DYNA

Dyalog North America – 29-30 September 2025

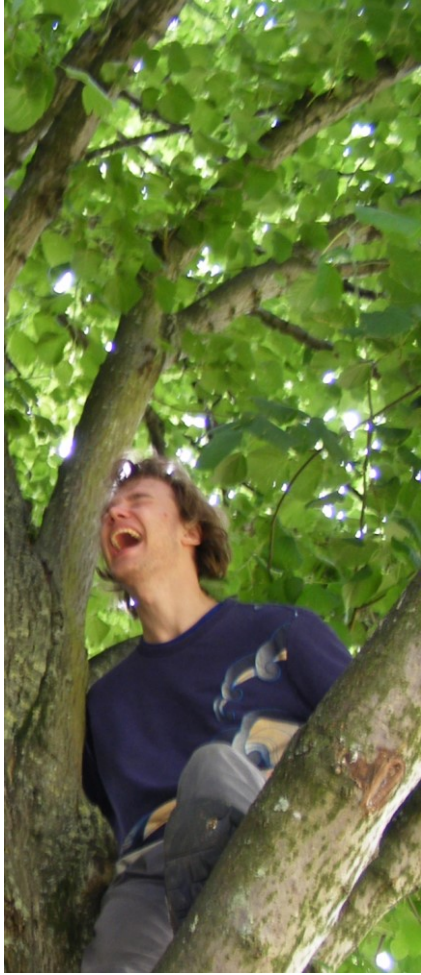
What can Vectorised Trees Do for You?

Asher Harvey-Smith

Me

Freshly graduated 🎉

(Computer Science MEng, University of Warwick)



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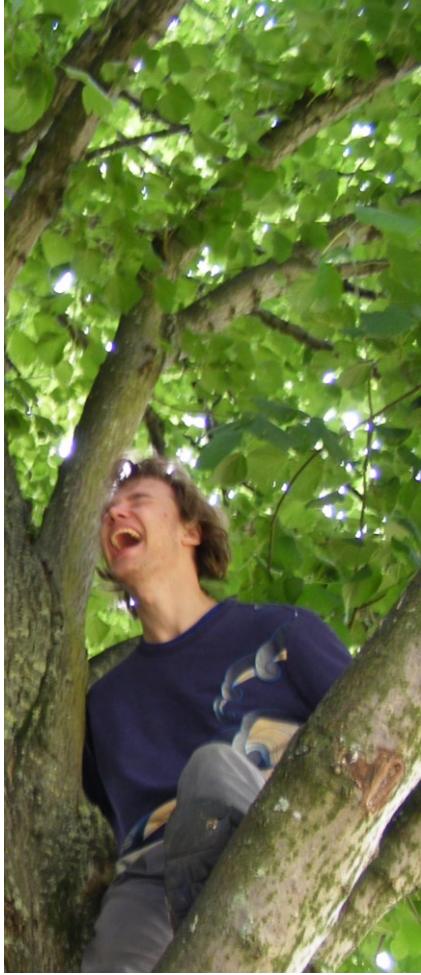

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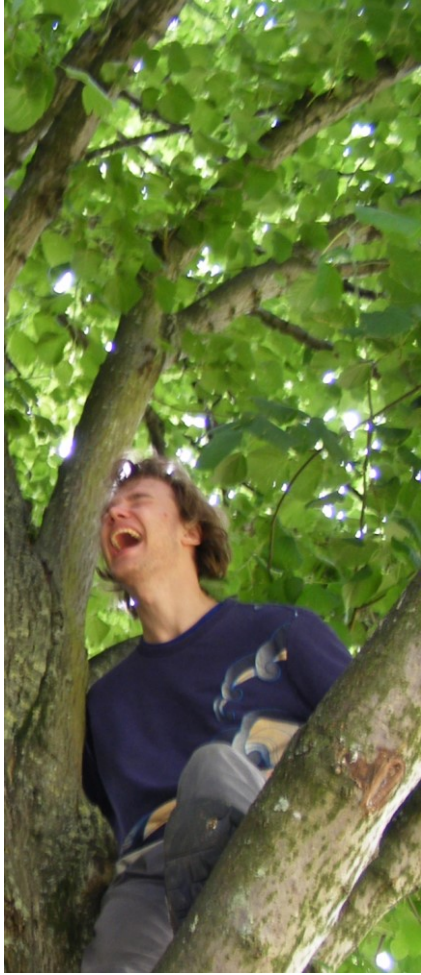

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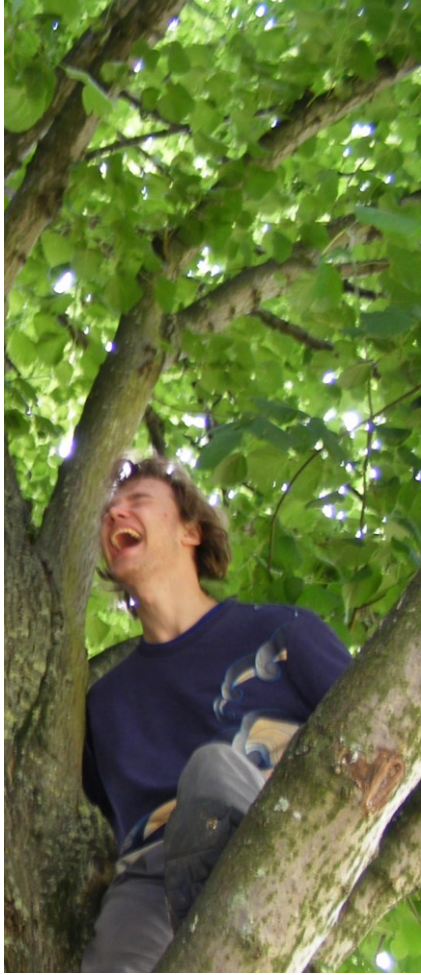
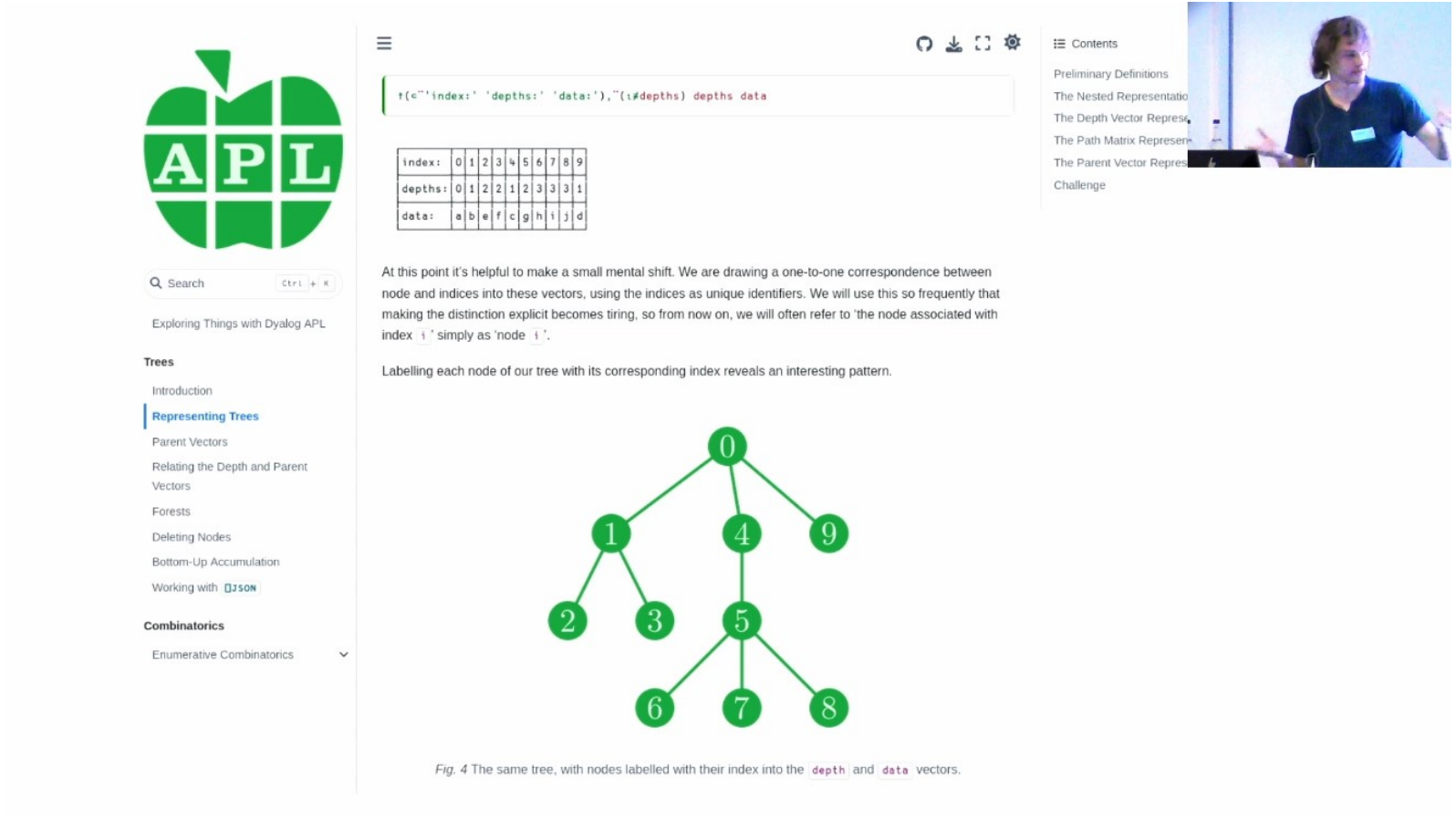
Proper employee 🎉





