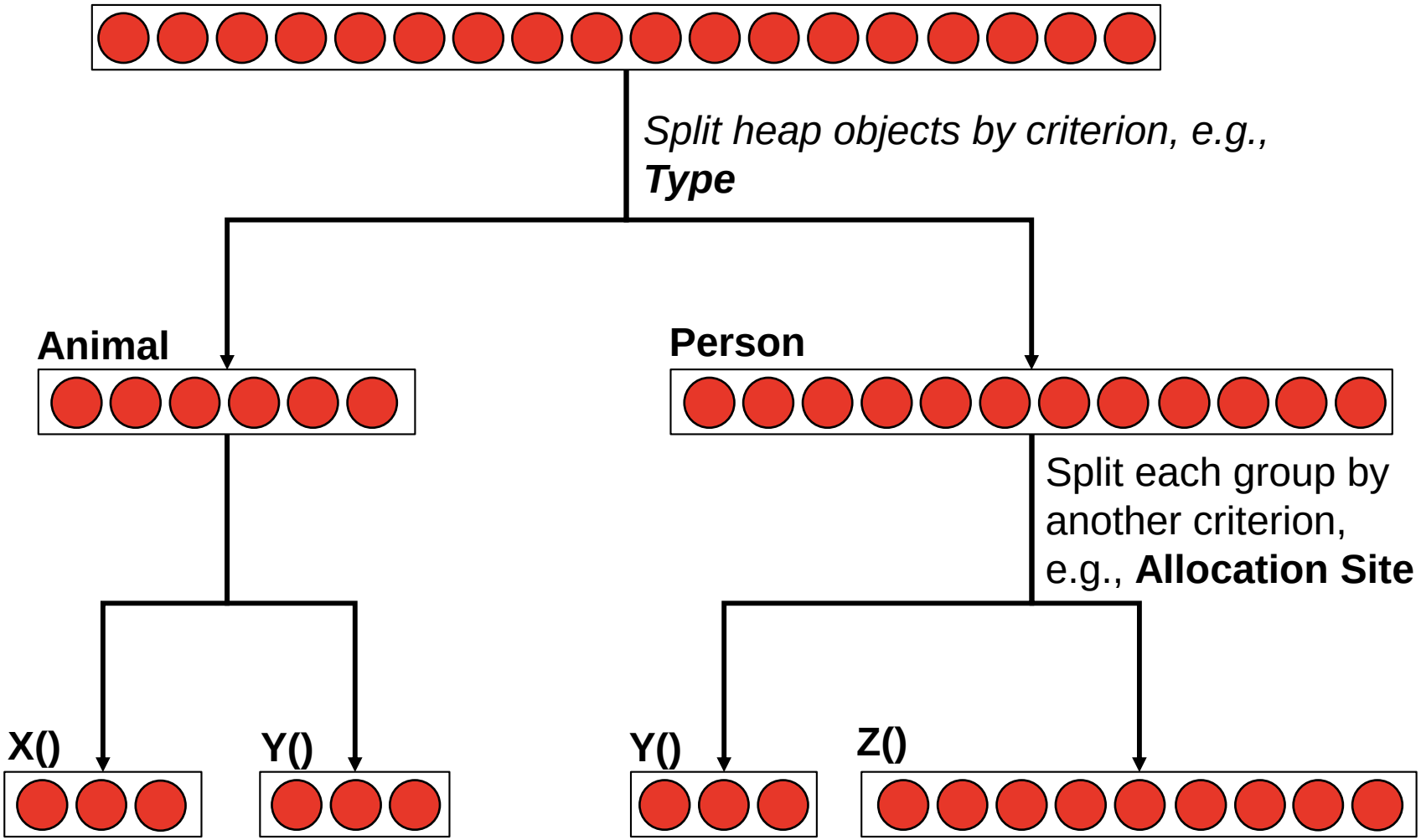

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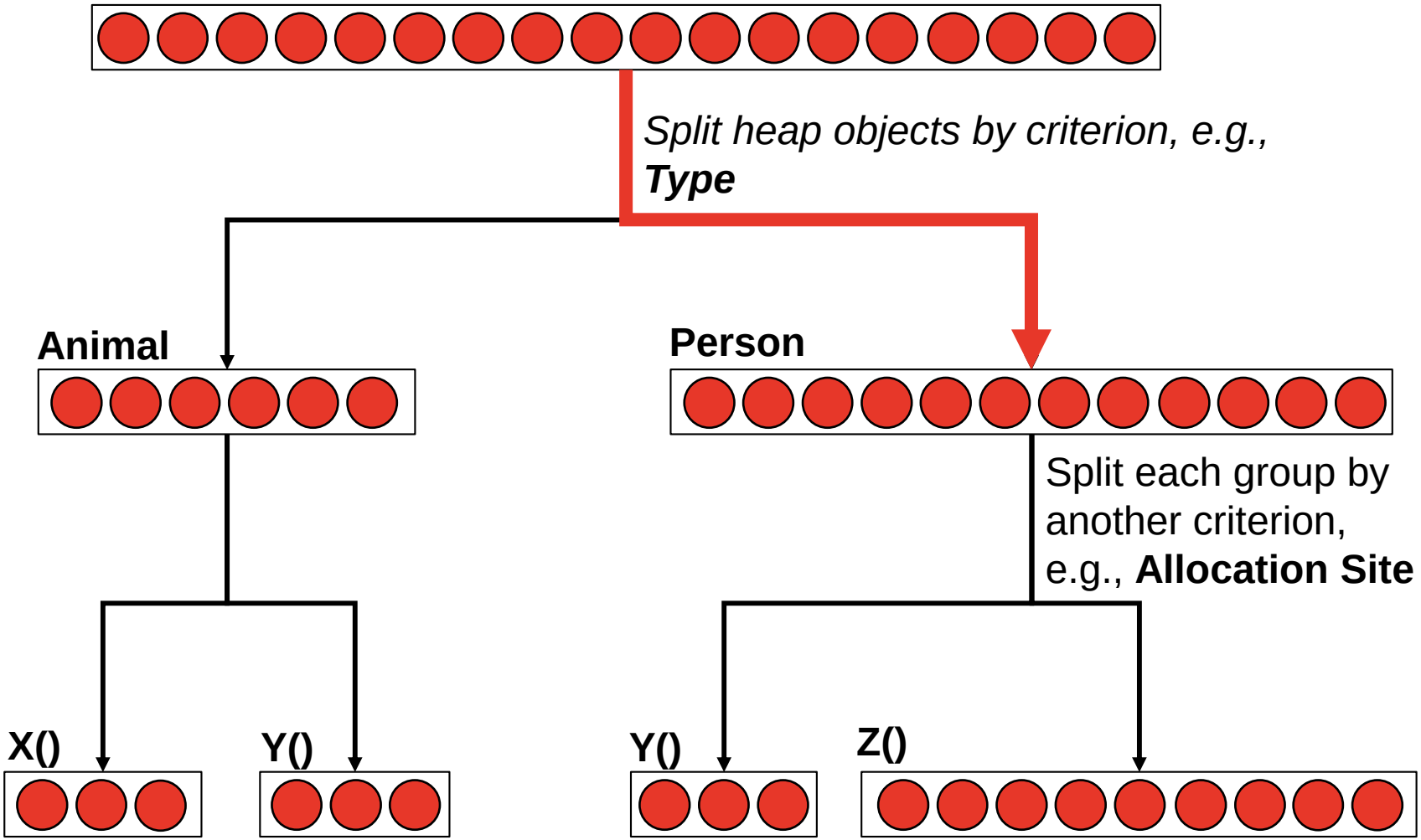

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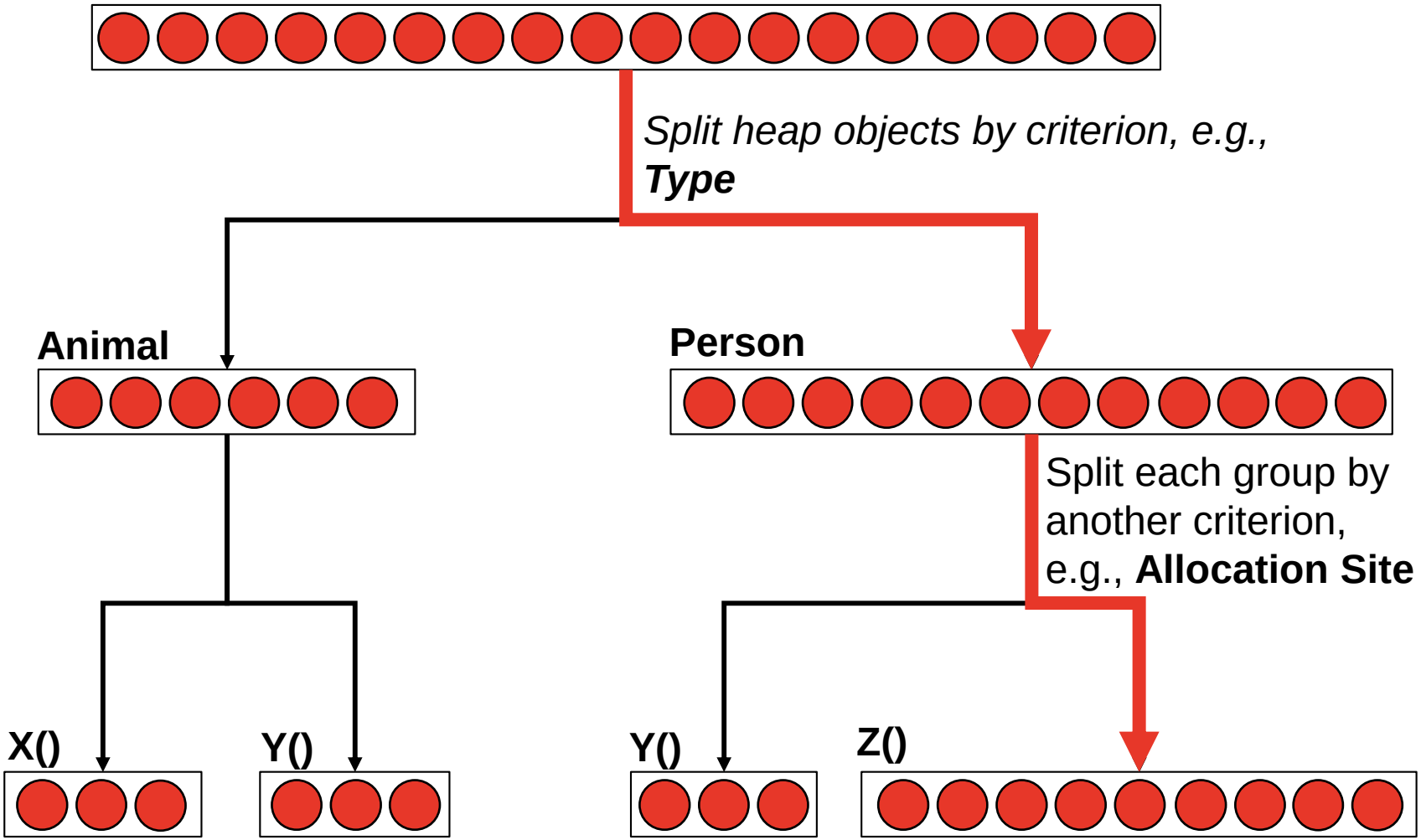

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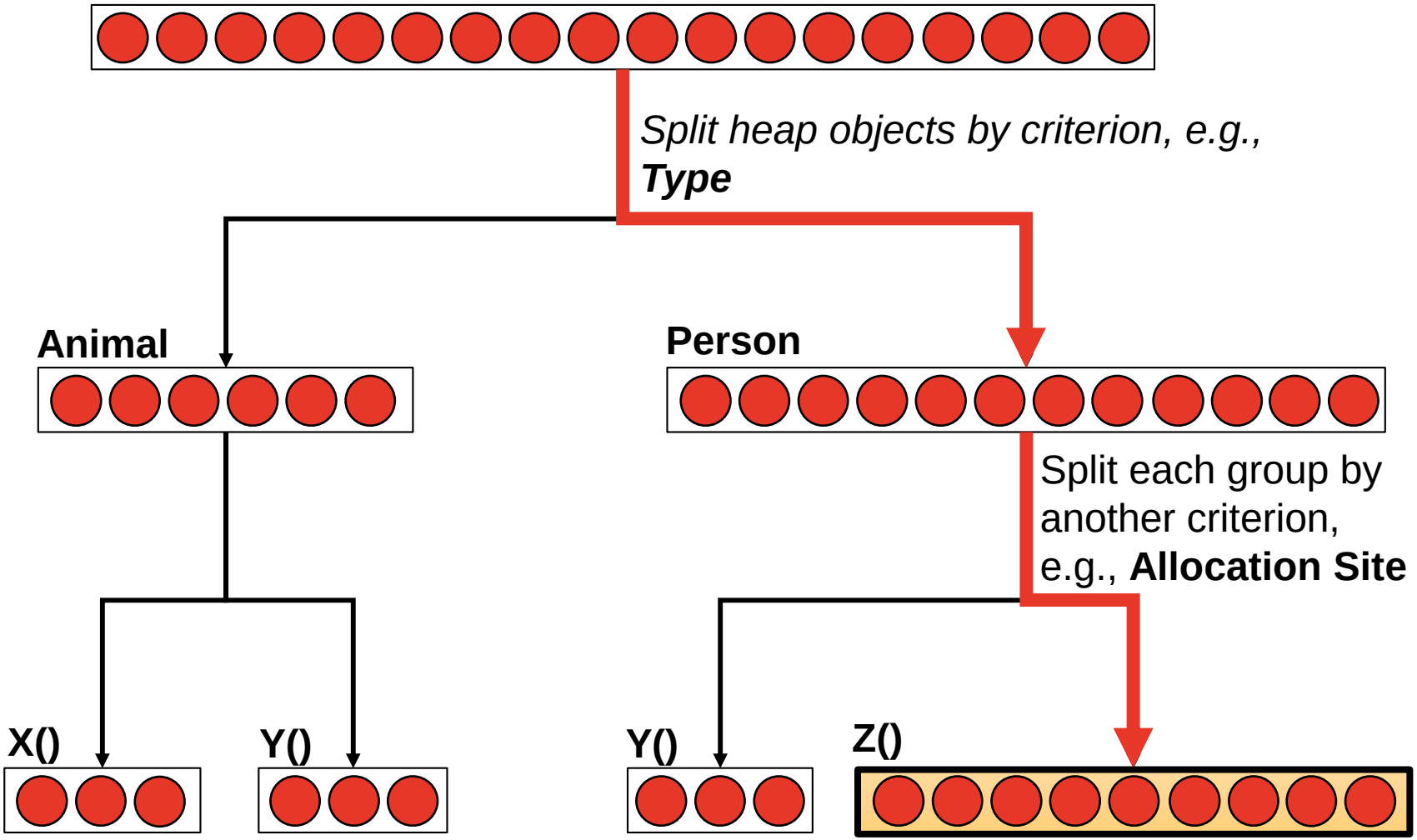

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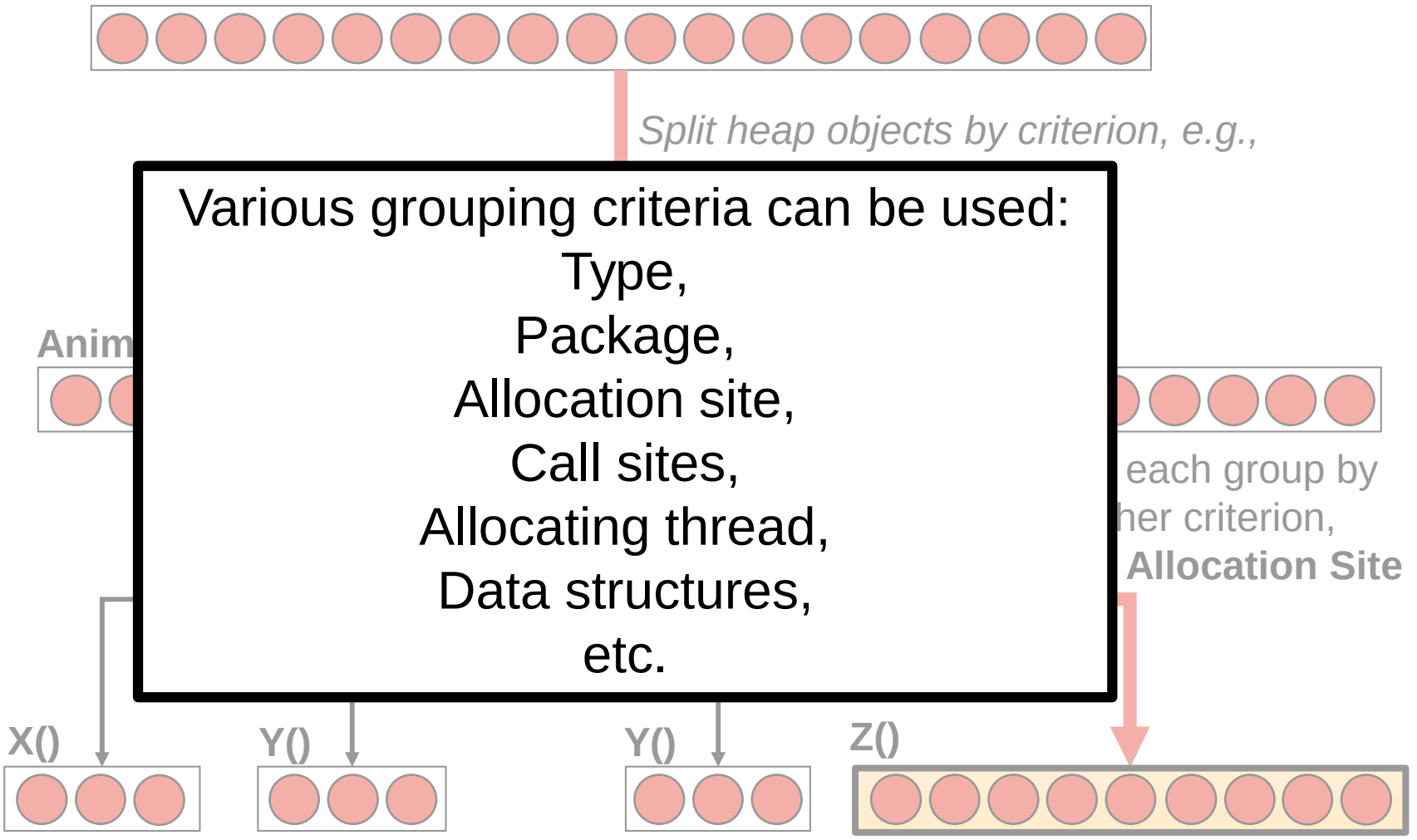
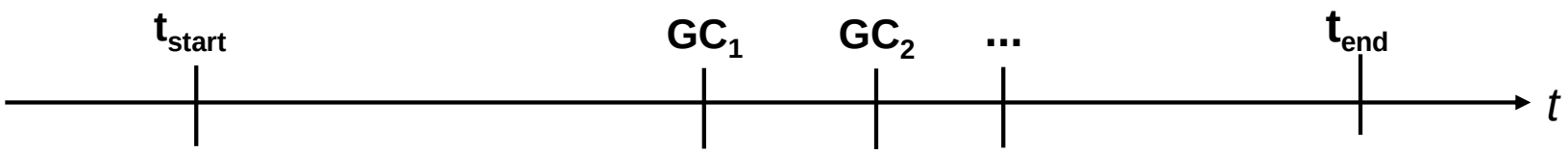


MEMORY EVOLUTION



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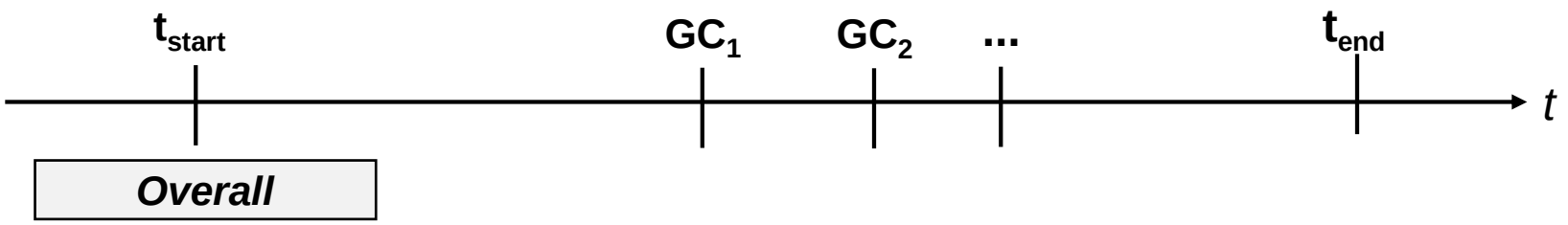

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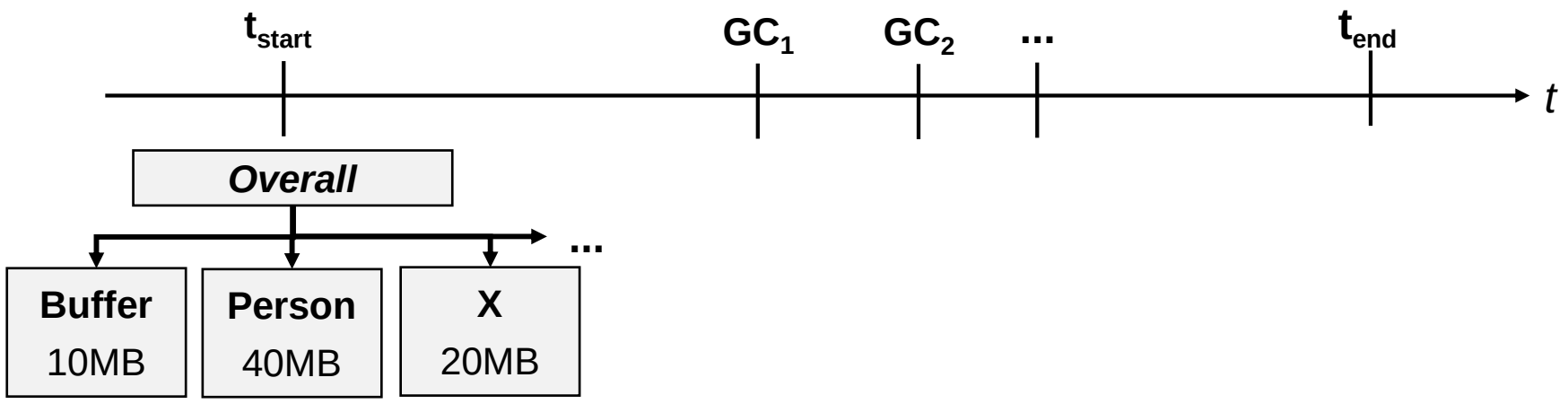

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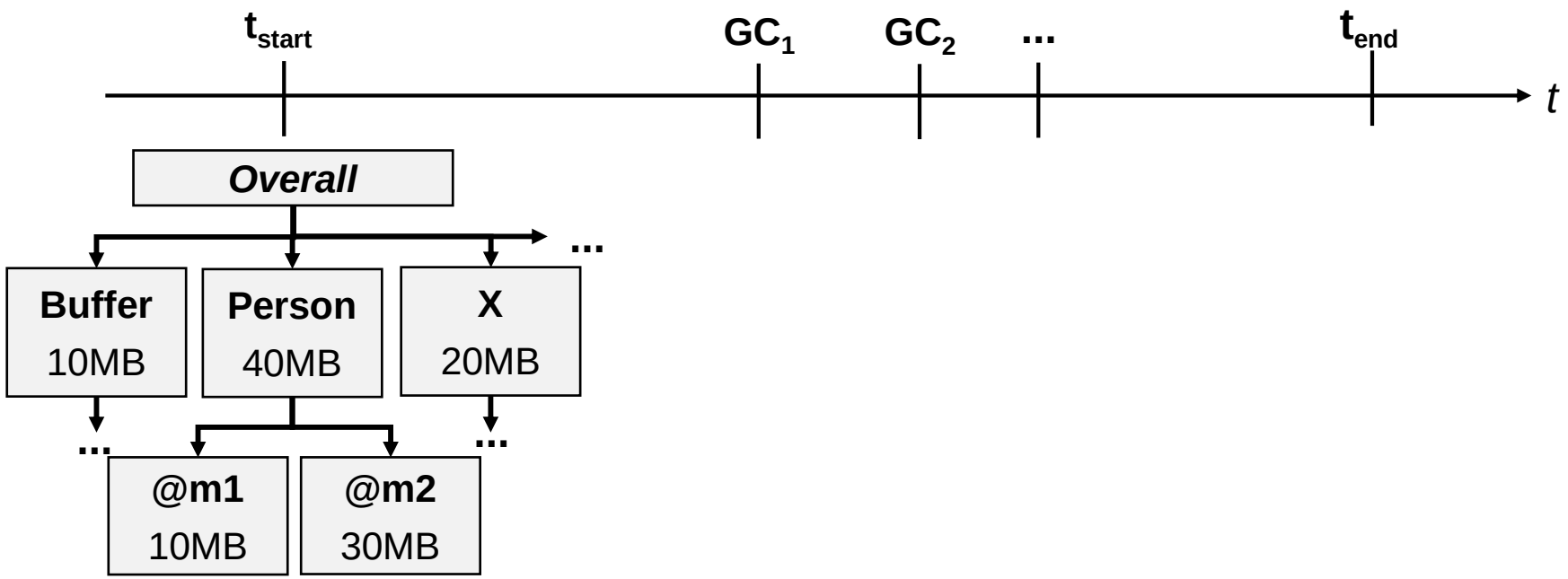

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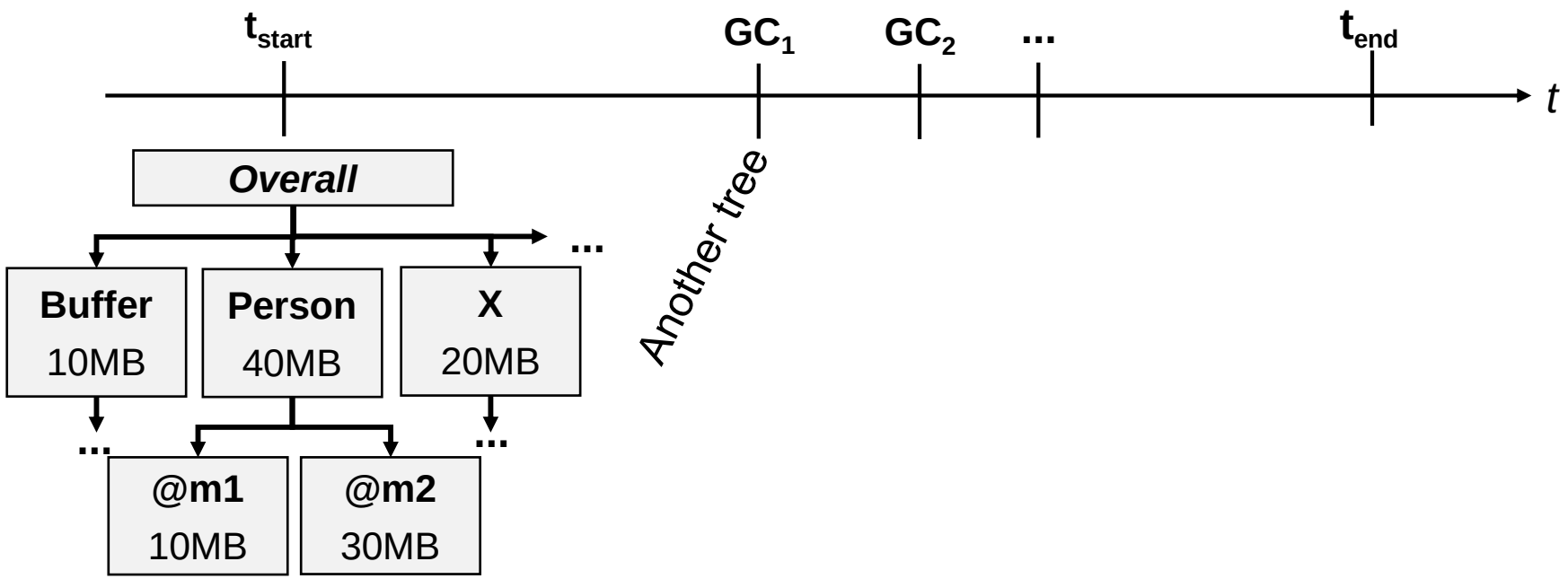

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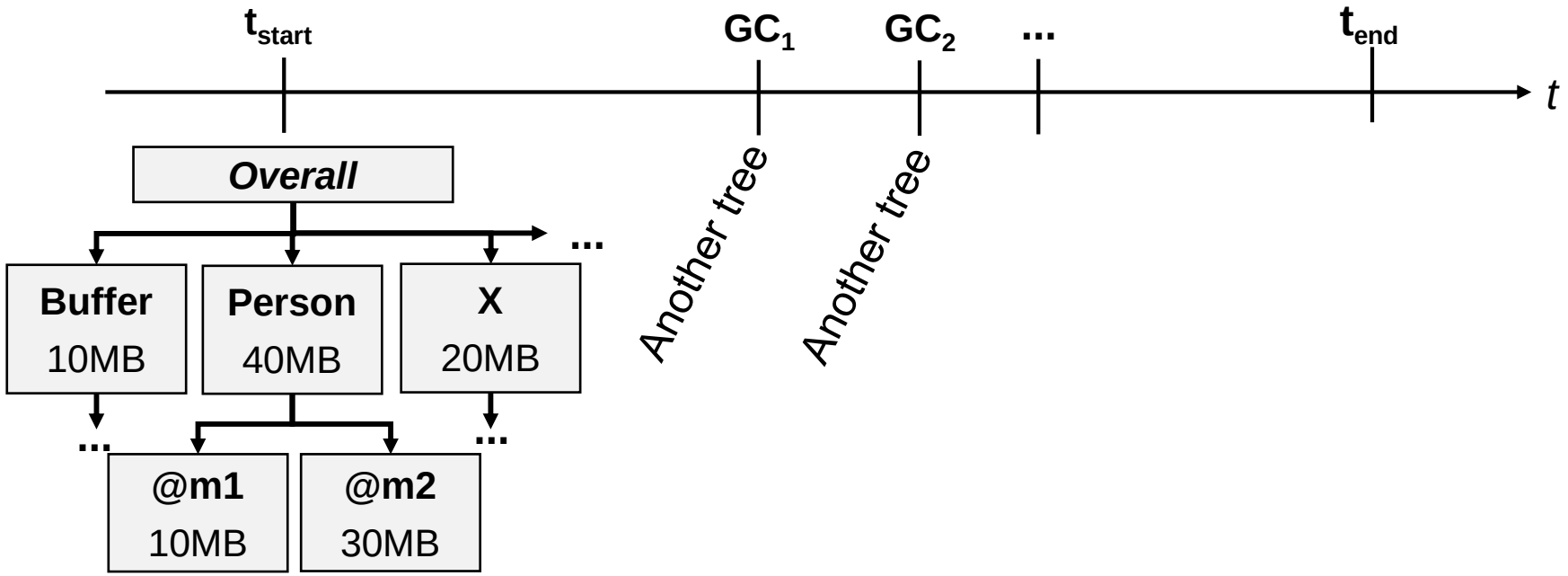

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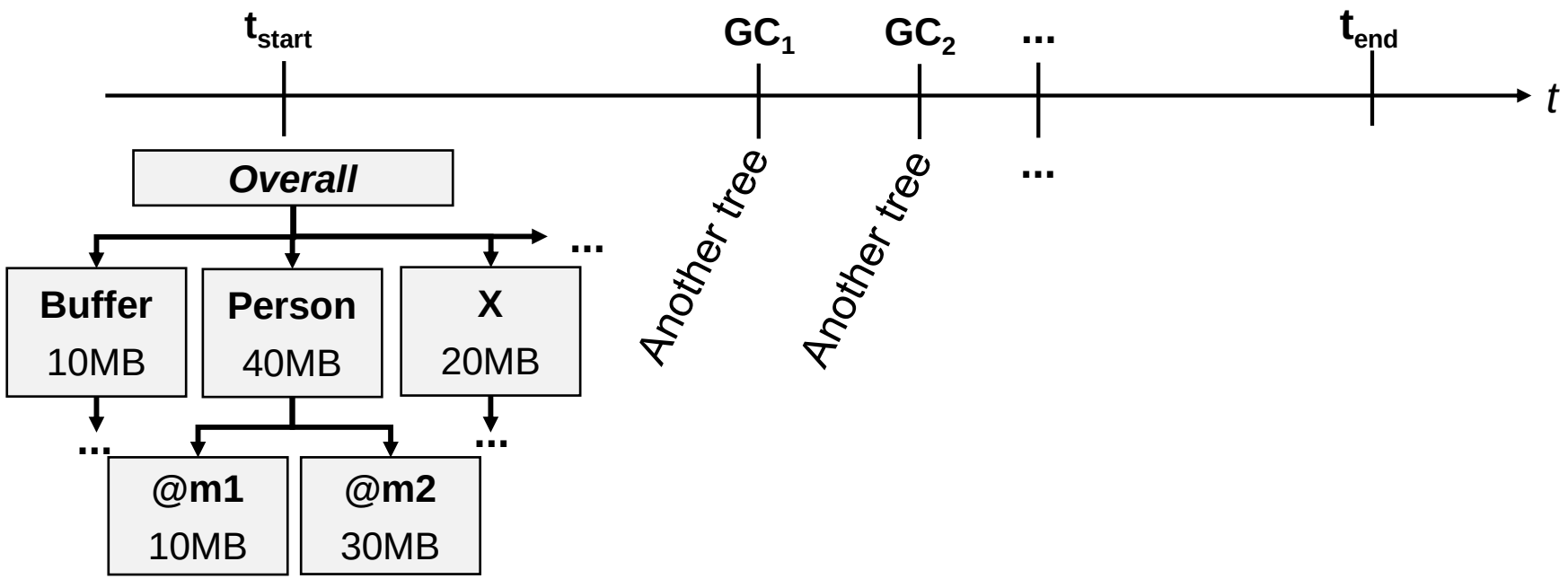

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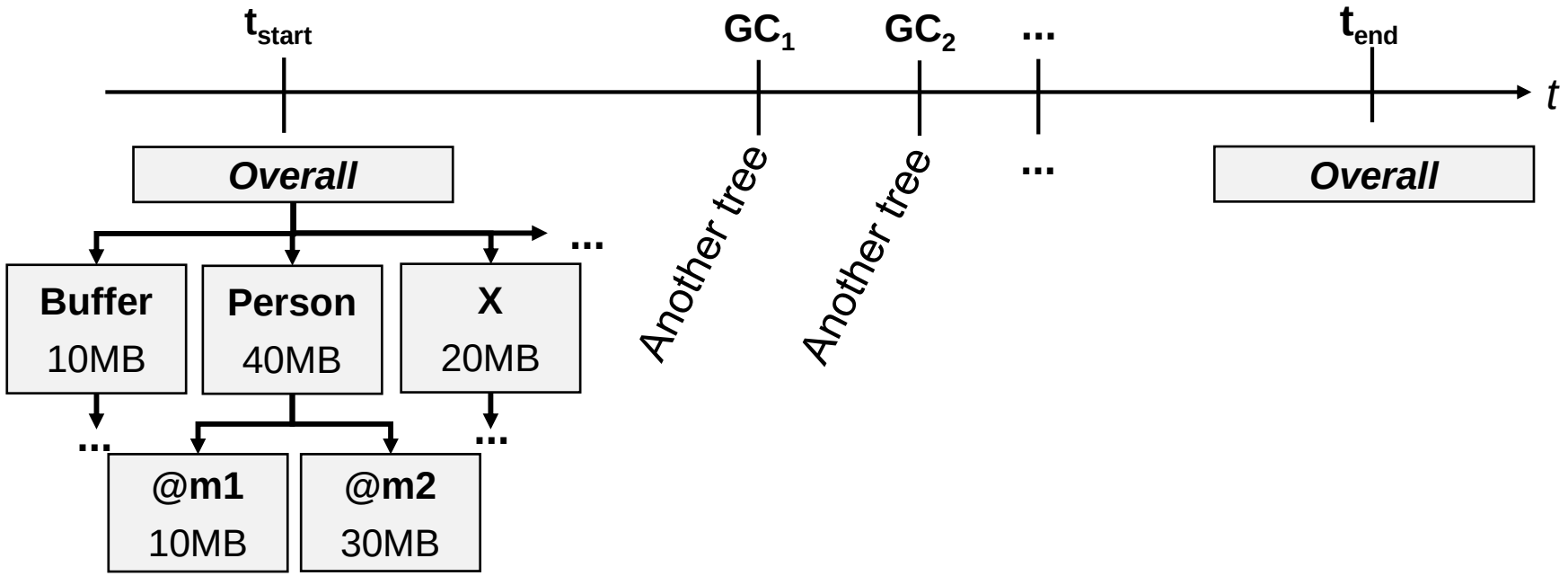