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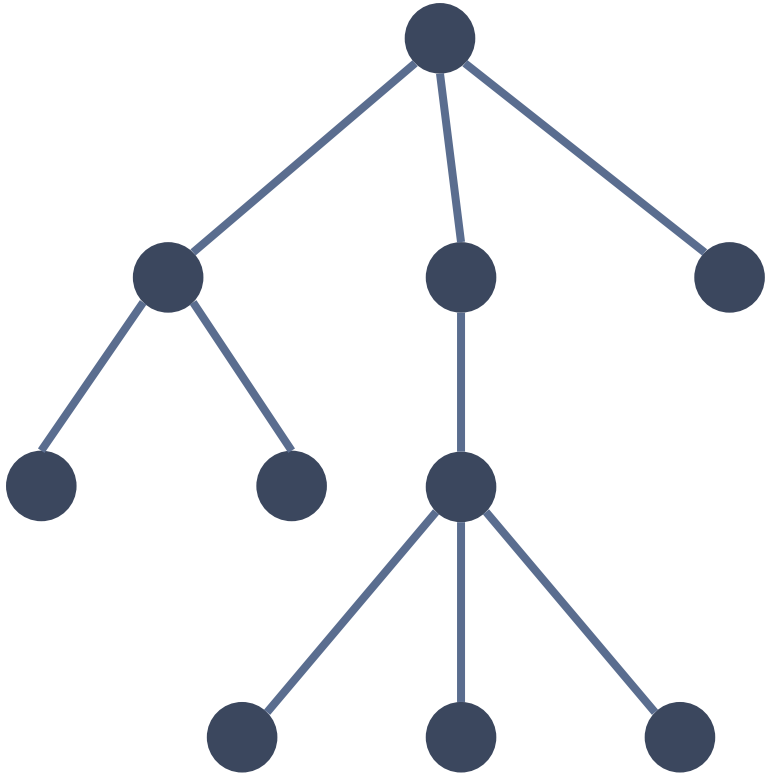

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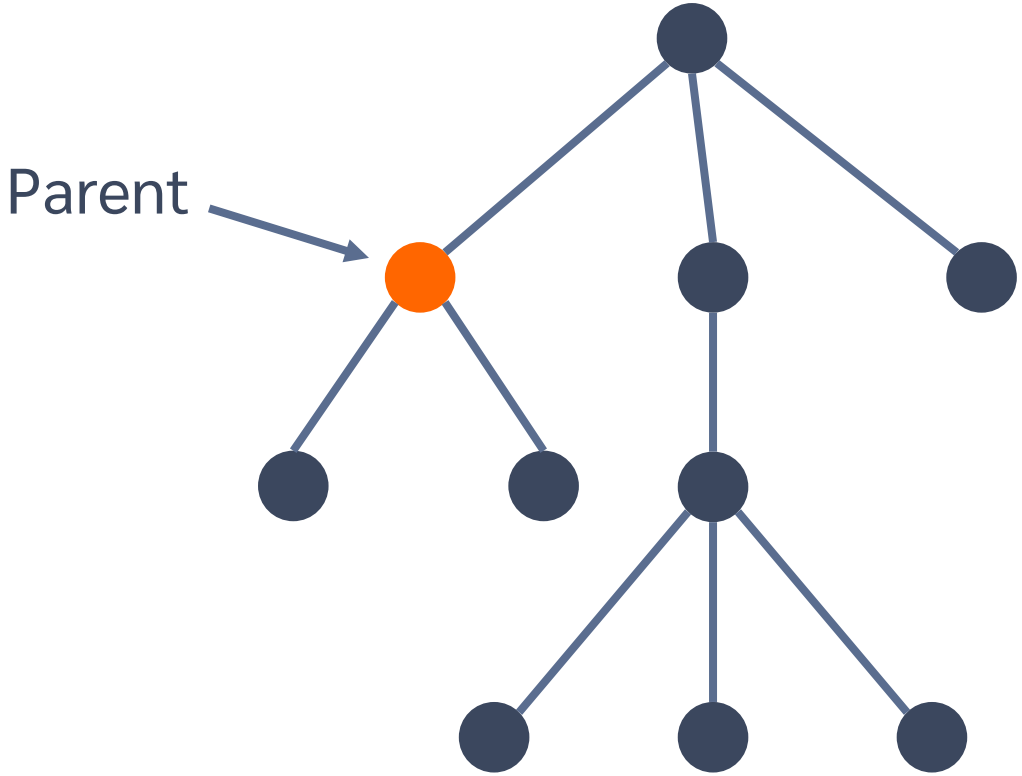

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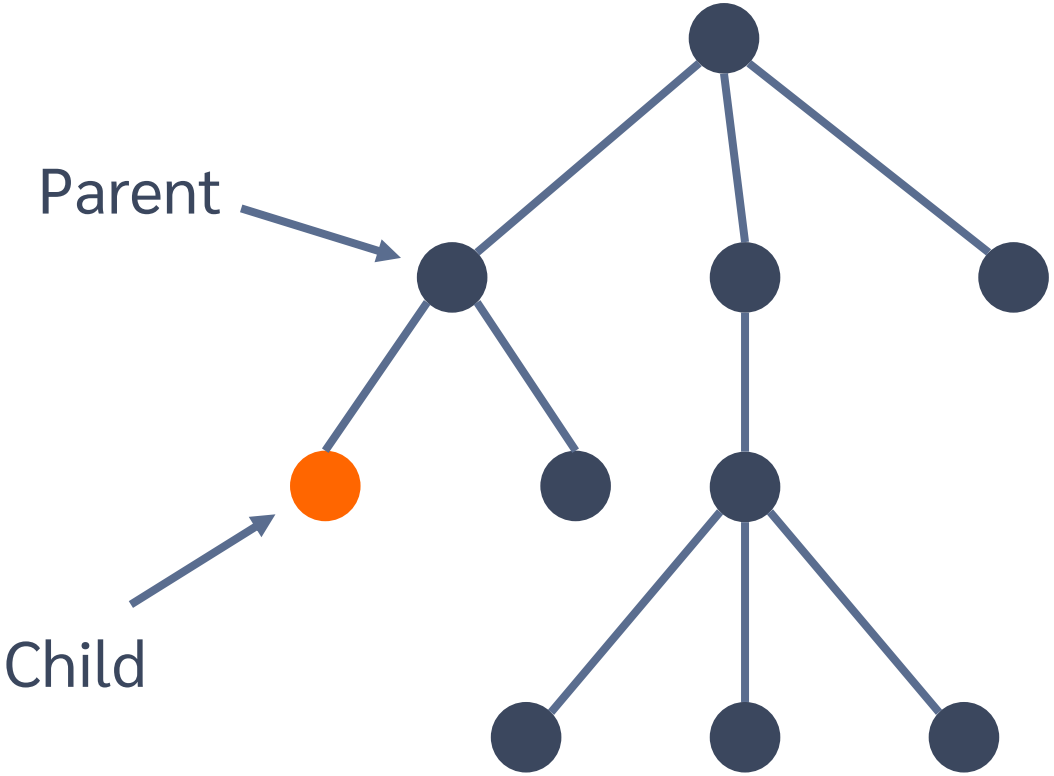

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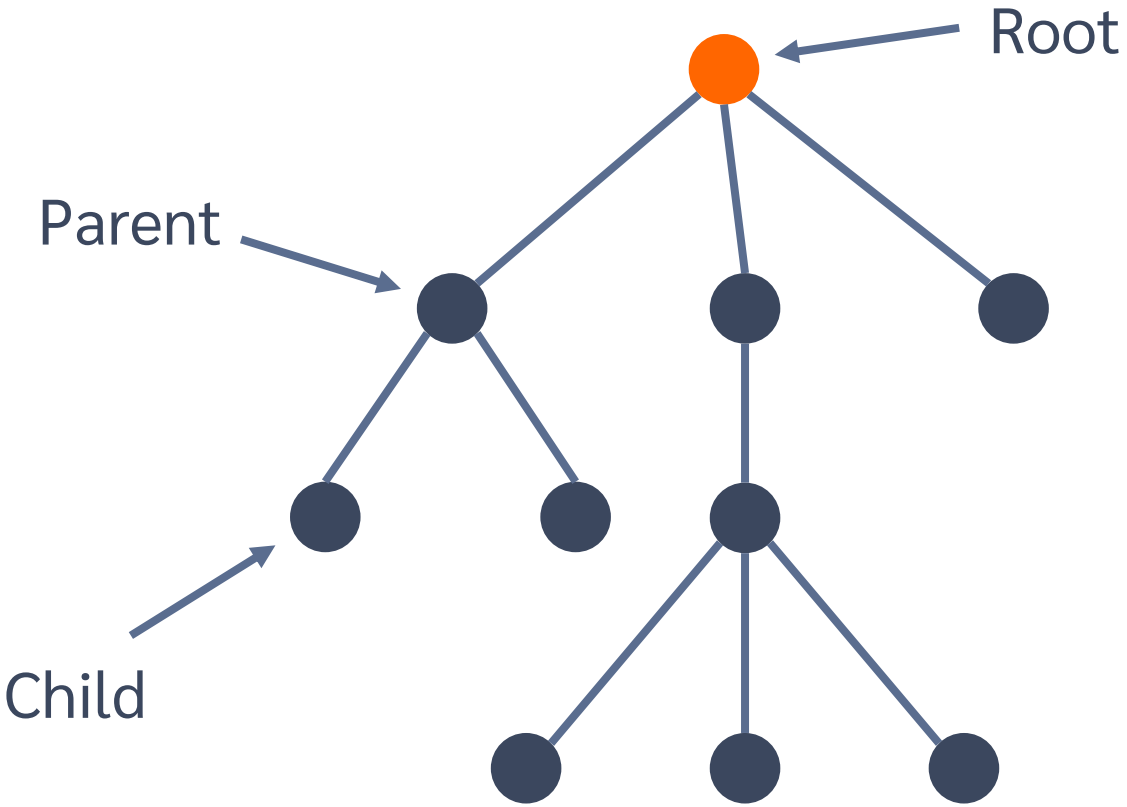