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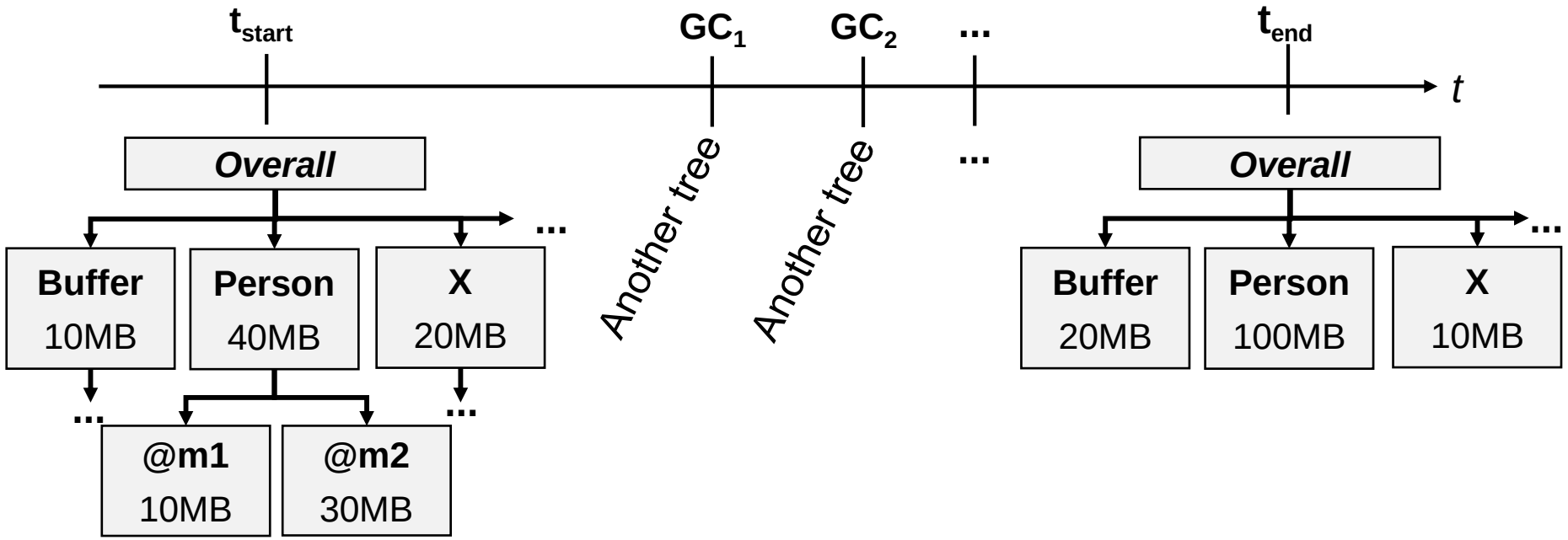

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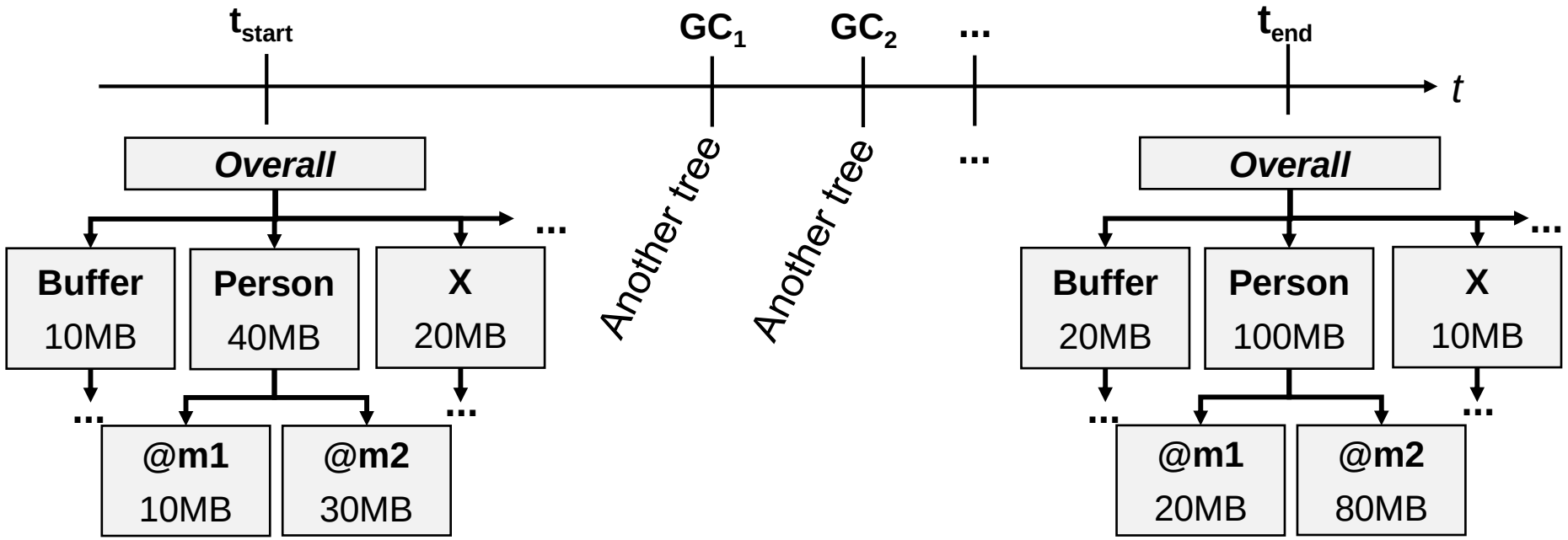

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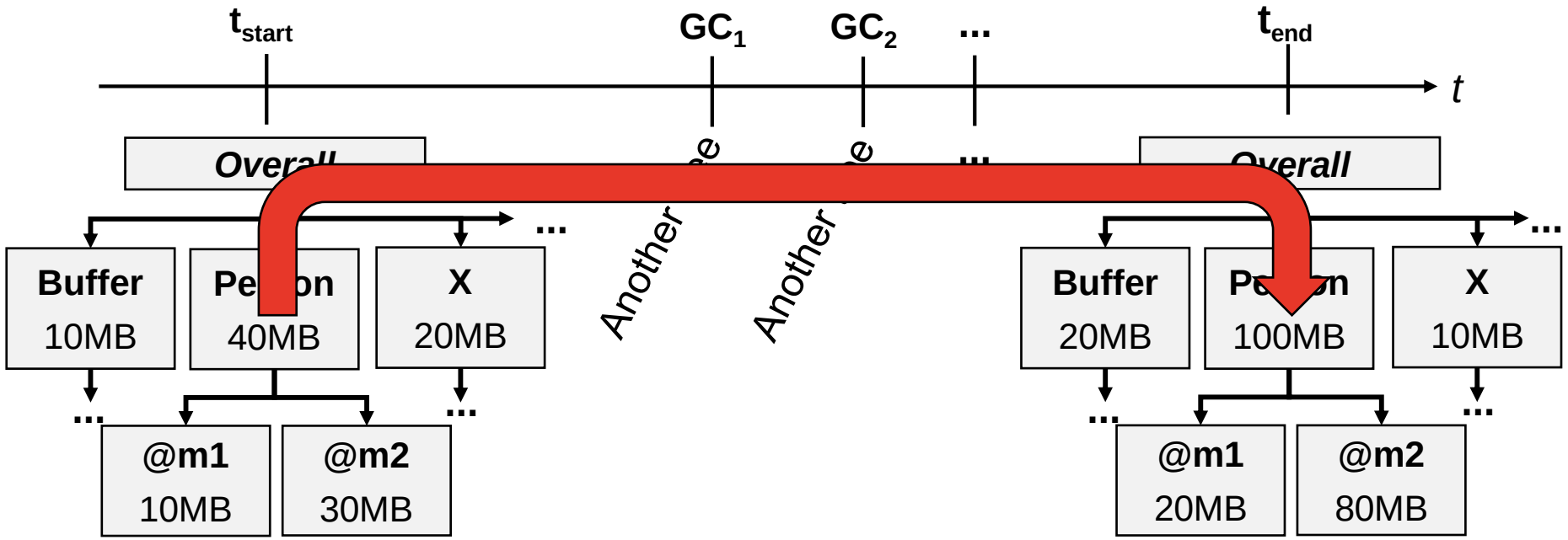

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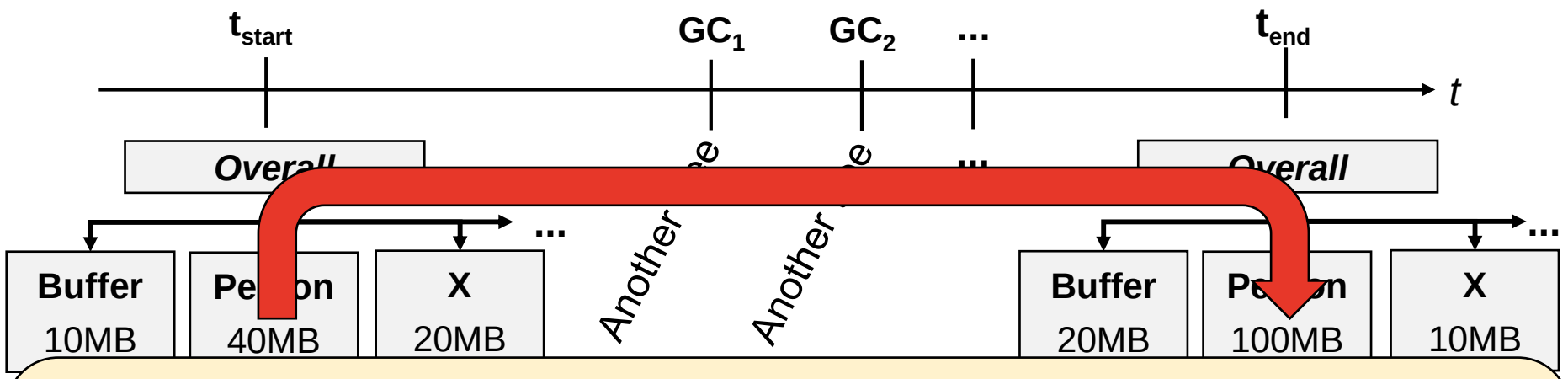

Question: How to visualize memory trees and their evolution?

REQUIREMENTS

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“Bigger is more” principle

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Suitable for interactive visualization

REQUIREMENTS

“Bigger is more” principle

Suitable for interactive visualization

Proven and easy to understand

REQUIREMENTS

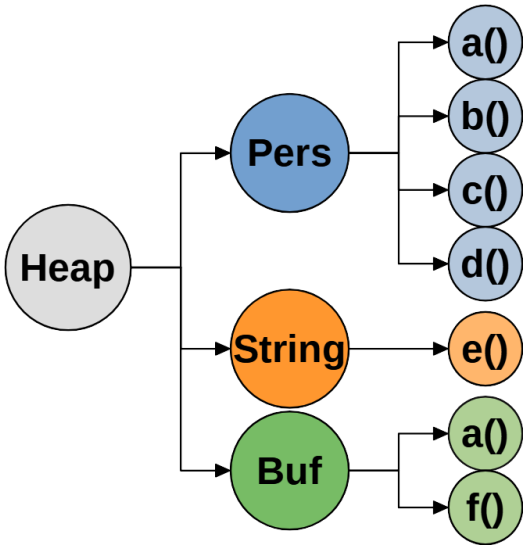
“Bigger is more” principle

Suitable for interactive visualization

Proven and easy to understand

Stable layout on evolving data

VISUALIZATIONS COMPARED



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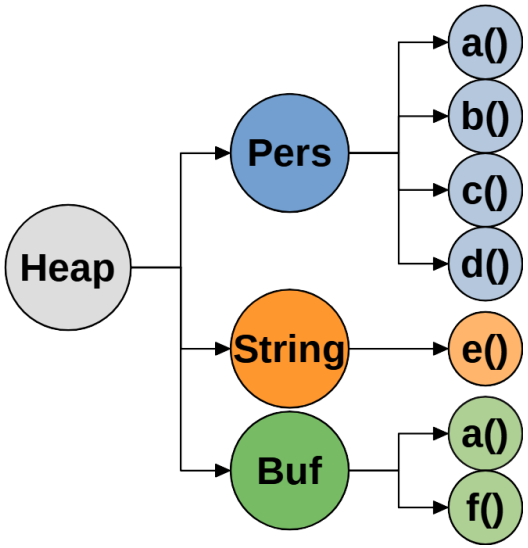
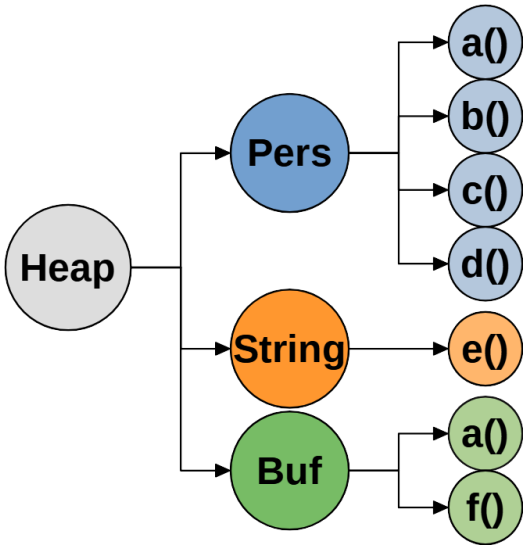


Node-Link Diag.

VISUALIZATIONS COMPARED



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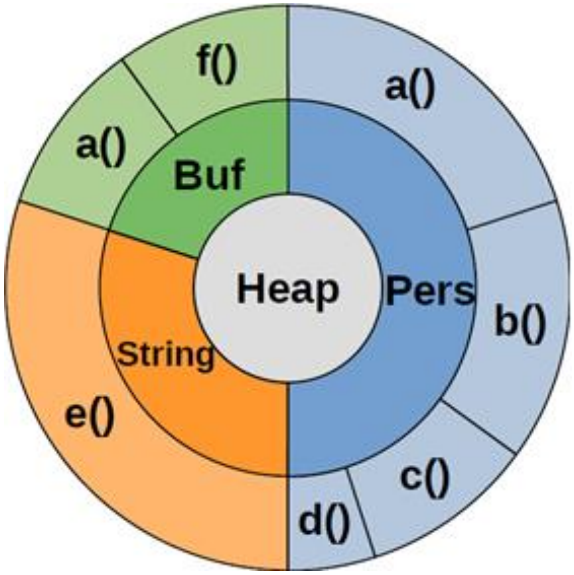

Sunburst

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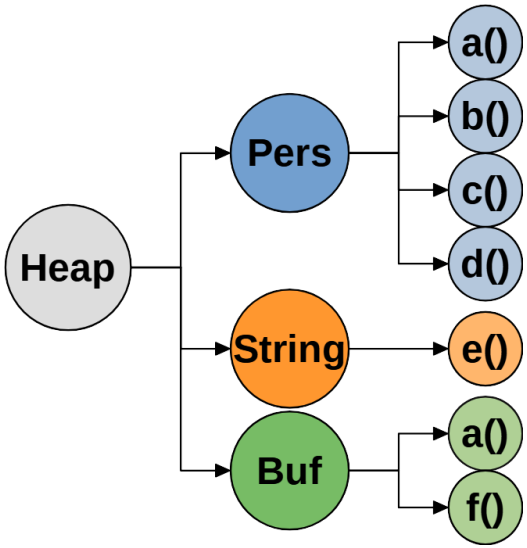

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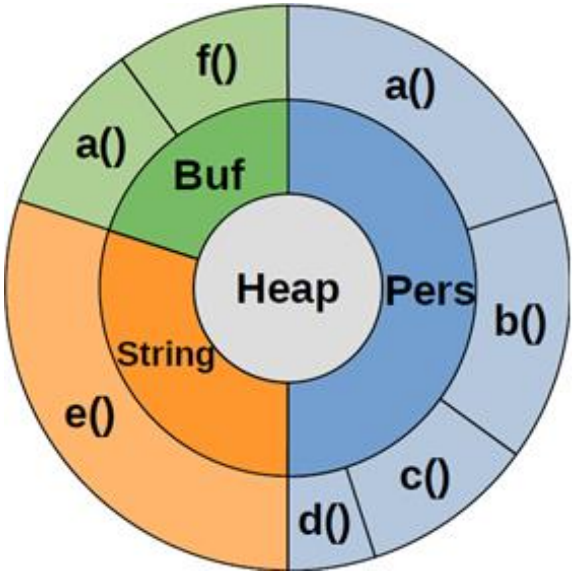

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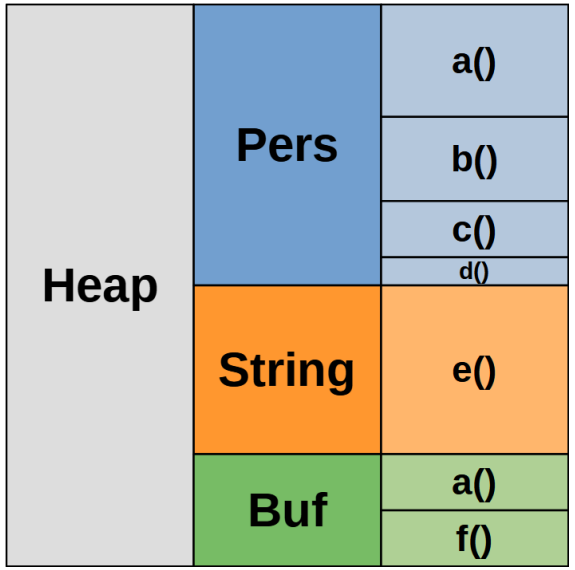

Icicle

HEAP STATE VISUALIZATION

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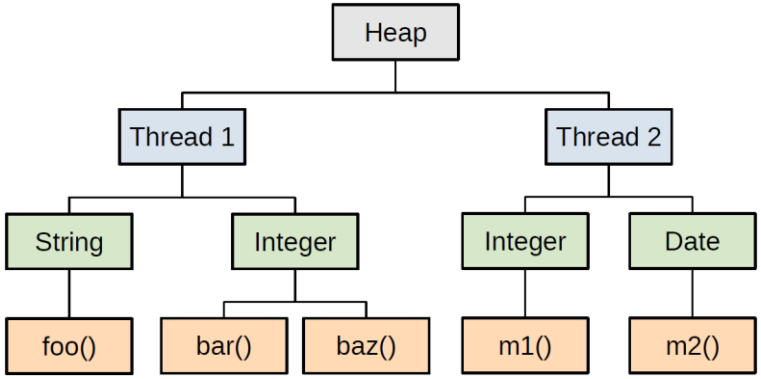

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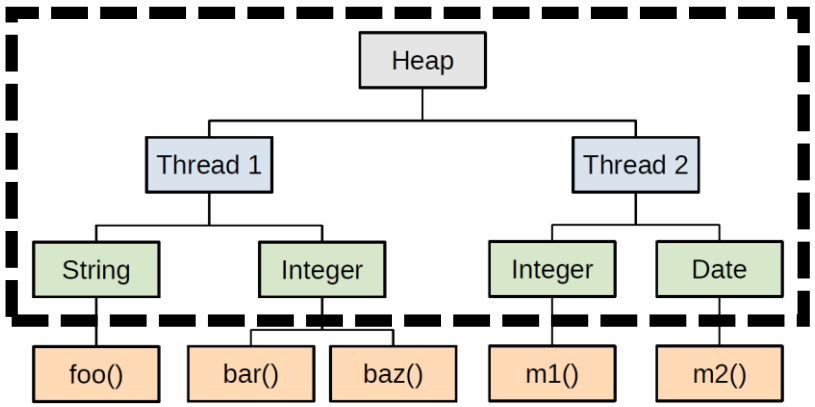

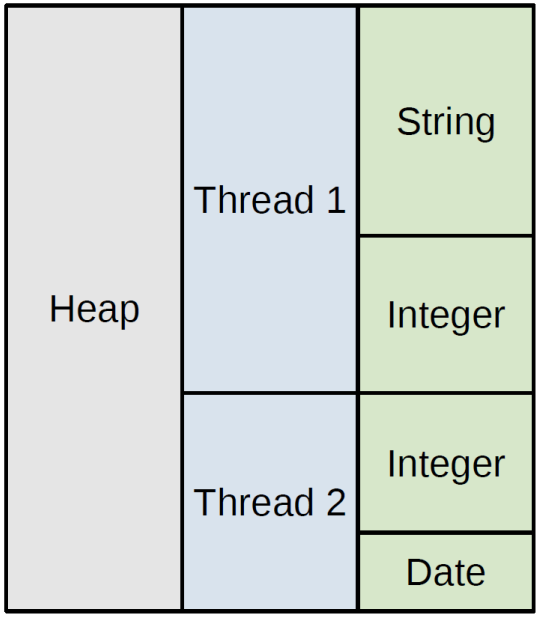

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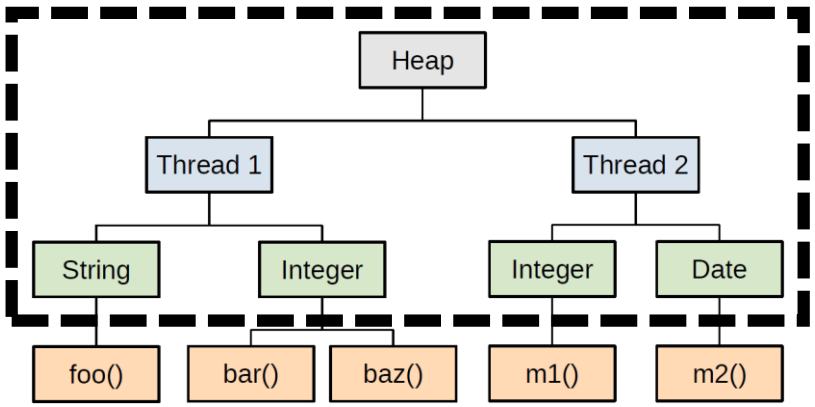
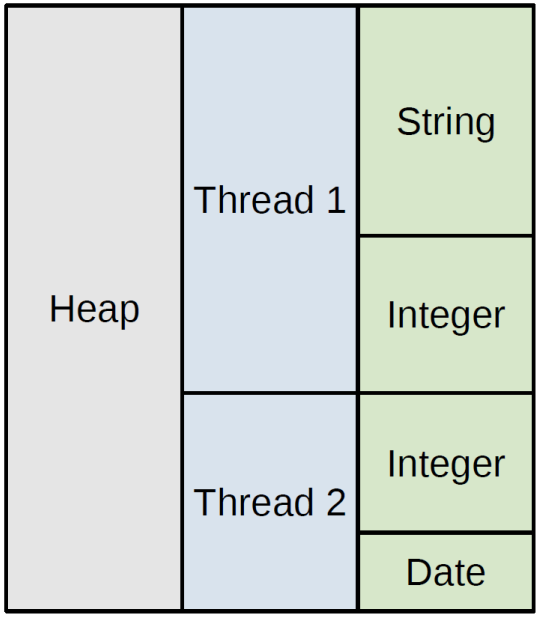
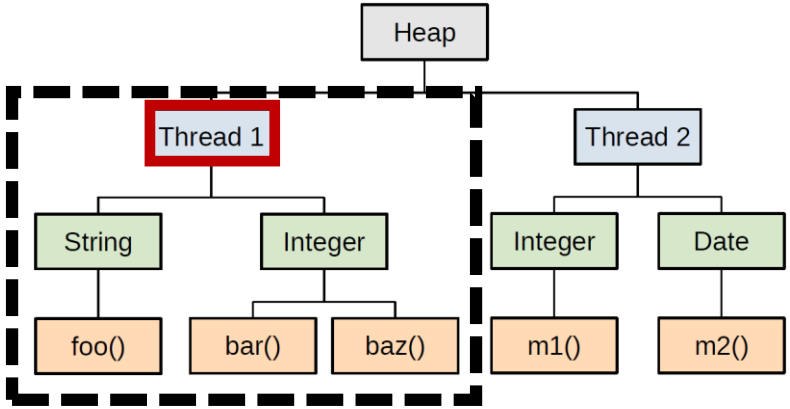


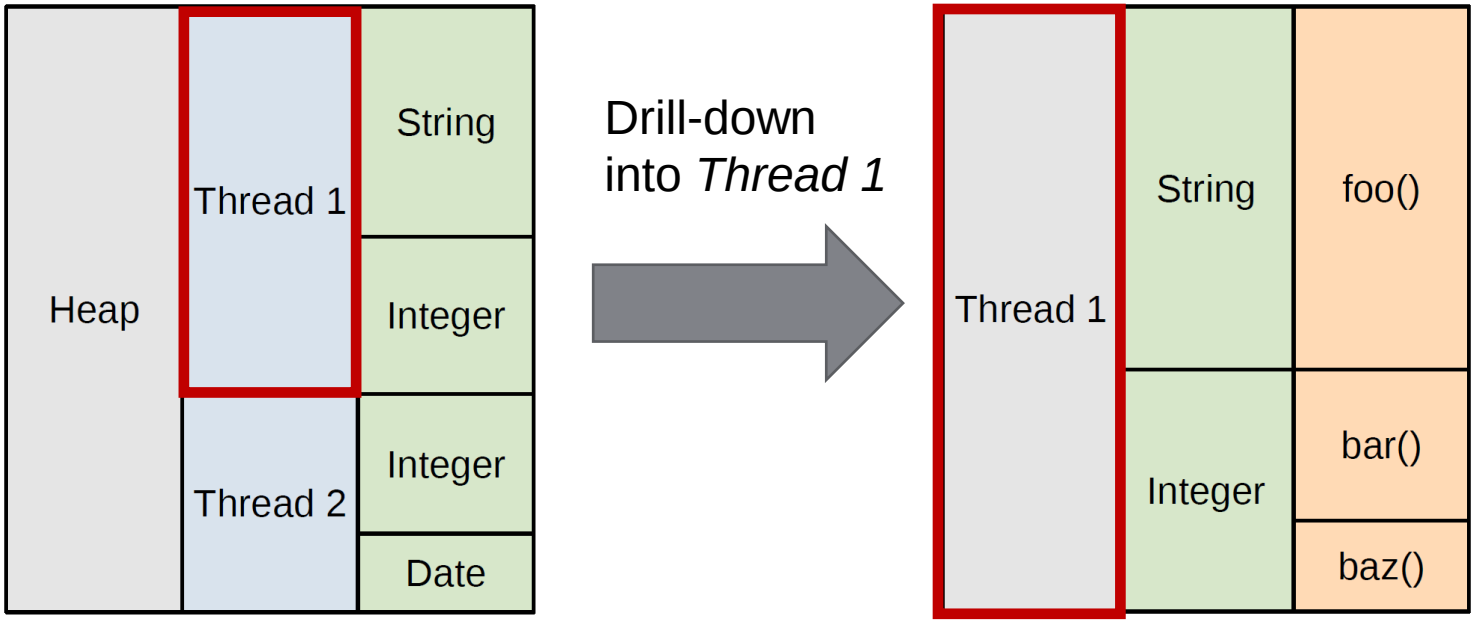
Drill-down



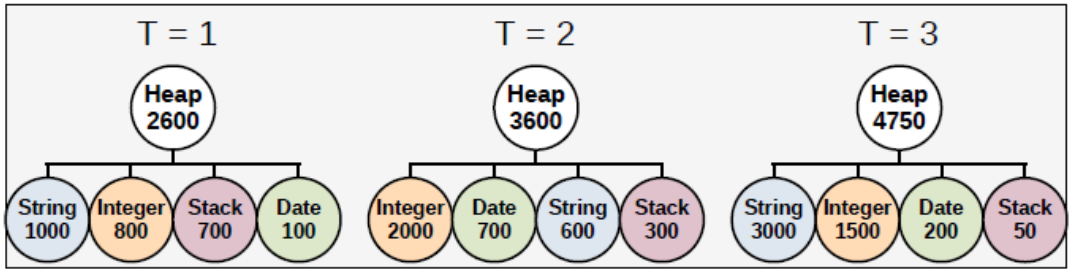
HEAP STATE VISUALIZATION



Drill-down

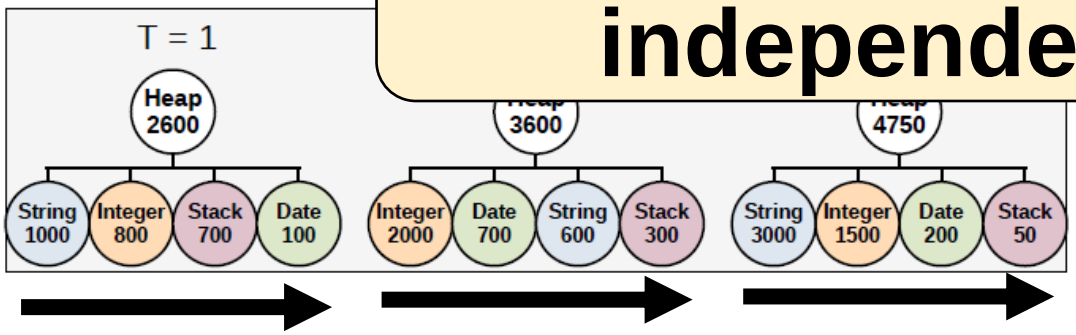


HEAP EVOLUTION VISUALIZATION

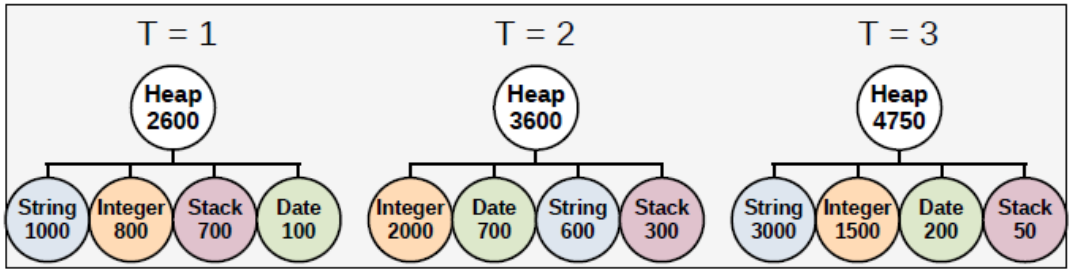


HEAP EVOLUTION VISUALIZATION

Each tree sorted independently



HEAP EVOLUTION VISUALIZATION



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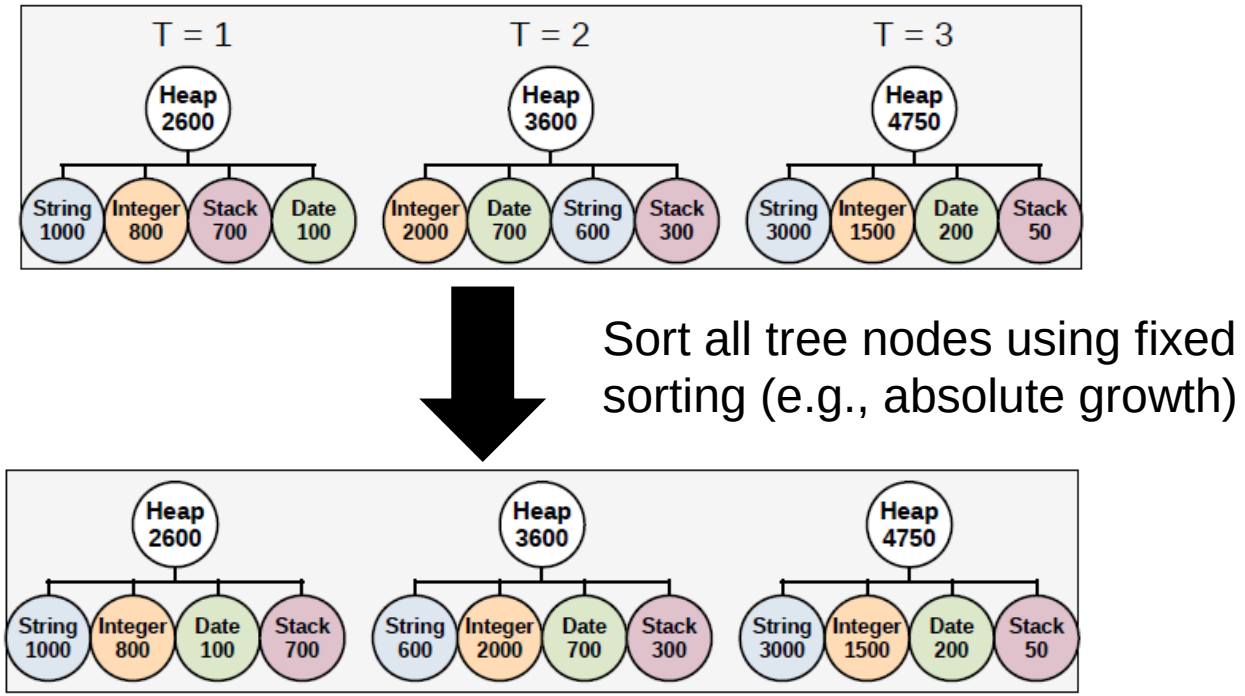
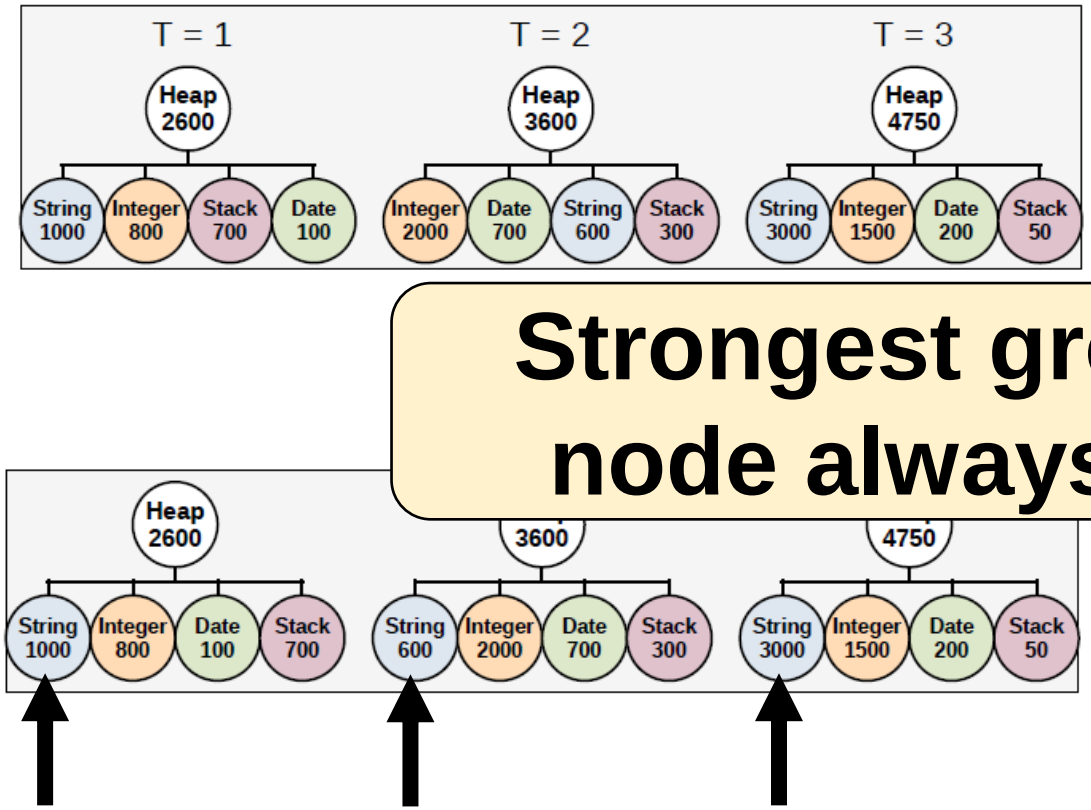