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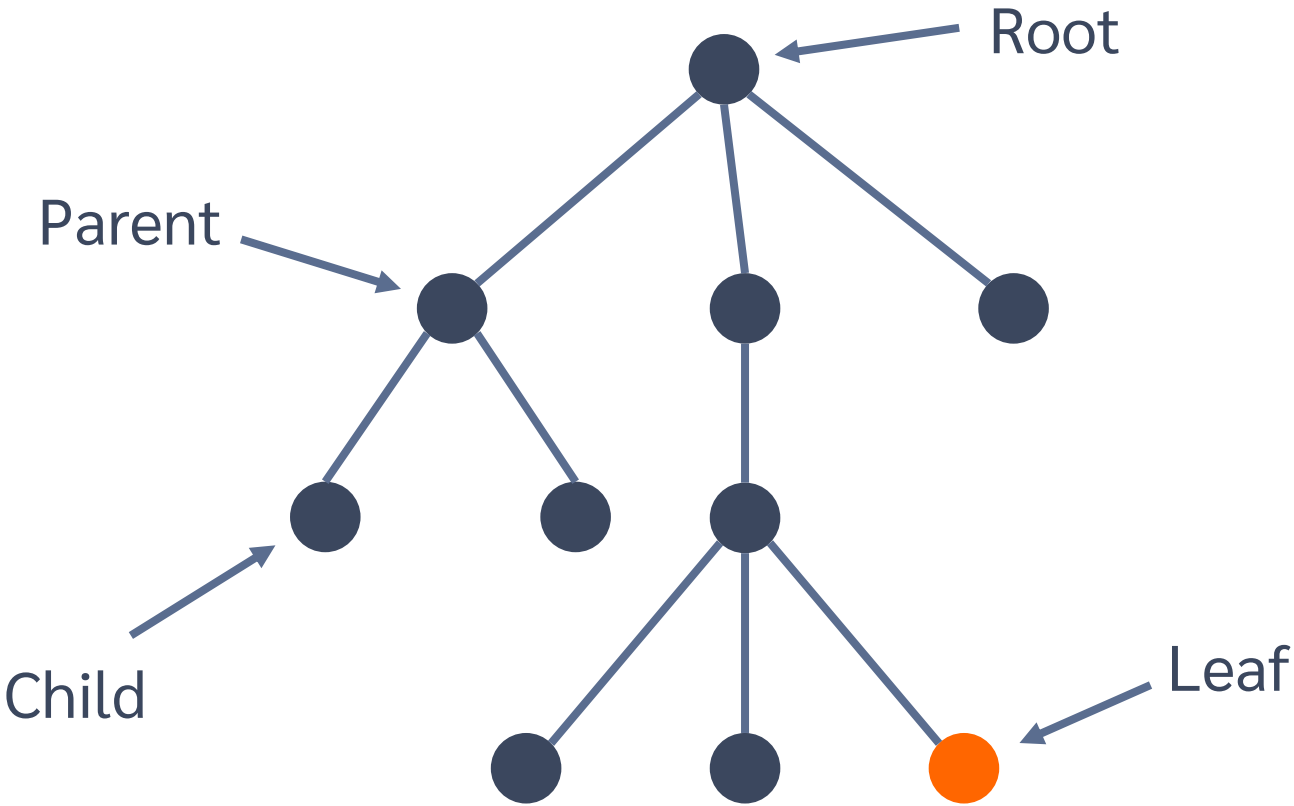
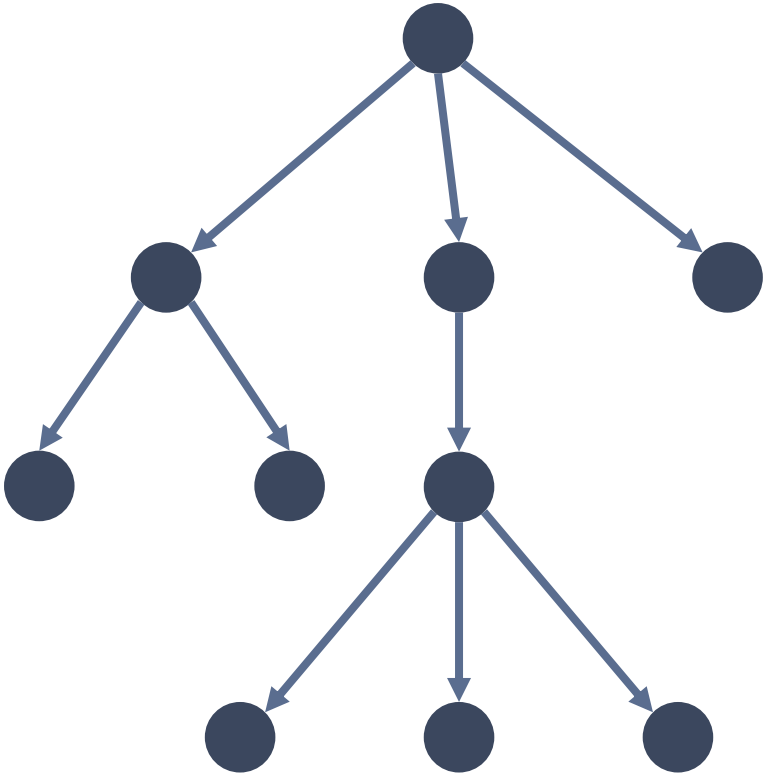

Root
Parent
Child
Leaf



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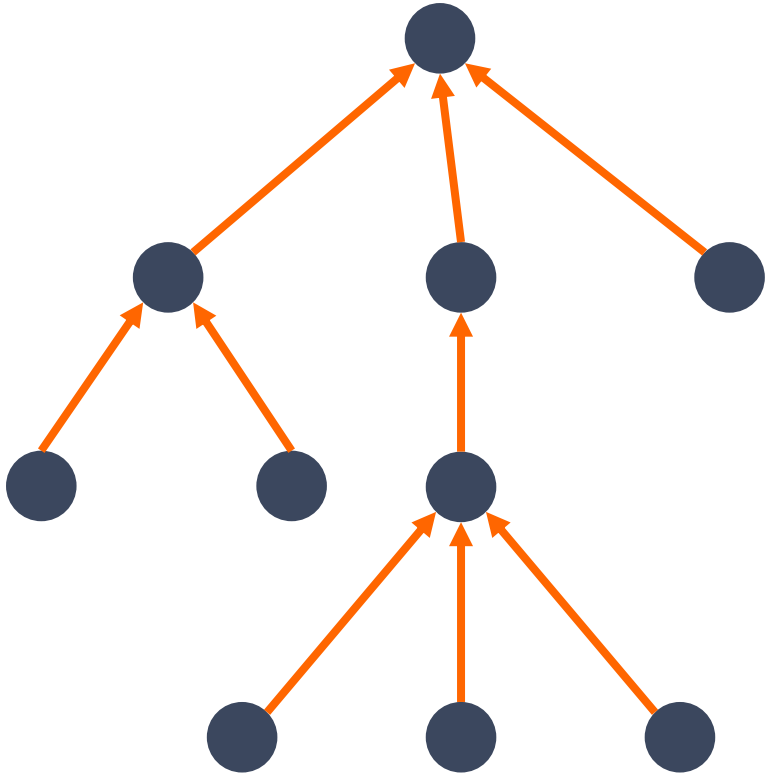

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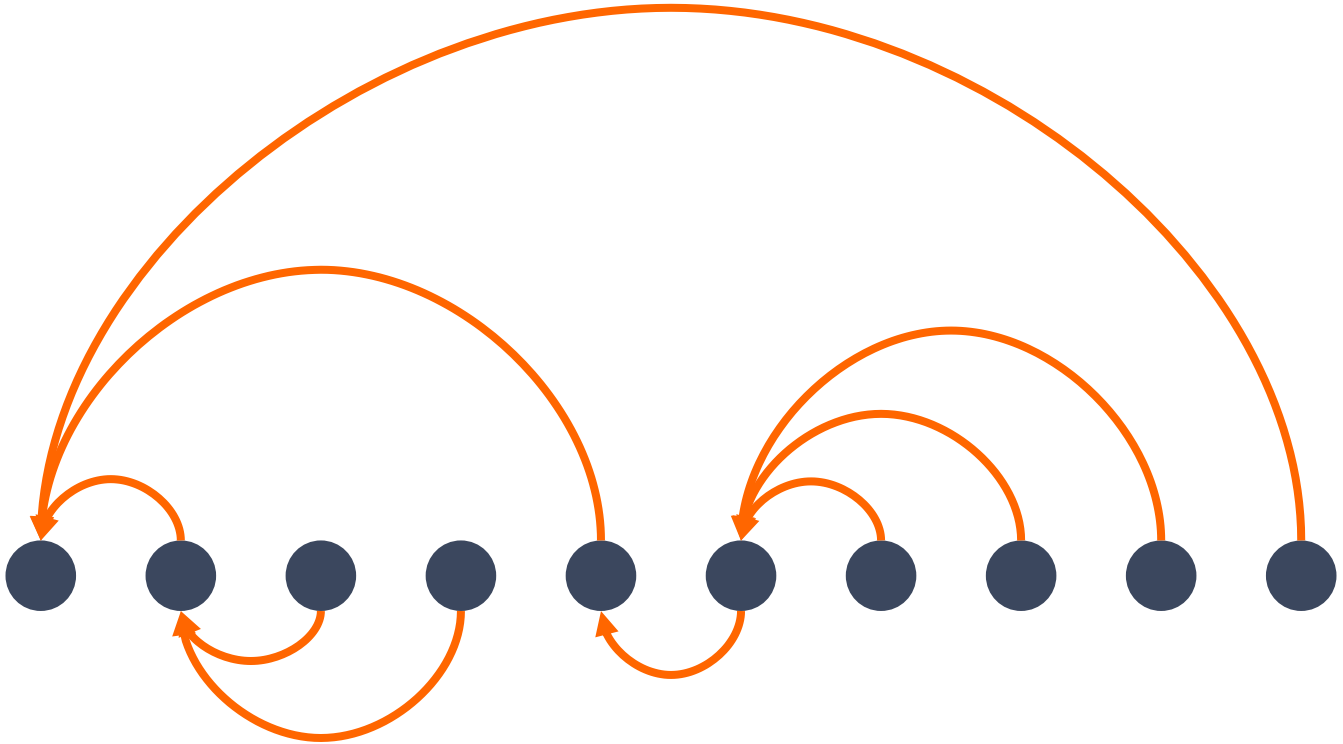