HEAP EVOLUTION VISUALIZATION



RELATIVE POSITION ANIMATION

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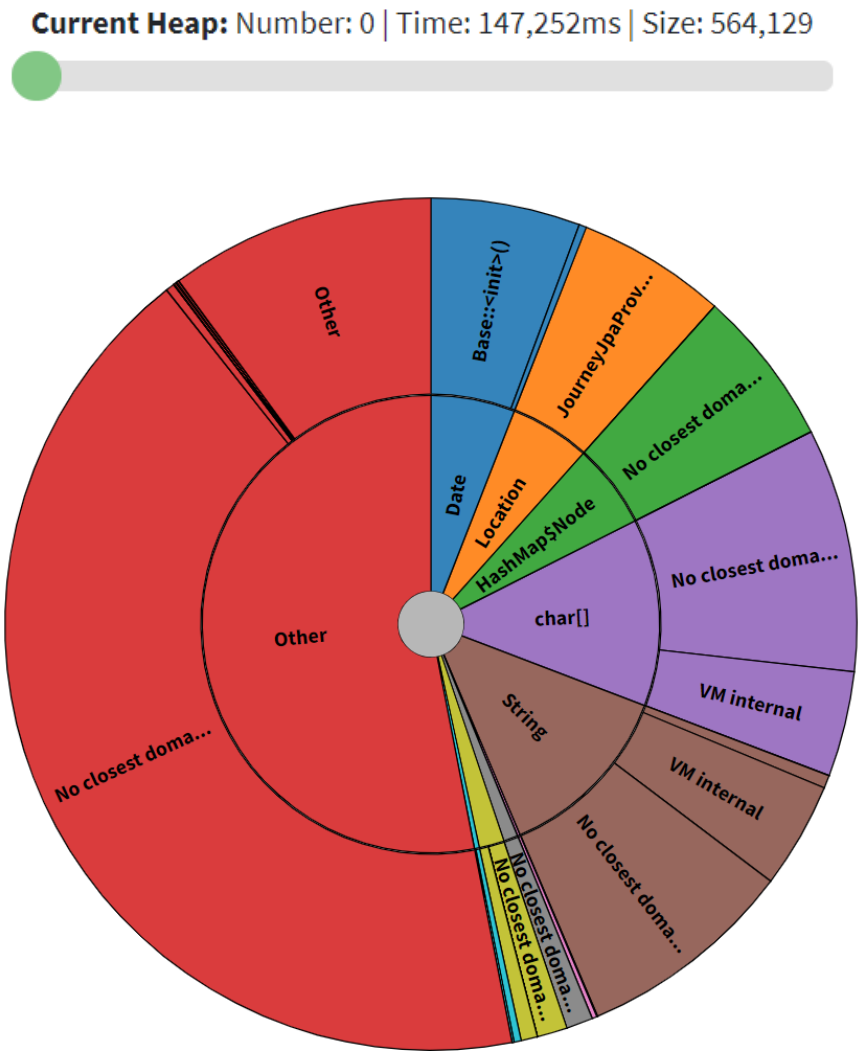
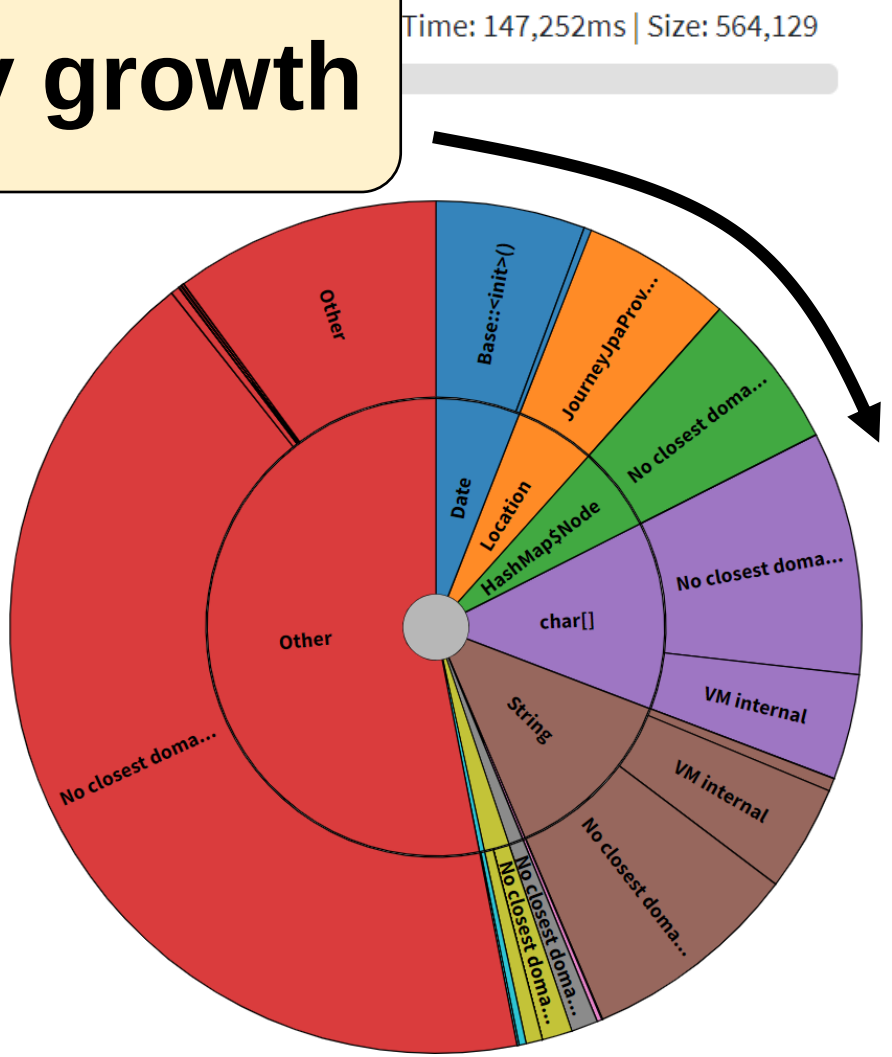


RELATIVE POSITION ANIMATION

Sorted by growth



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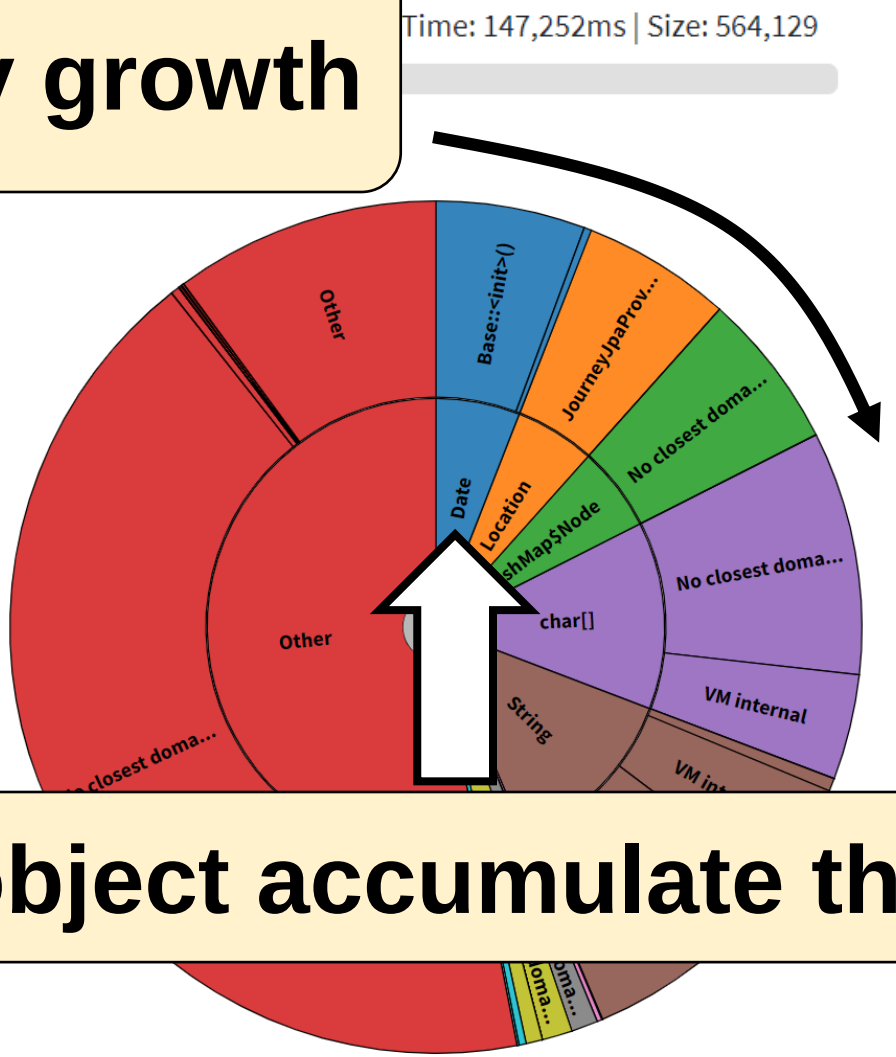
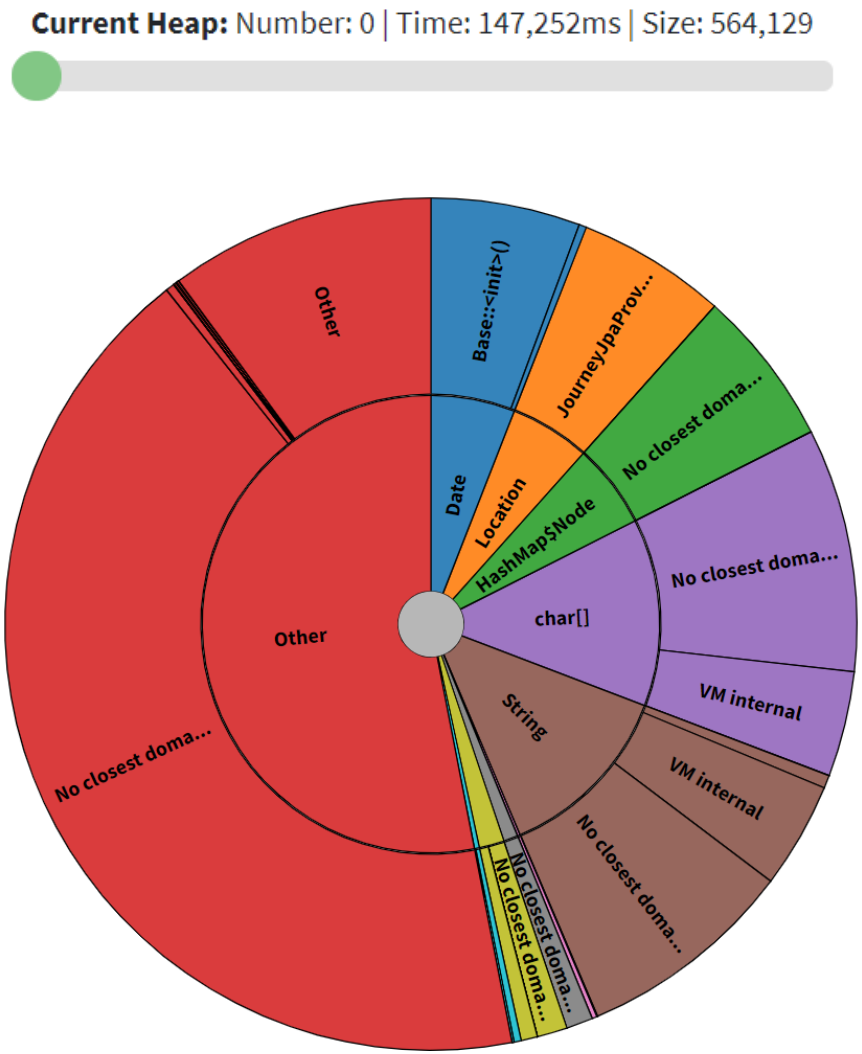


***Date* object accumulate the most**

RELATIVE POSITION ANIMATION



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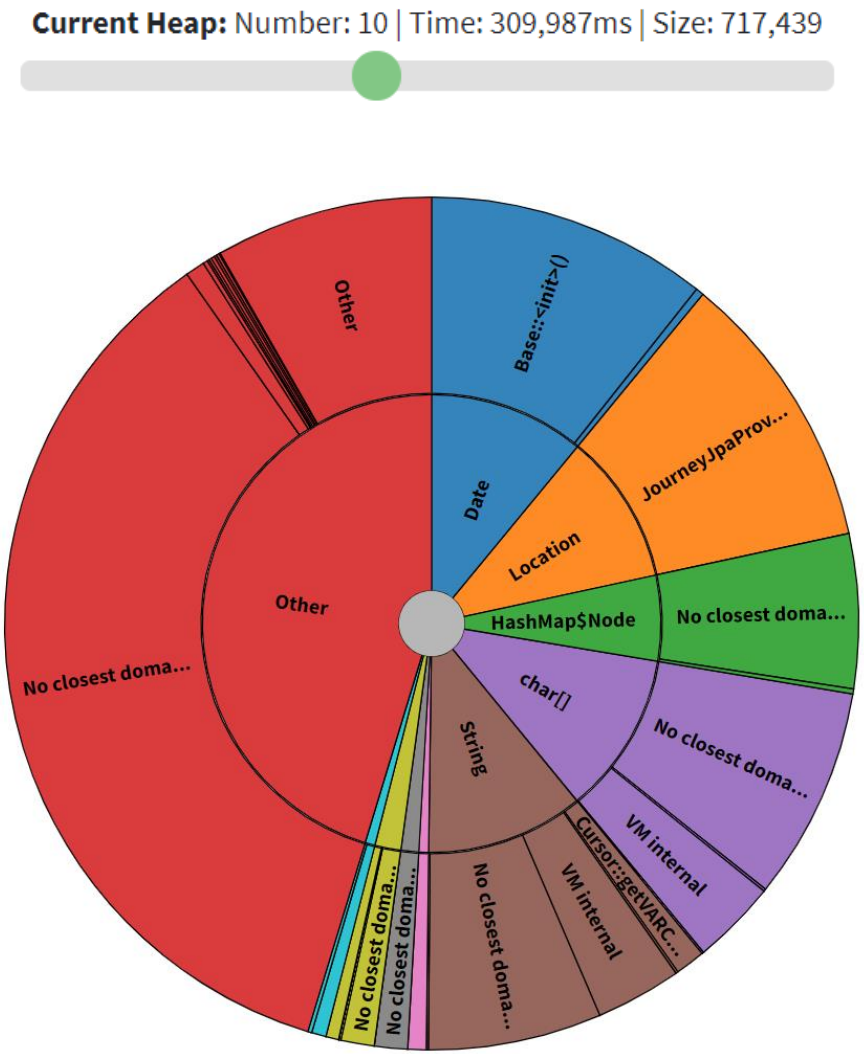

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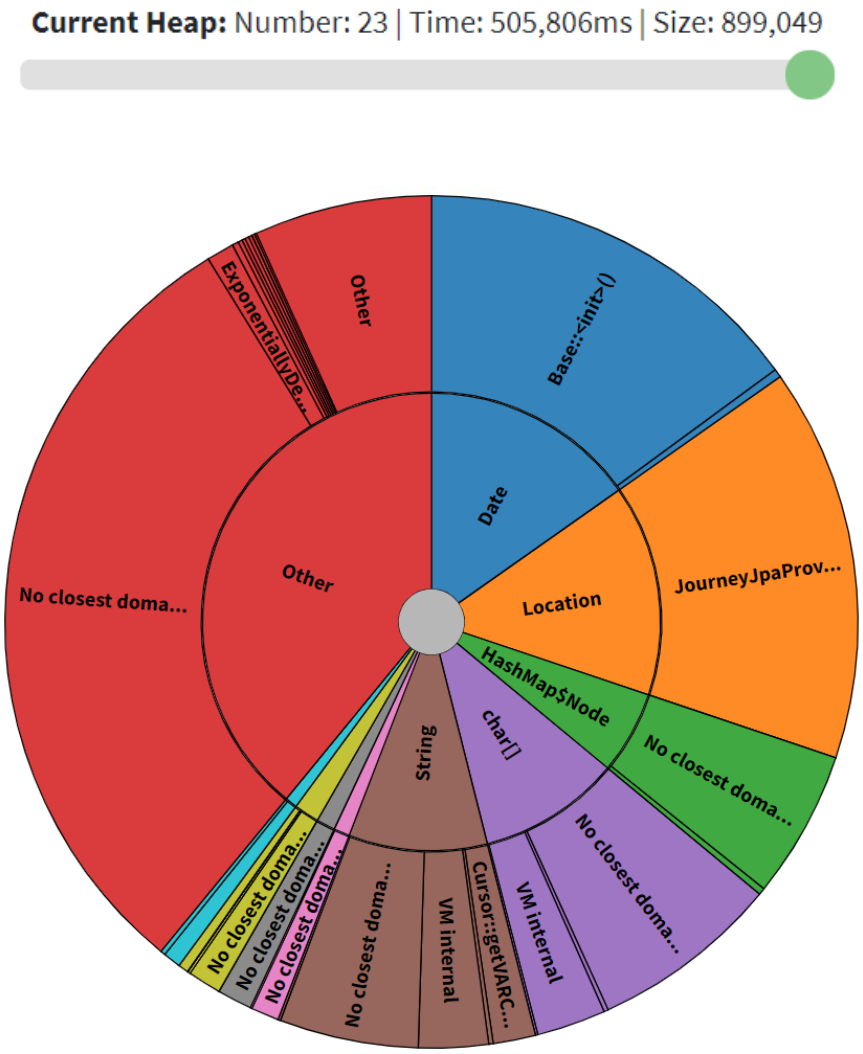