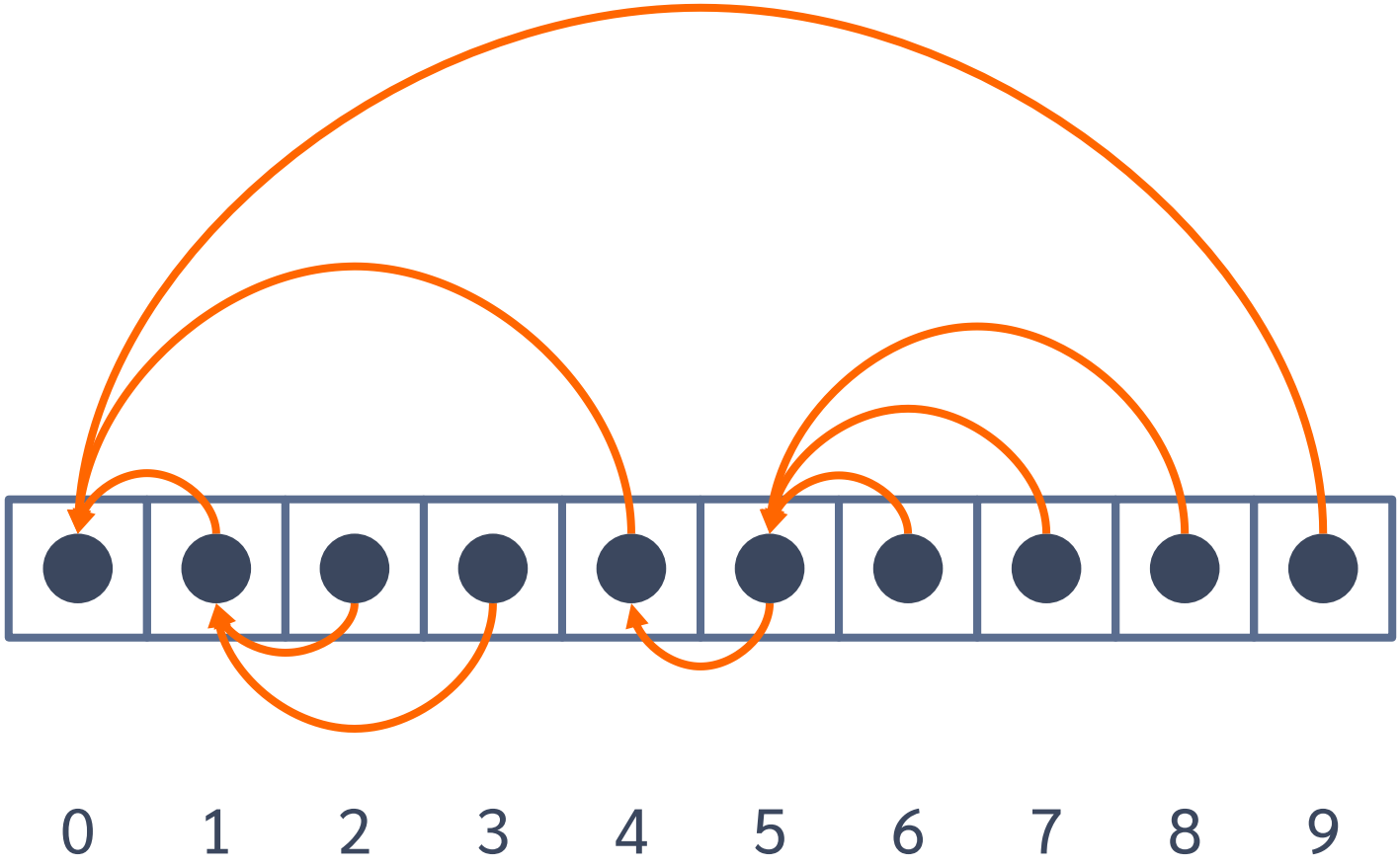
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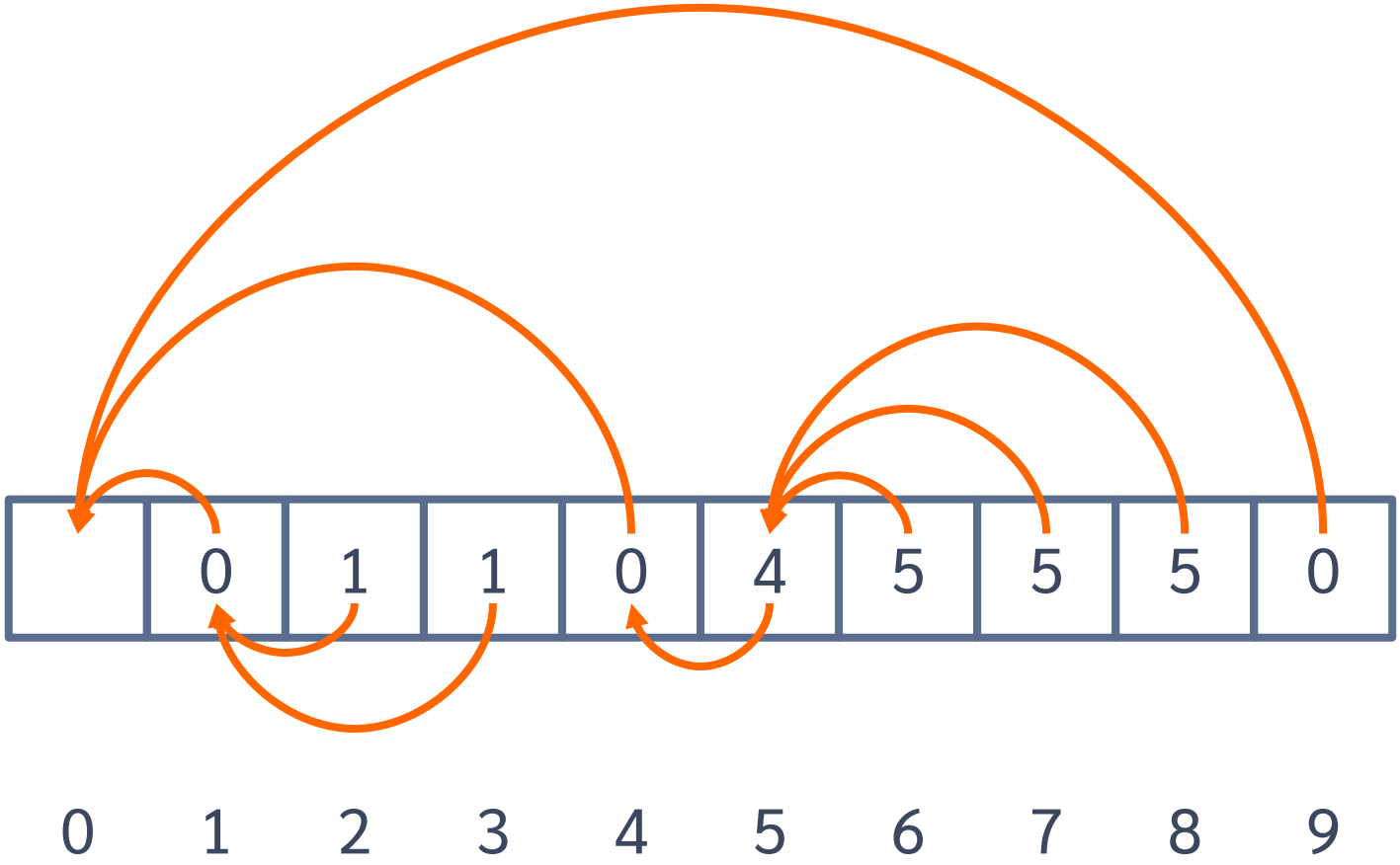
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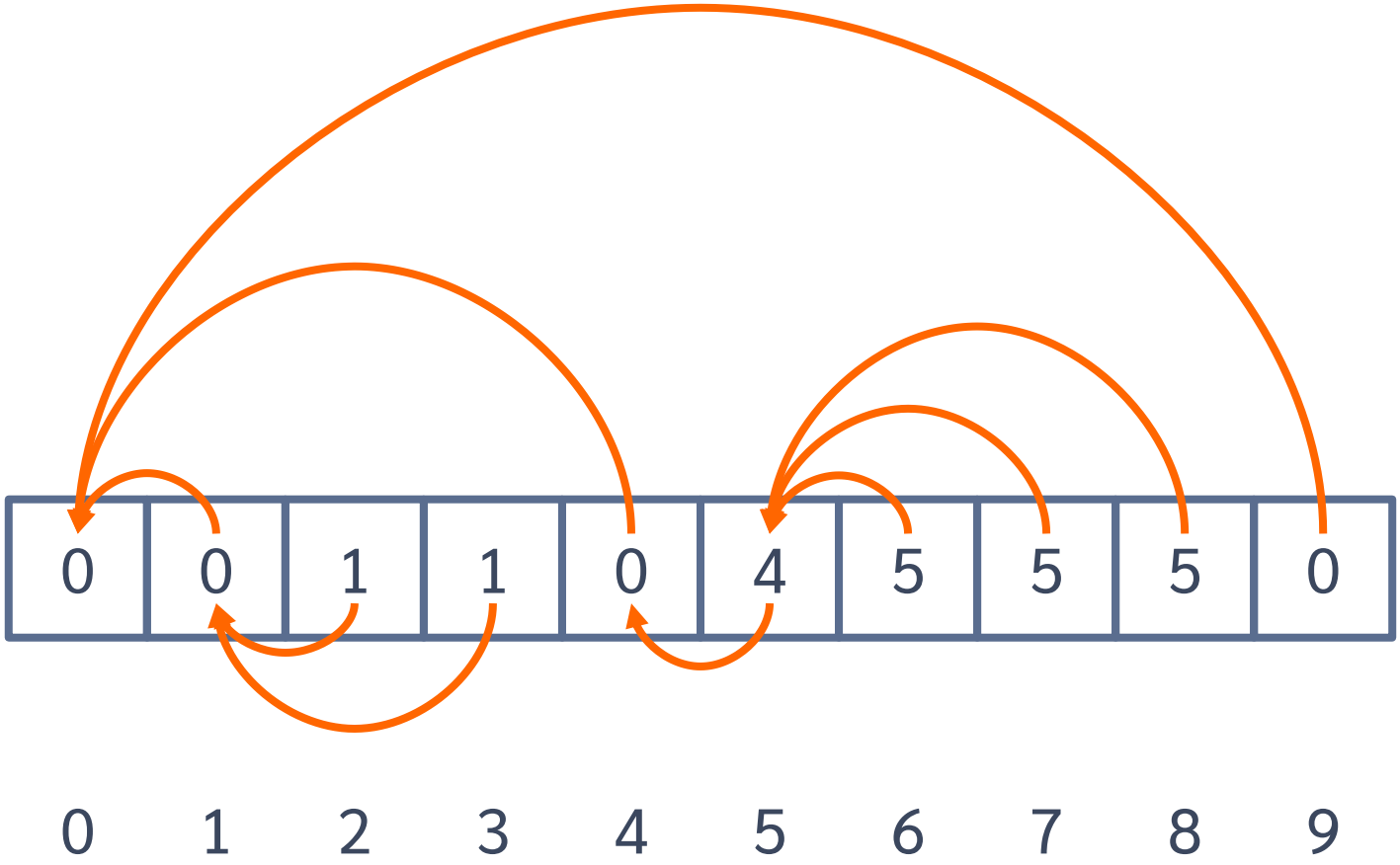
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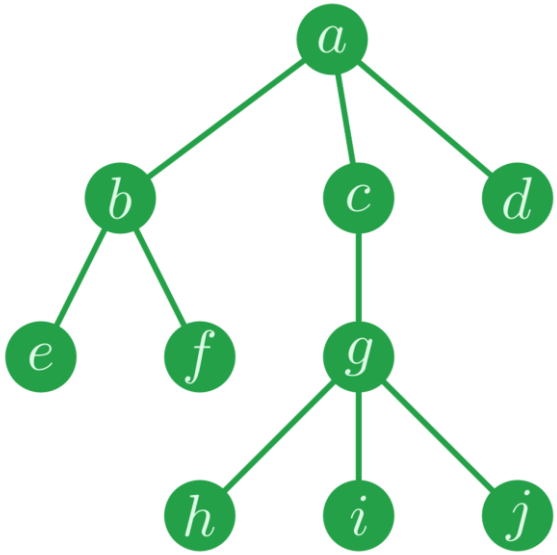
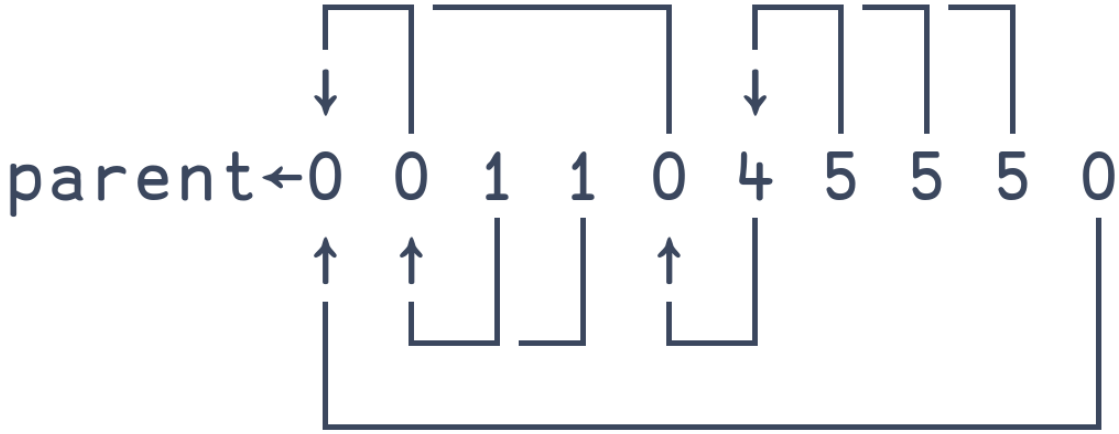
Parent Vectors





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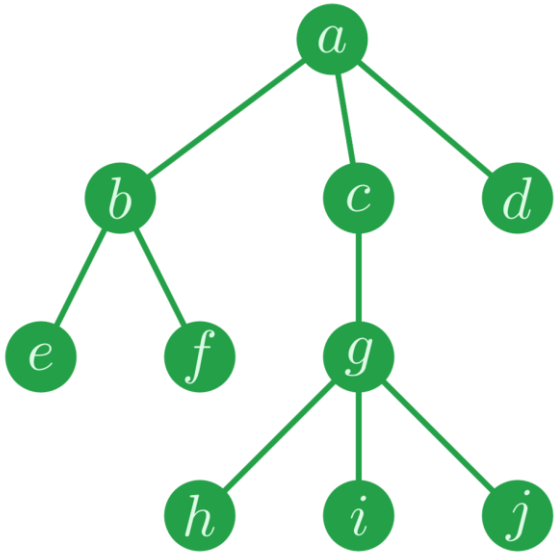

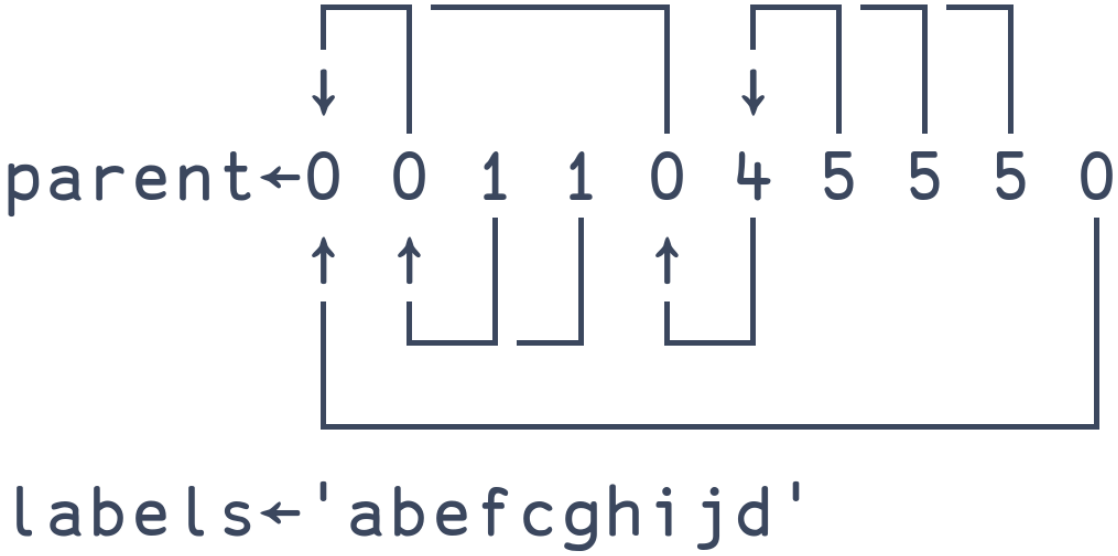

Parent Vectors

Let’s see some code

When Are Parent Vectors Useful?

- Large ✓
  - Larger trees have more performance gains from vectorisation.

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- Large ✓
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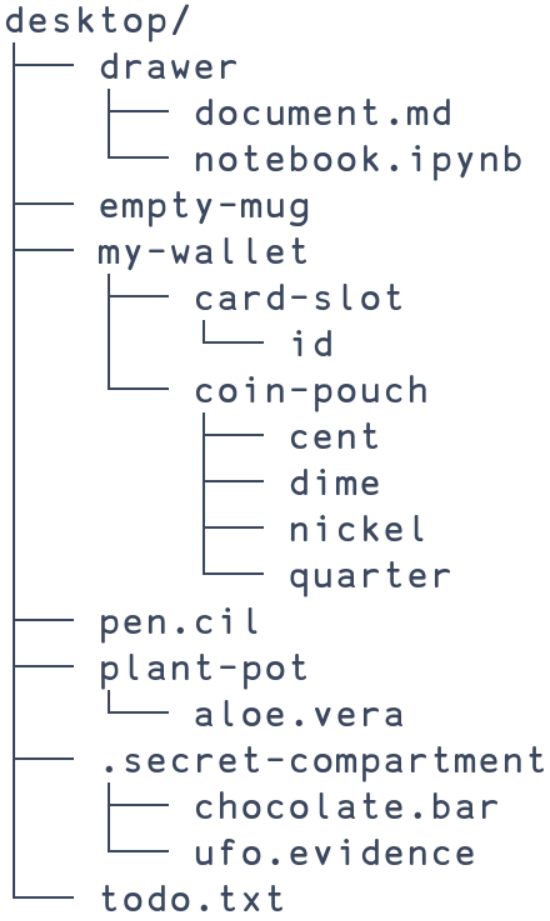
- Irregular ✓
  - For trees with a predictable shape, you can get away with ad-hoc approaches.
- Traversing bottom-up ✓
  - Parent pointers take us up the tree.
  - You can go bottom-up more often than you think!