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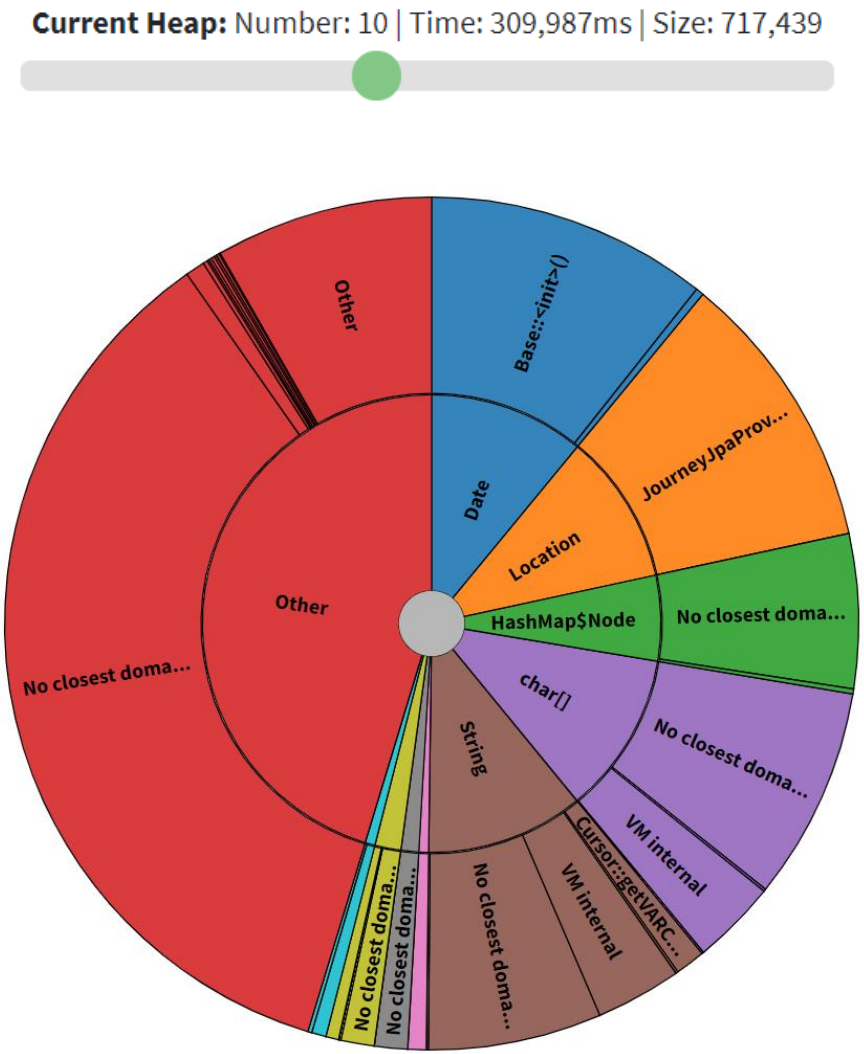

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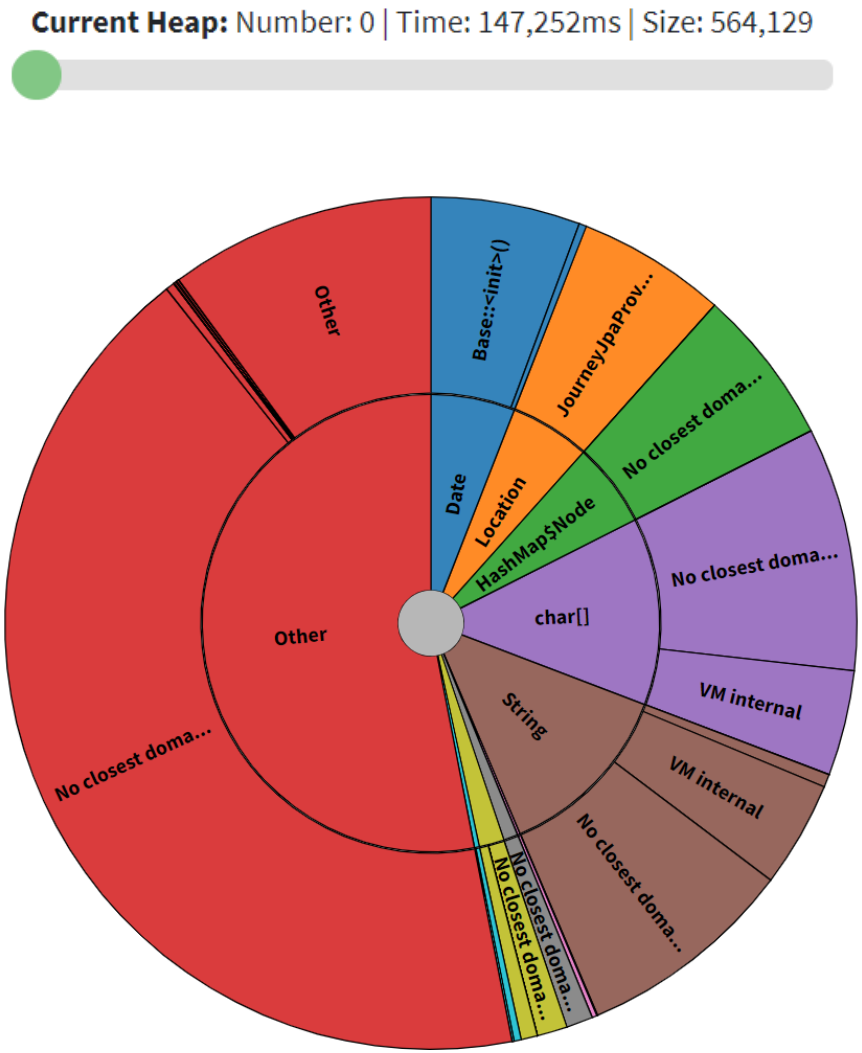

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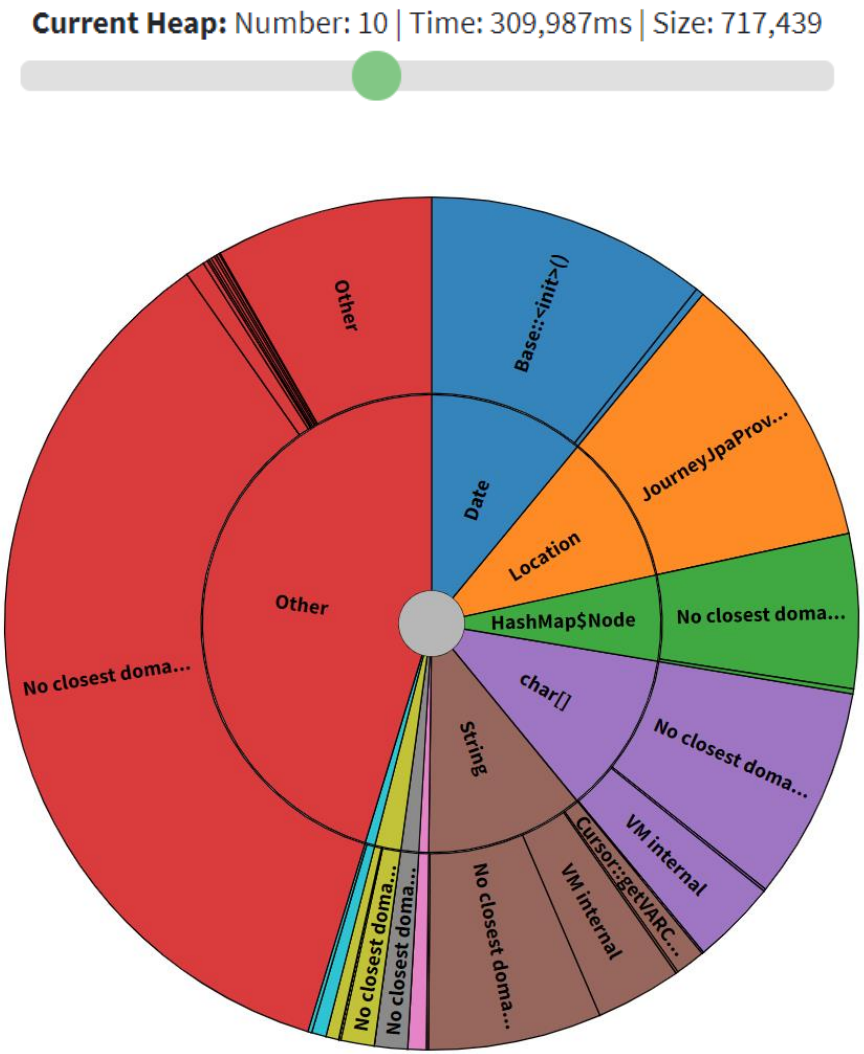
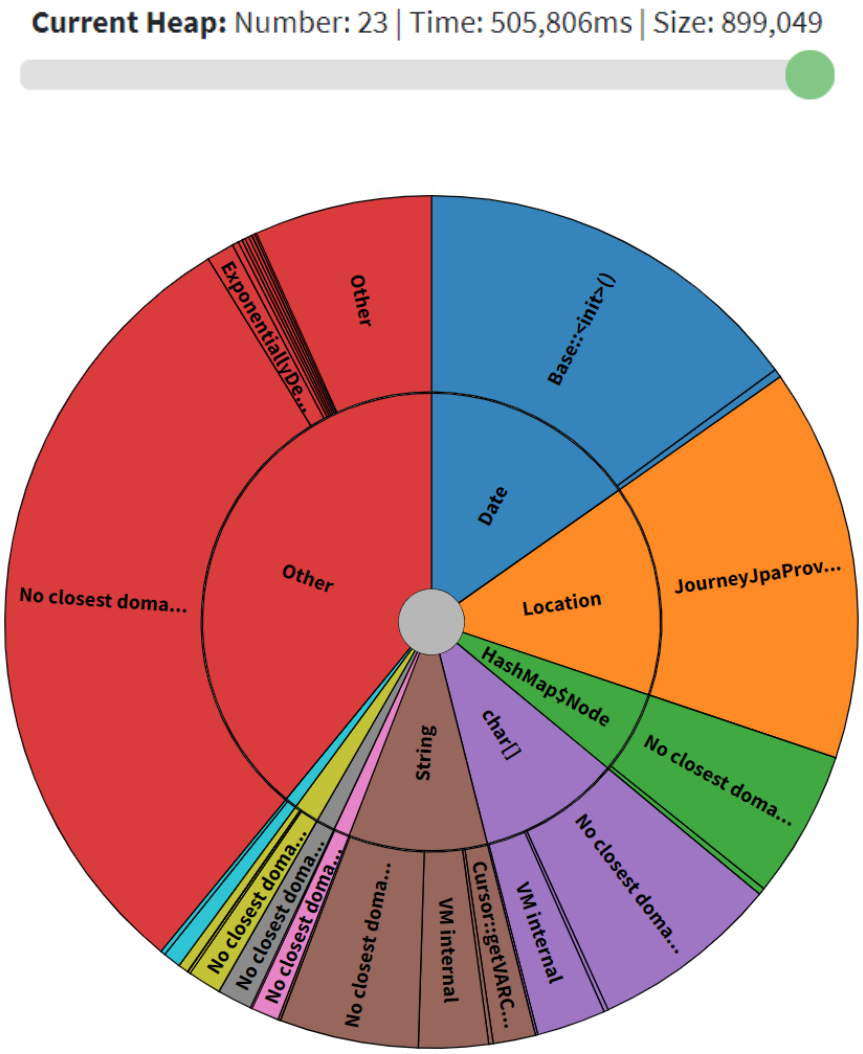
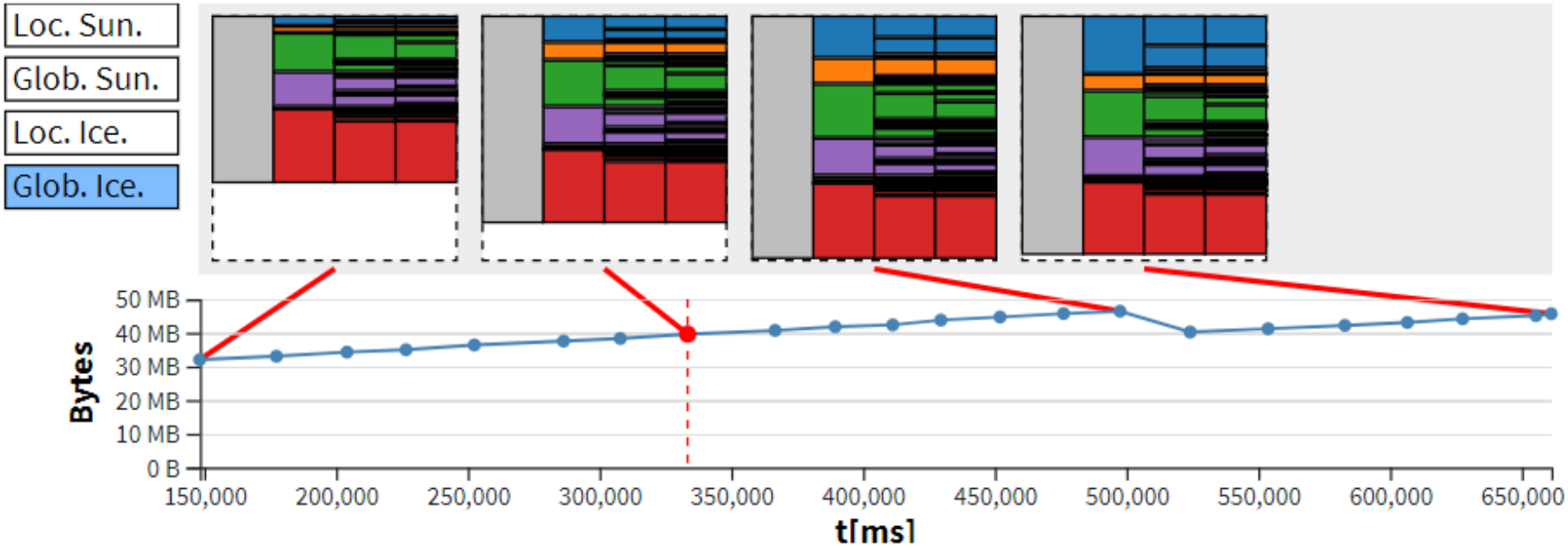