Case Study: Co-dfns & Static Analysis

- Syntax tree is represented by a parent vector
  - Large ✓
  - Irregular ✓
  - Bottom-up traversals ✓
- Largest serious projects using the technique (that I know of)

Case Study: File System Queries

- File systems are* trees
  - *pedants will bring up file system links, we will ignore the pedants
- They can be large ✓ and irregular ✓
- You can do all sorts of queries very easily on a parent vector
  - Using bottom-up traversals ✓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empty-mug
my-wallet
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plant-pot
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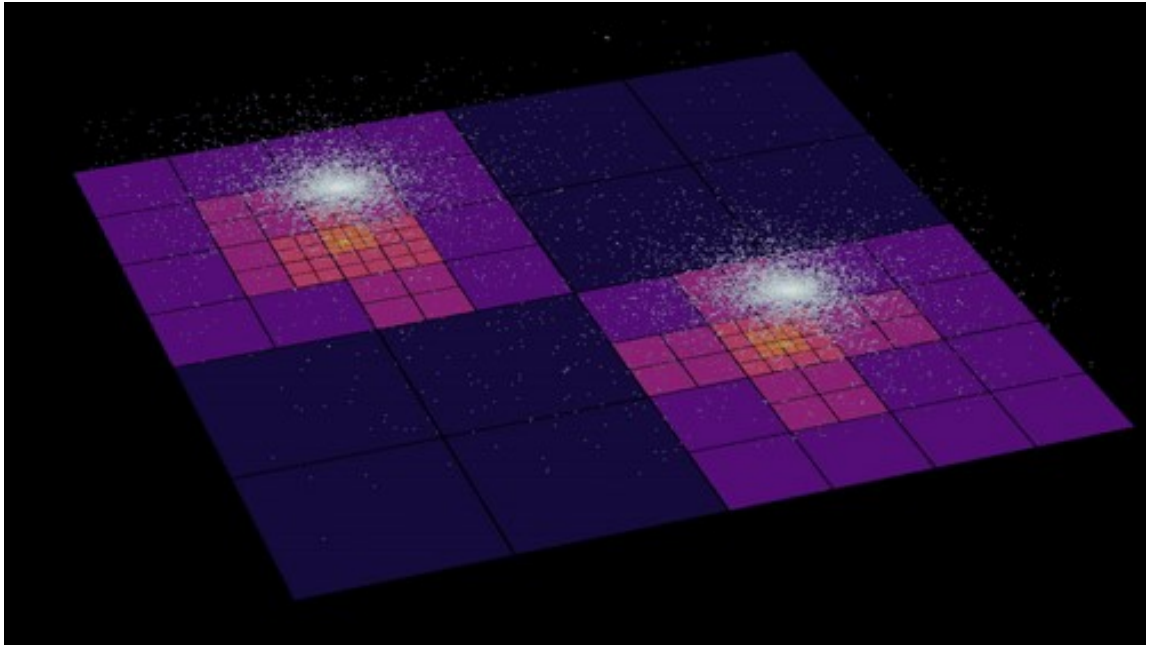
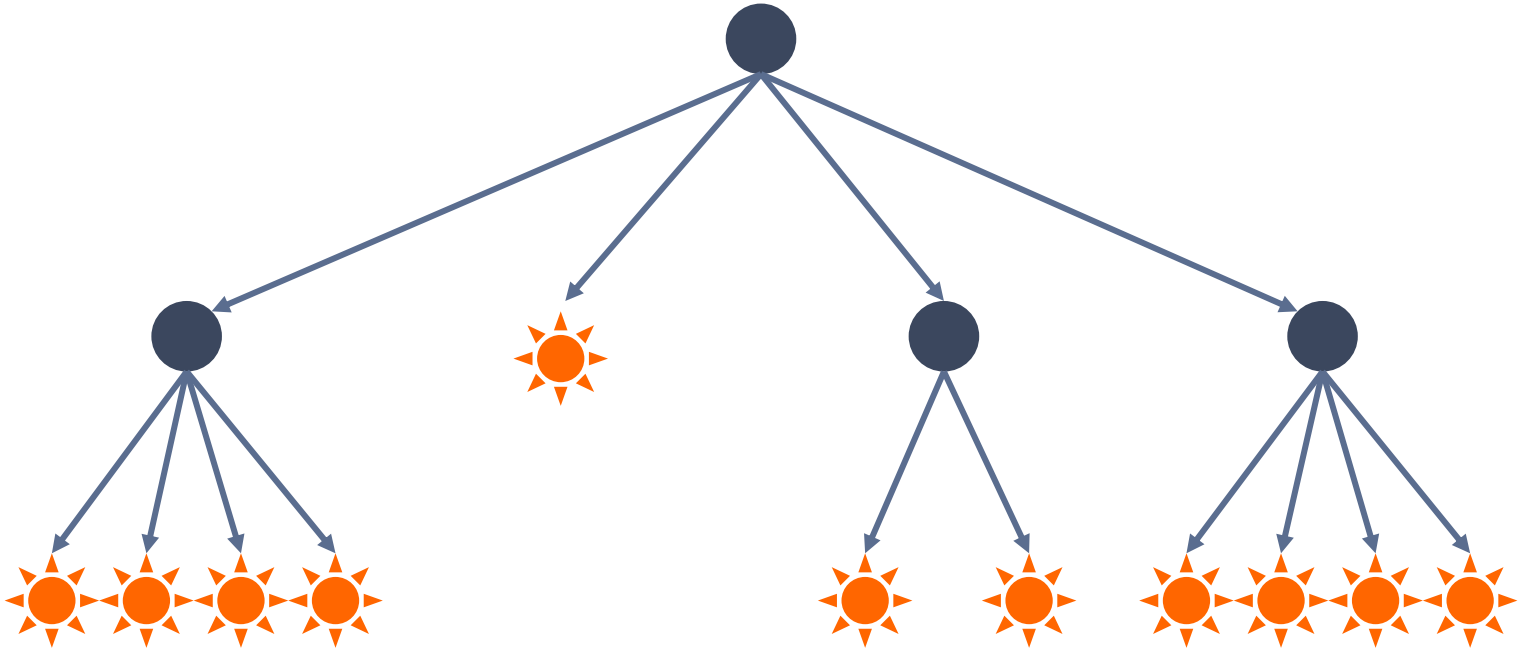
todo.txt

Case Study: Barnes-Hut Simulation



By Perossello - Own work, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=147365688



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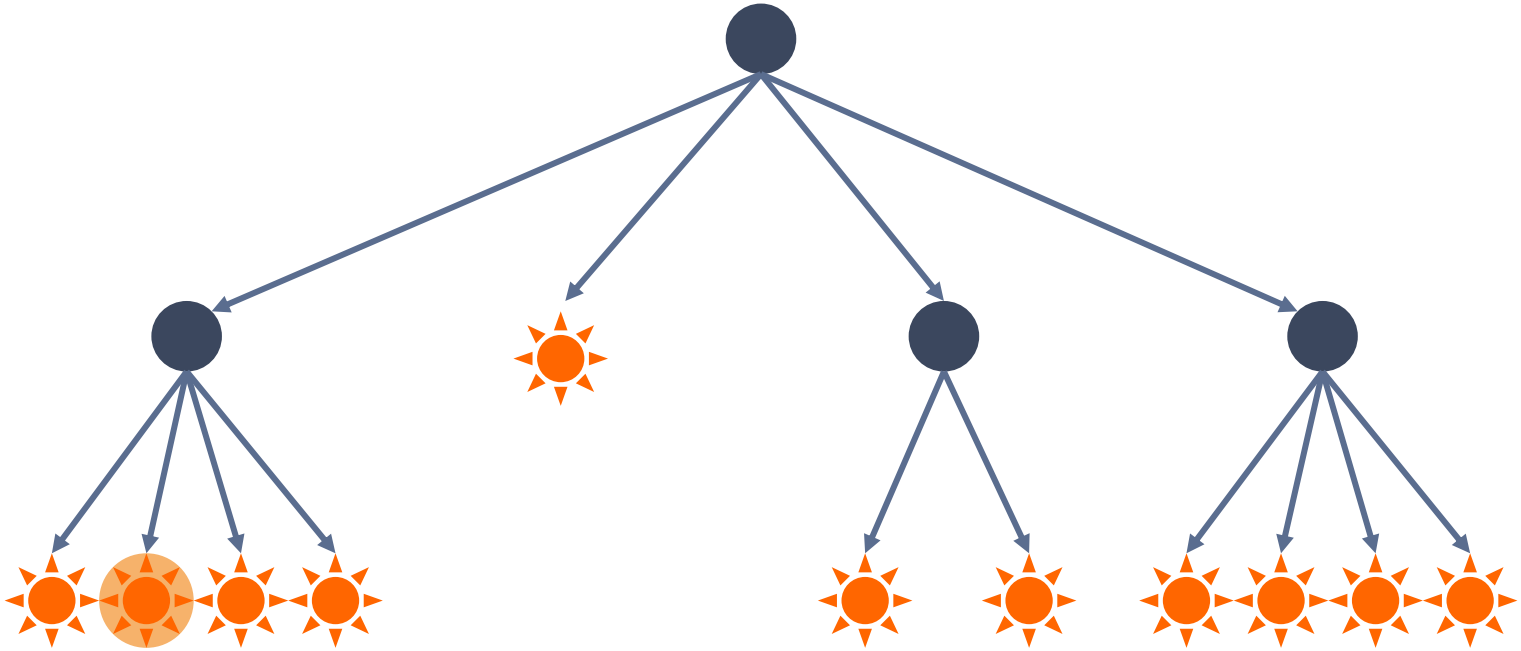