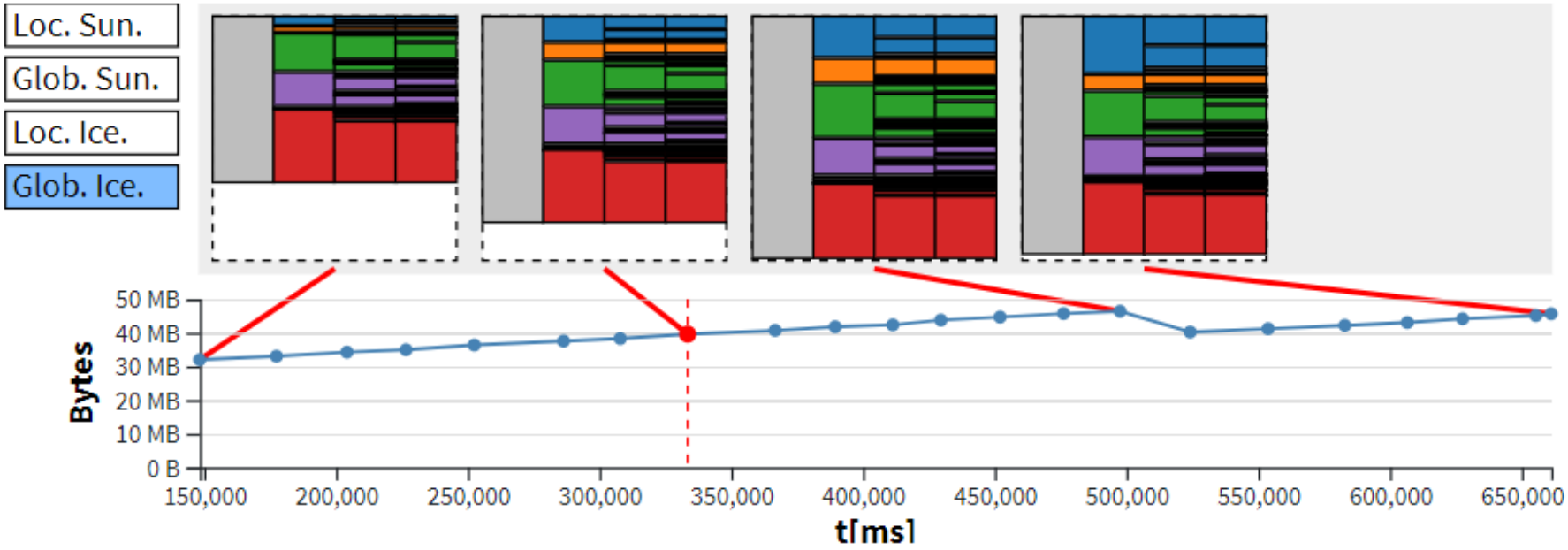
RELATIVE POSITION ANIMATION



TIMELINE VIEW

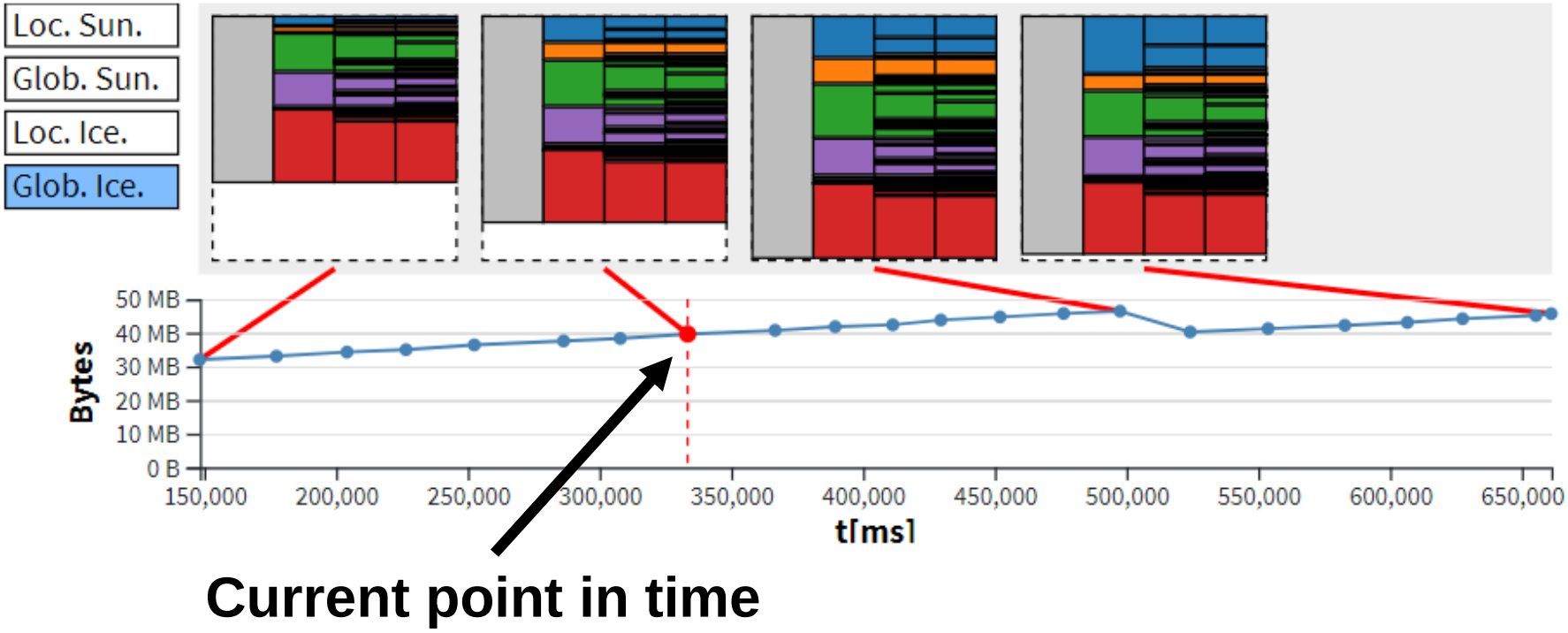


TIMELINE VIEW



Small multiples at different points in time

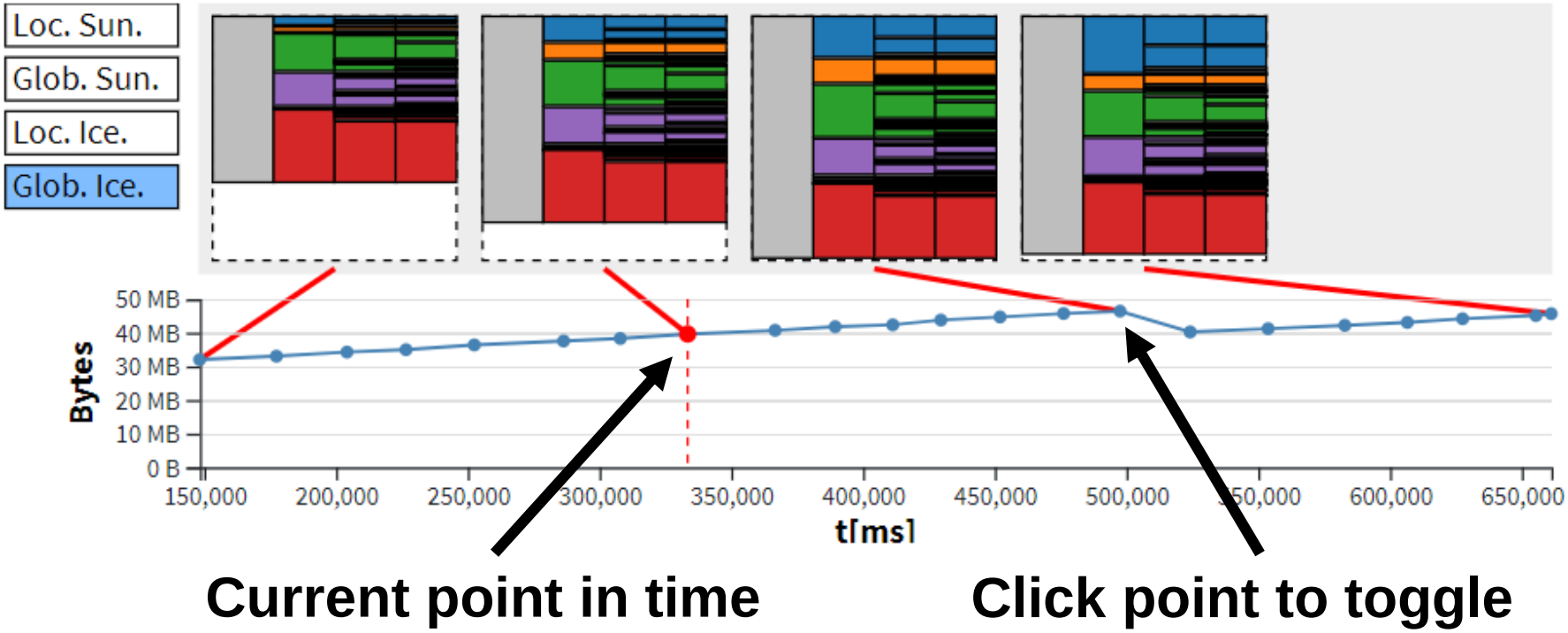
TIMELINE VIEW



Current point in time

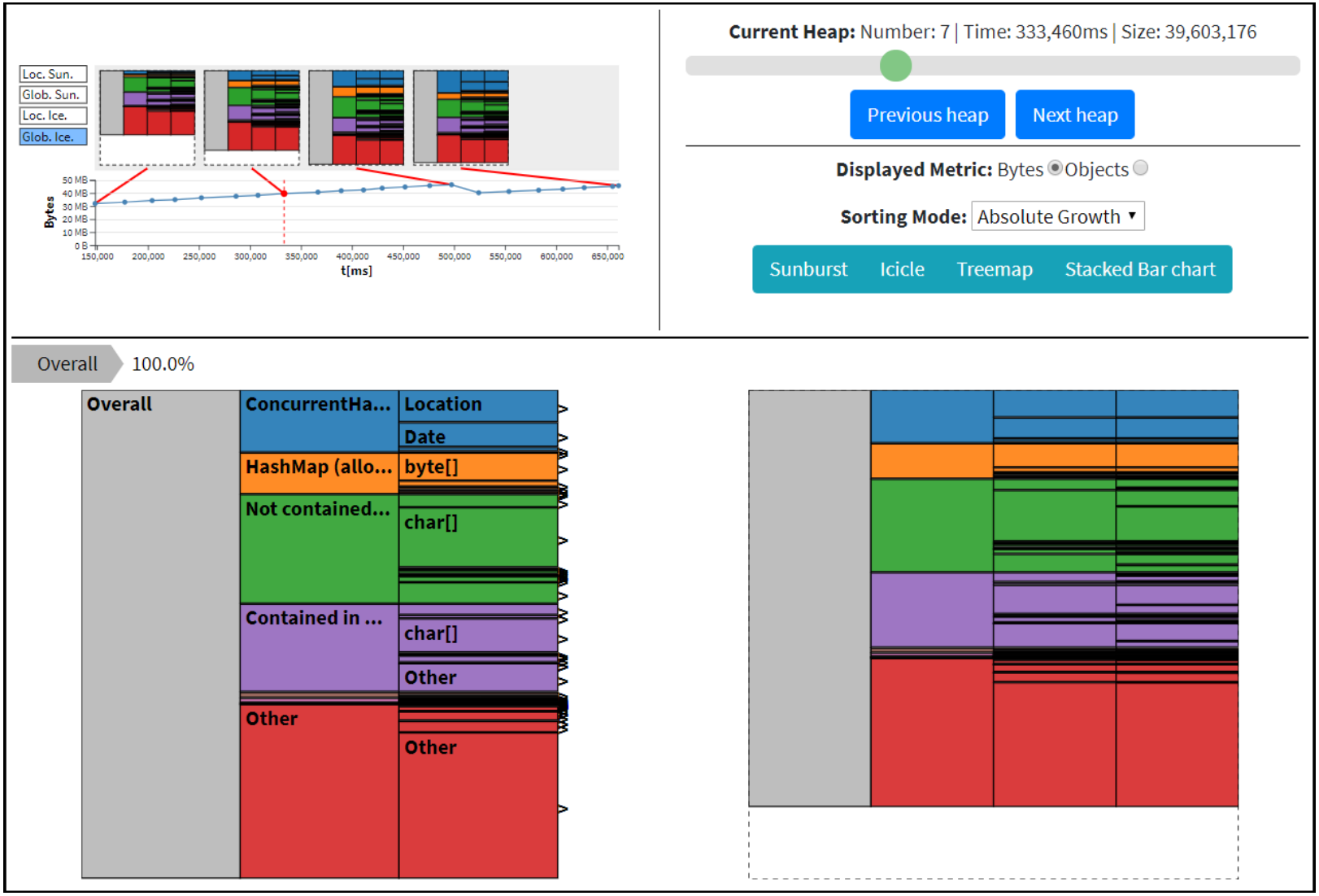
Small multiples at different points in time