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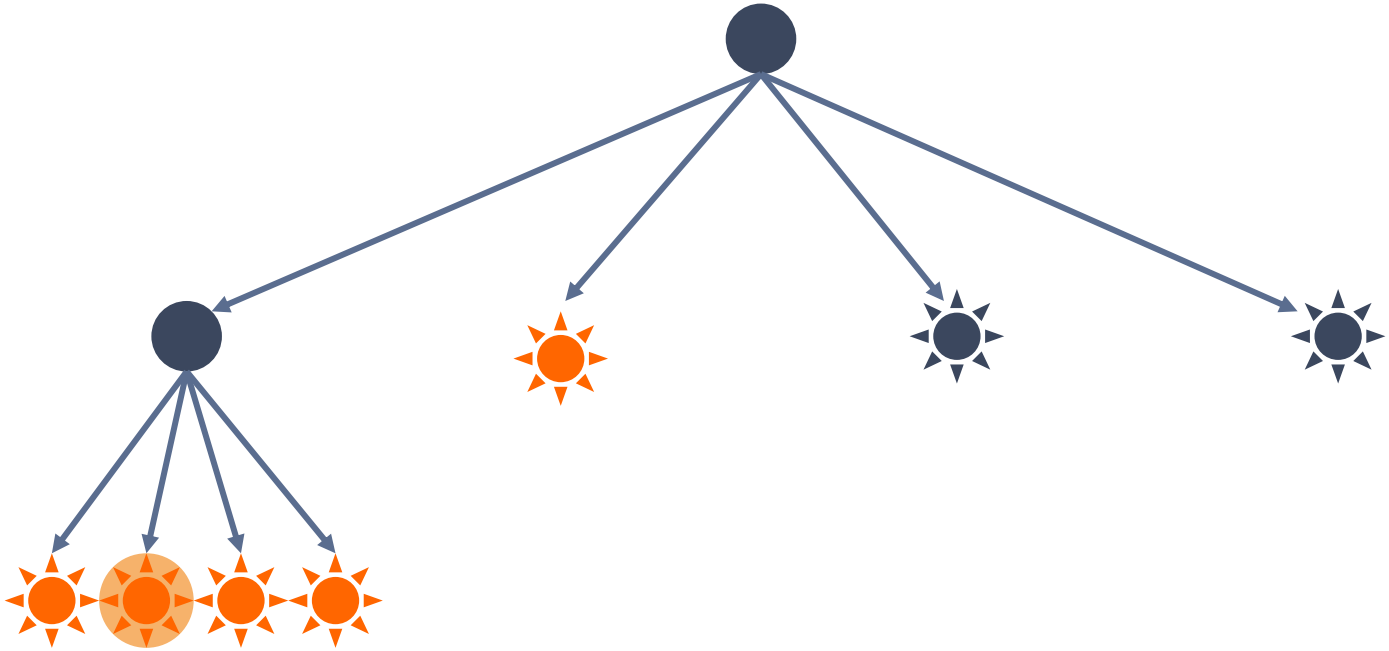

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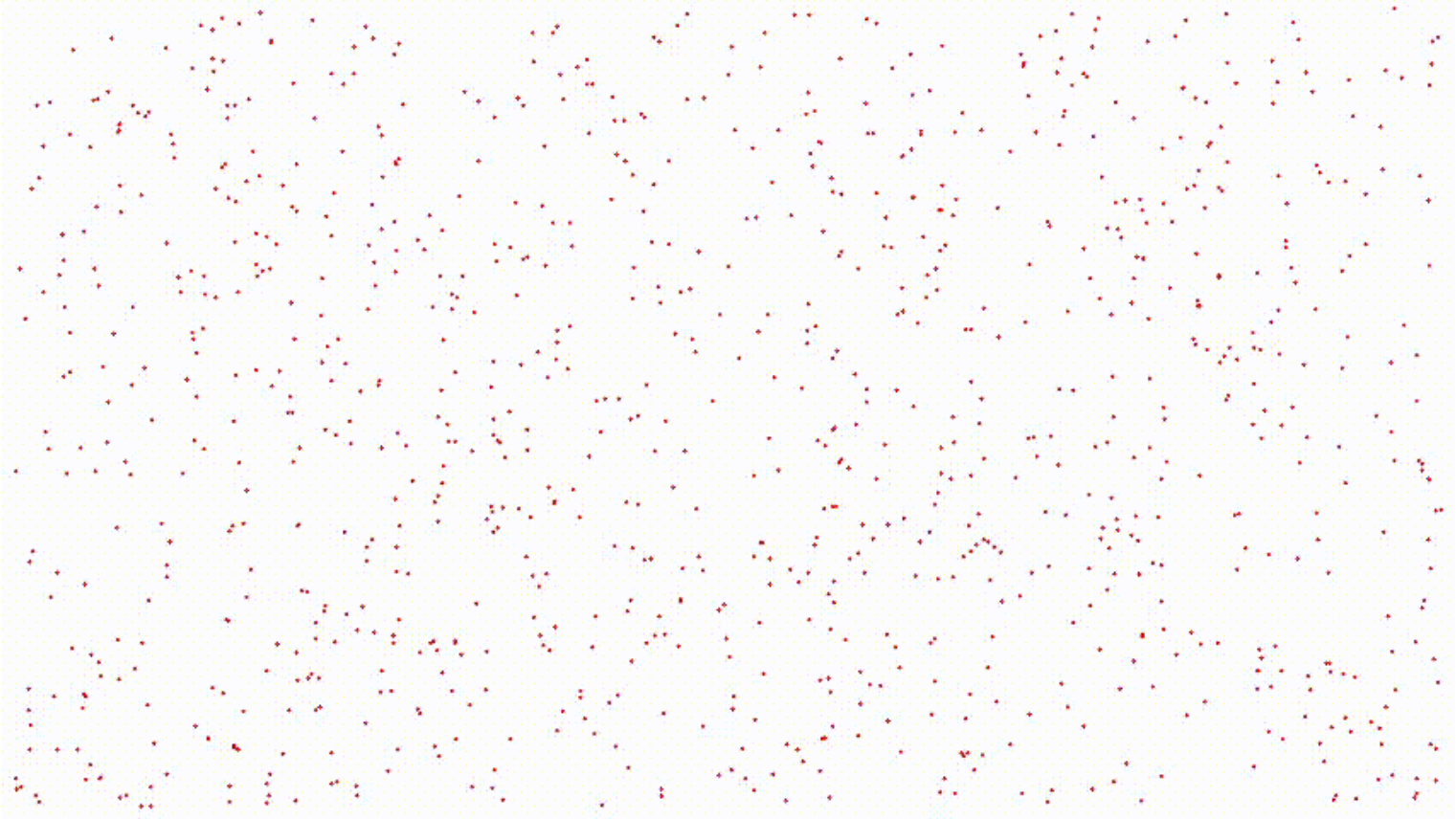

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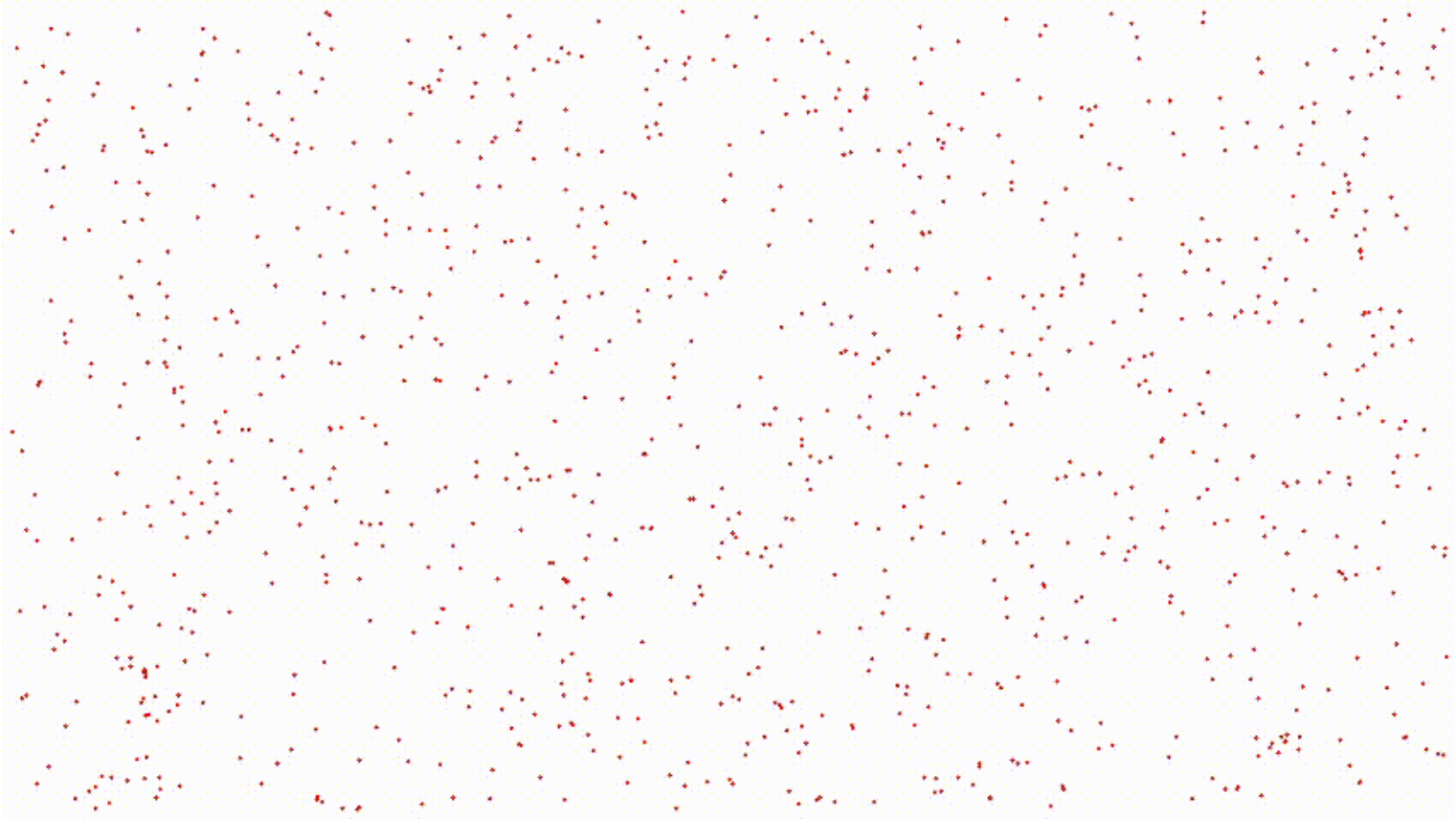

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Case Study: Barnes-Hut Simulation