TIMELINE VIEW

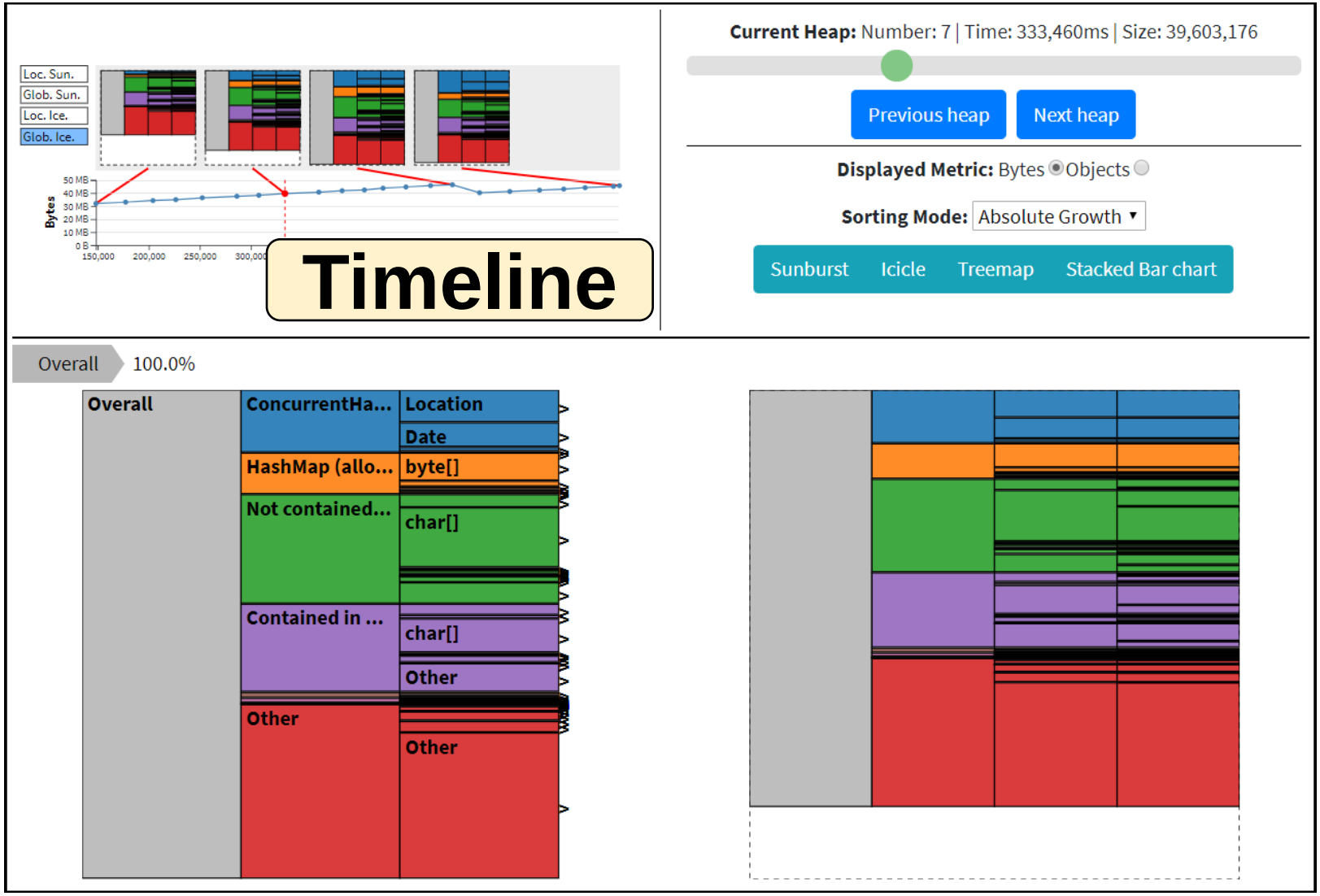


Small multiples at different points in time

PROTOTYPE AVAILABLE

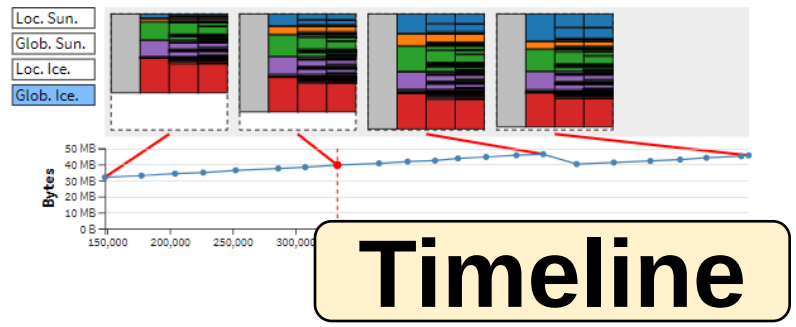


PROTOTYPE AVAILABLE

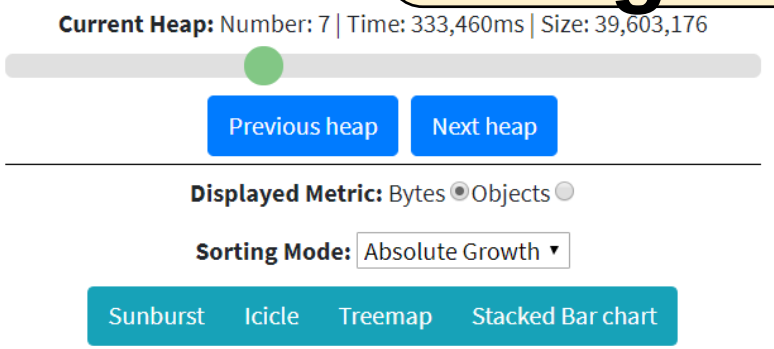


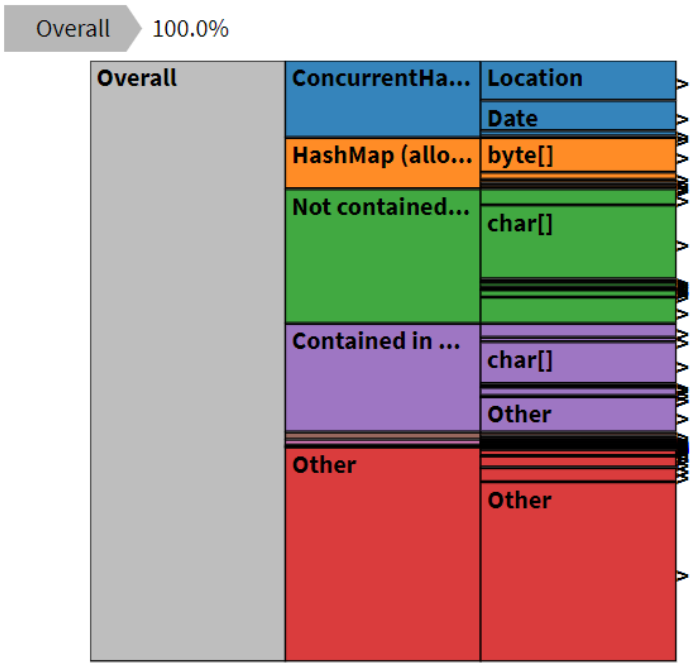
PROTOTYPE AVAILABLE

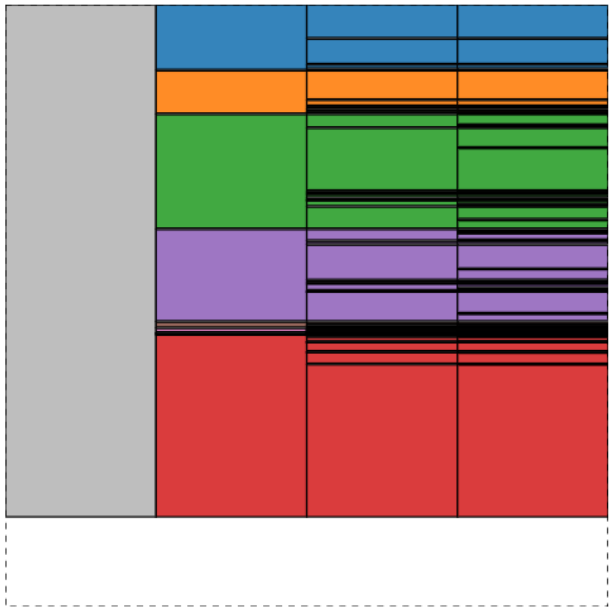
Time navigation



Timeline

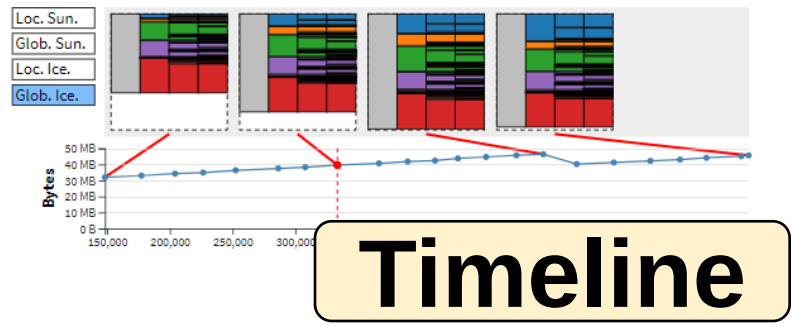






PROTOTYPE AVAILABLE

Time navigation



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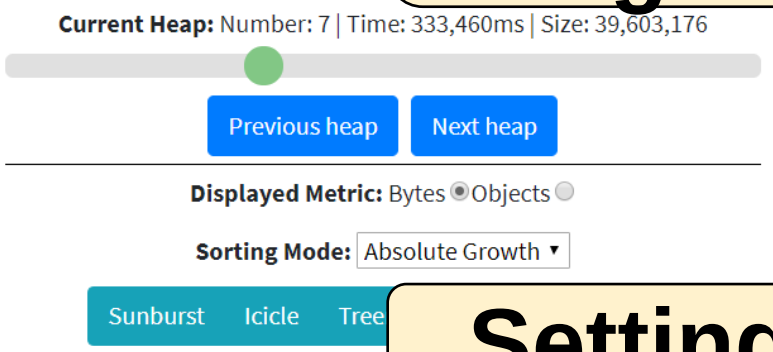
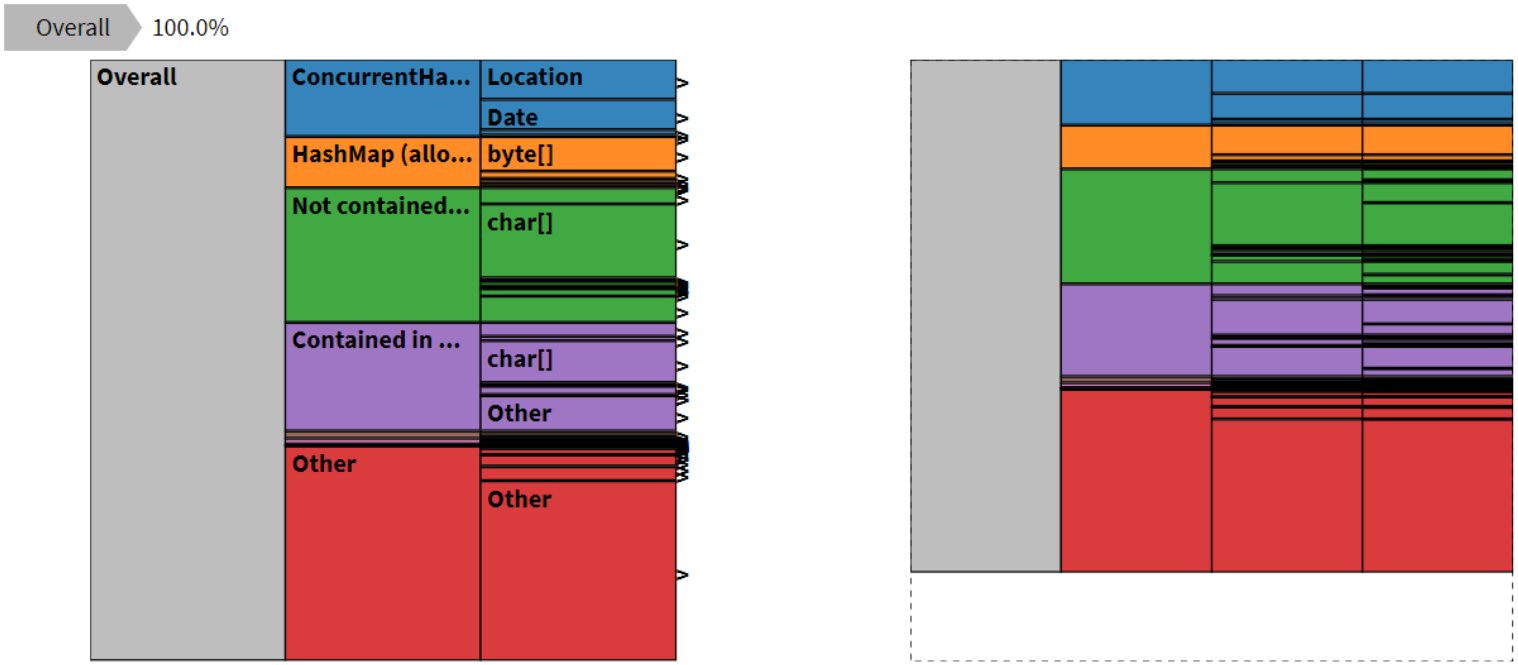
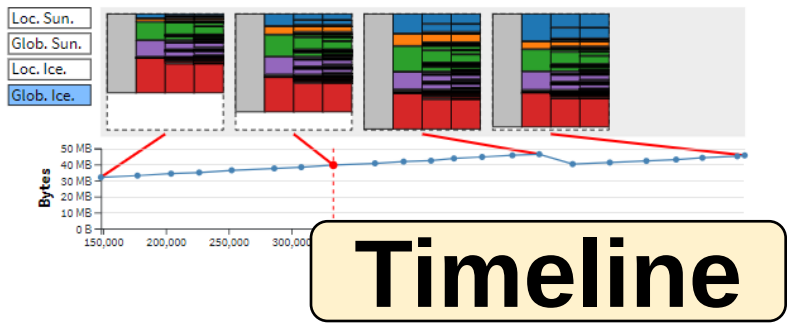


Settings



PROTOTYPE AVAILABLE

Time navigation



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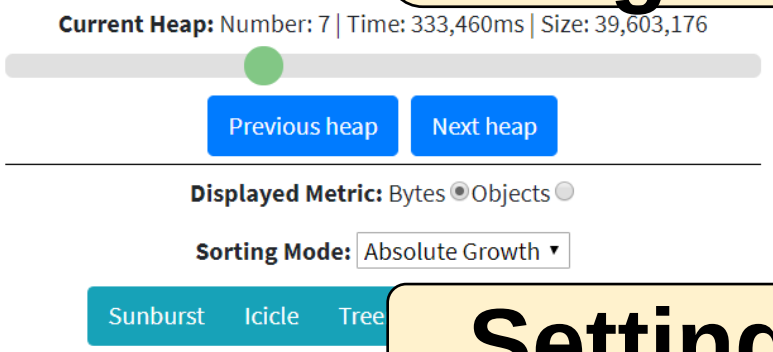

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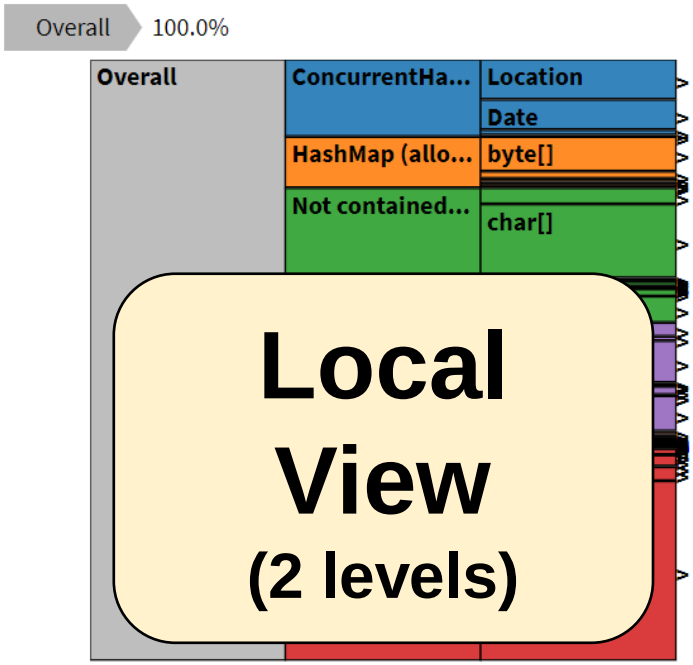
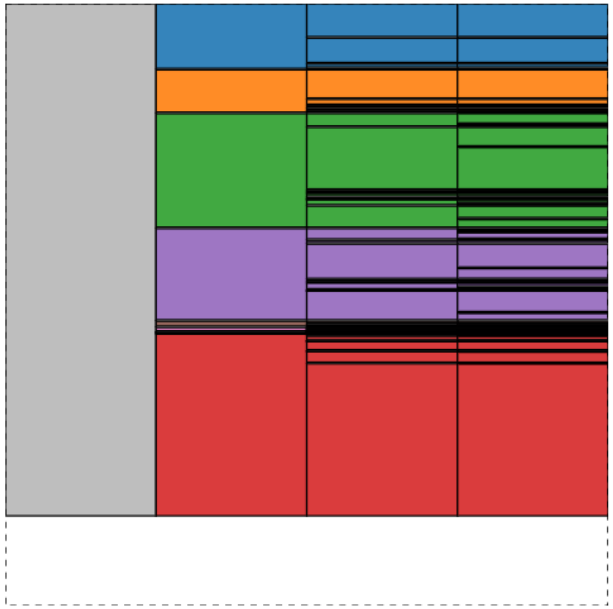
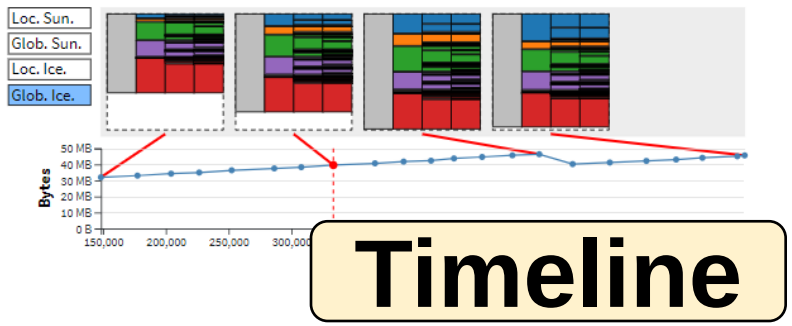


Local View (2 levels)

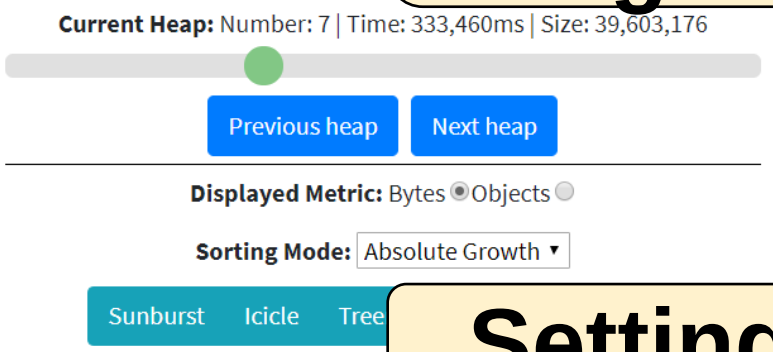


PROTOTYPE AVAILABLE

Time navigation



Timeline



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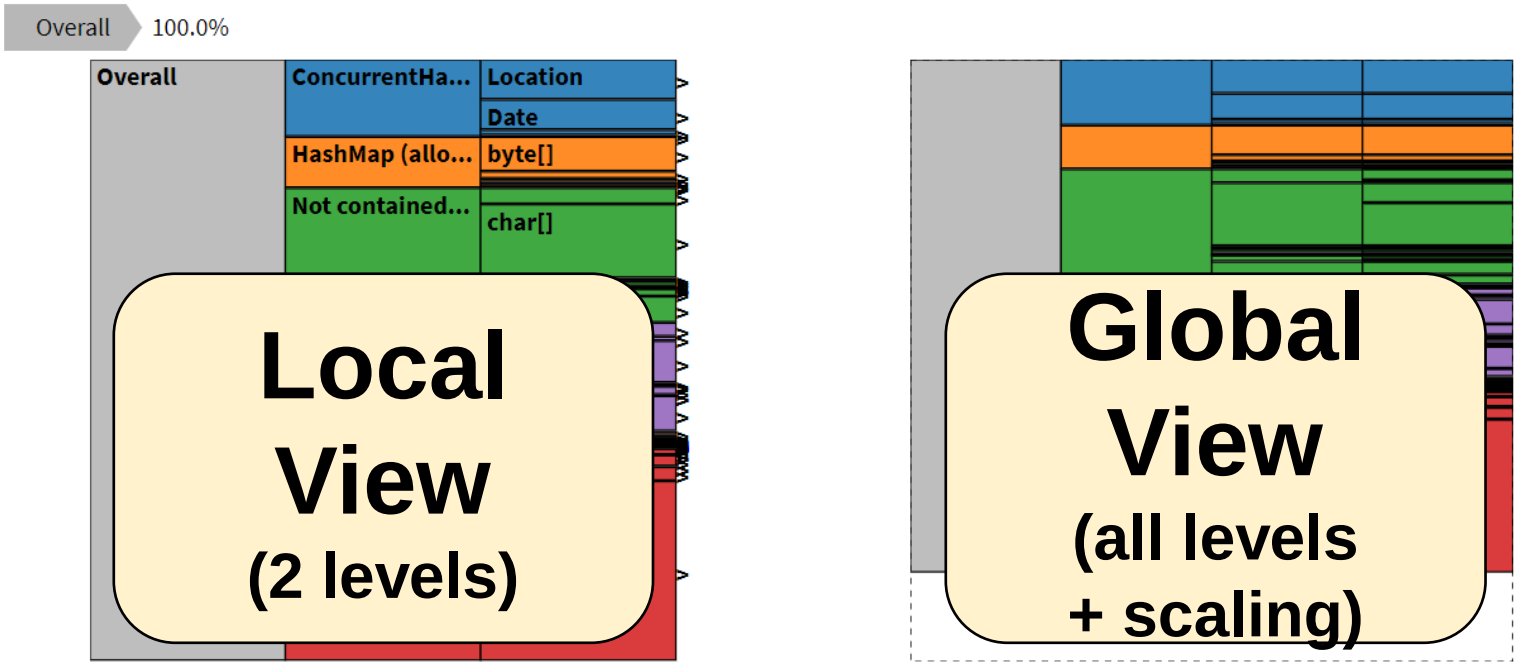

Local View (2 levels)

Global View (all levels + scaling)

FUTURE WORK

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FUTURE WORK

- Follow-up work accepted at STAG 2020
  „Memory Leak Analysis using Time-Travel-based and Timeline-based Tree Evolution Visualizations “

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STAG 2020
SMART TOOLS AND APPLICATIONS FOR GRAPHICS

- Guidance

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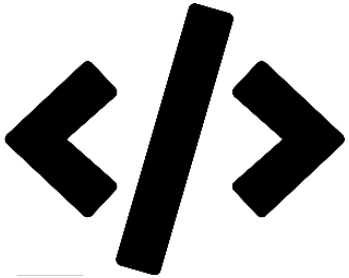
STAG 2020
SMART TOOLS AND APPLICATIONS FOR GRAPHICS

- Guidance

- IDE Integration



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TAKE-AWAYS

TAKE-AWAYS

Problem

How to visualize memory evolution (i.e., memory trees) over time?

TAKE-AWAYS

Problem	Tree Visualizations
How to visualize memory evolution (i.e., memory trees) over time?	Target audience: Novice memory analysts Sunburst Icicle

TAKE-AWAYS

Problem	Tree Visualizations	Evolution Over Time
How to visualize memory evolution (i.e., memory trees) over time?	Target audience: Novice memory analysts Sunburst Icicle	Stable layout „Relative position animation“ Don‘t destroy user‘s cognitive map

TAKE-AWAYS

Problem	Tree Visualizations	Evolution Over Time	Interaction
How to visualize memory evolution (i.e., memory trees) over time?	Target audience: Novice memory analysts Sunburst Icicle	Stable layout „Relative position animation“ Don‘t destroy user‘s cognitive map	Timeline view Time navigation Drill-down

TAKE-AWAYS

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How to visualize memory evolution (i.e., memory trees) over time?	Target audience: Novice memory analysts Sunburst Icicle	Stable layout „Relative position animation“ Don‘t destroy user‘s cognitive map	Timeline view Time navigation Drill-down

Prototype available at
https://bit.ly/
STAG-MemoryTreeVizTool

Video available at
https://bit.ly/
STAG-MemoryTreeVizVideo

TAKE-AWAYS

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Markus Weninger

Johannes Kepler University
Linz, Austria

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