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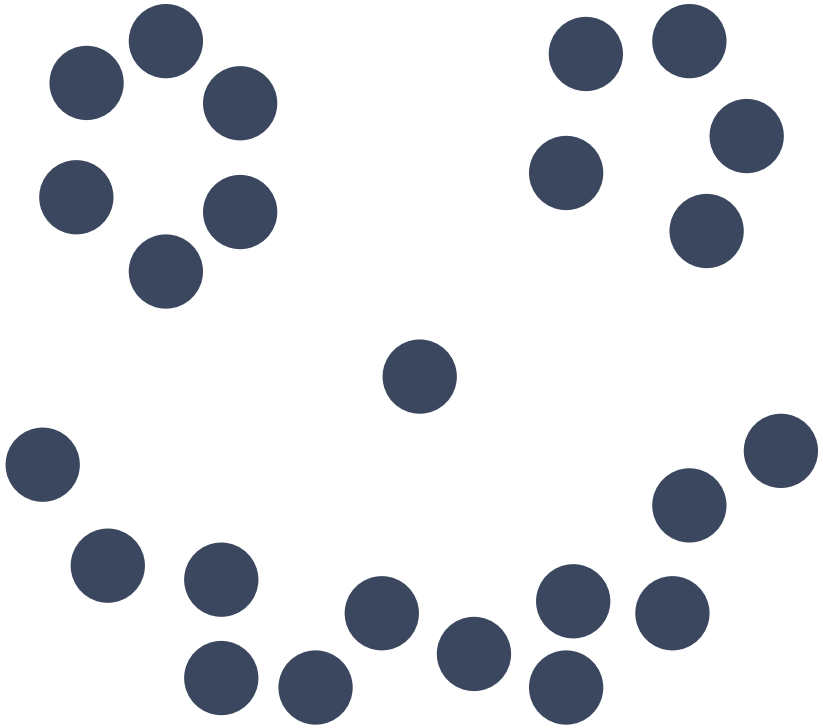
- Possibility 1: I did it wrong
- Possibility 2: Interpreter overhead is overwhelming the speedup
  - Top down traversal for each particle, without any sharing
- Maybe with more particles it is faster
  - My laptop is not strong enough to try
- The point: parent vectors don’t help us with top-down traversal!

Case Study: Disjoint Set Data Structure



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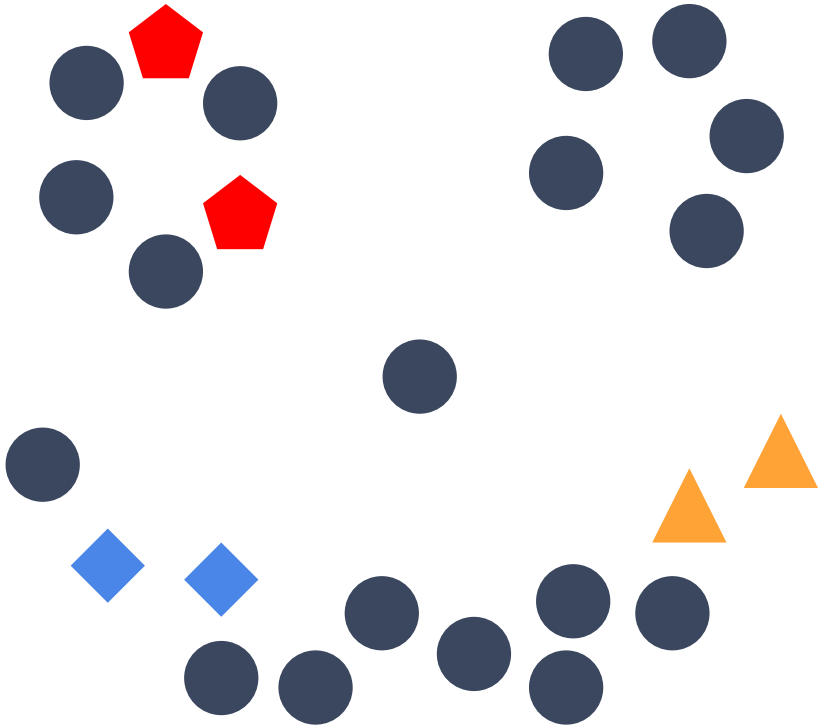

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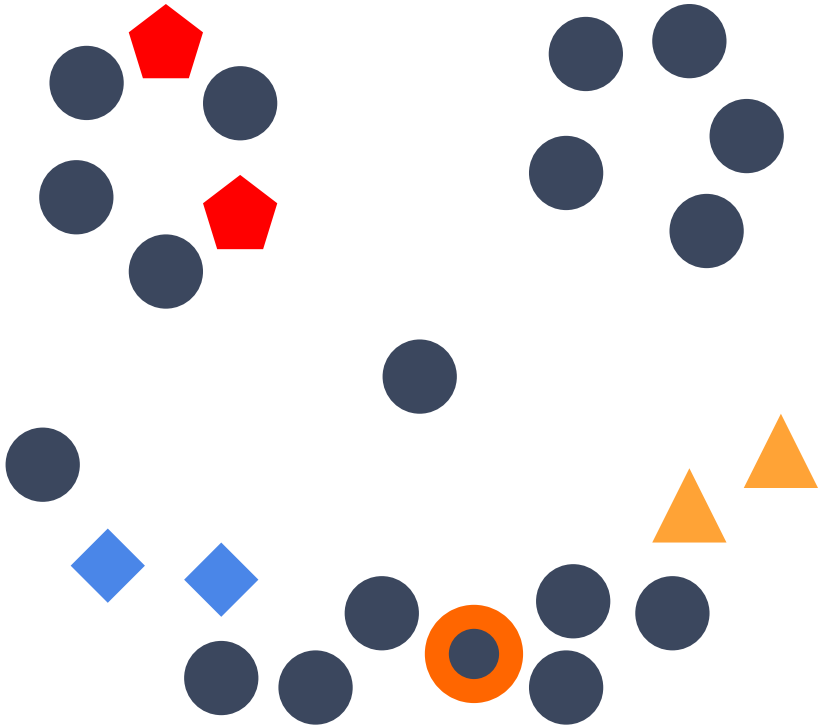

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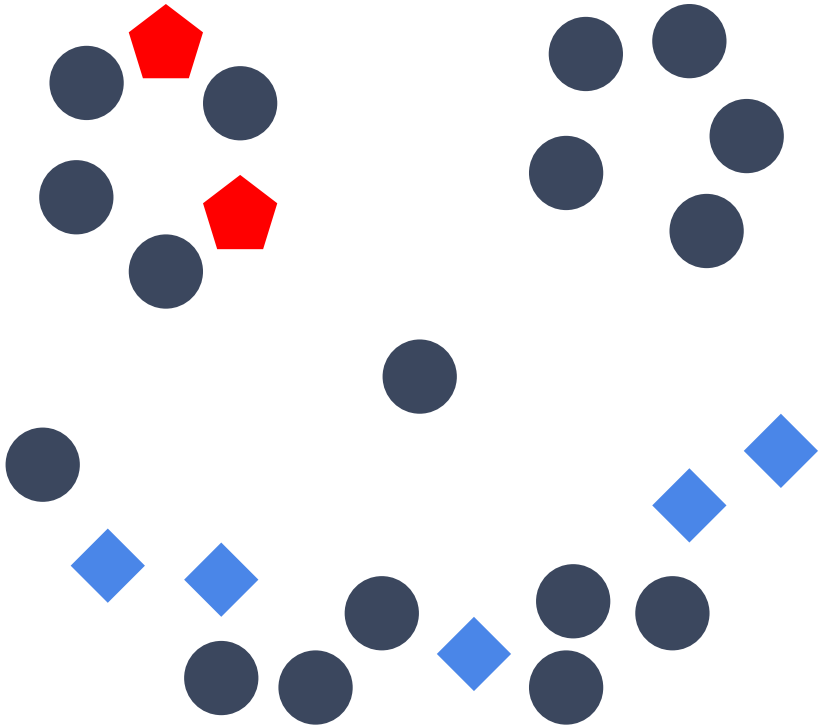

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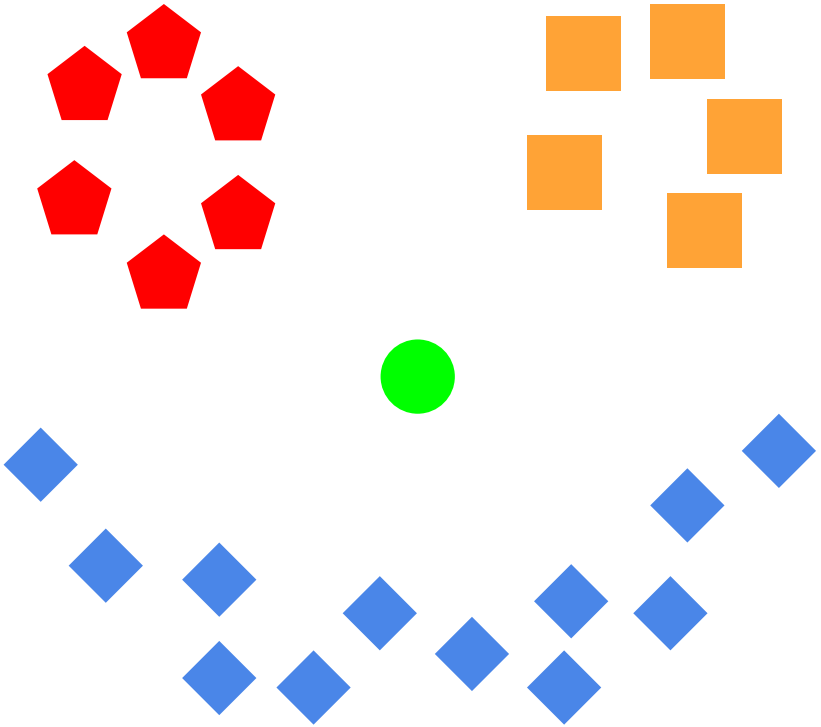

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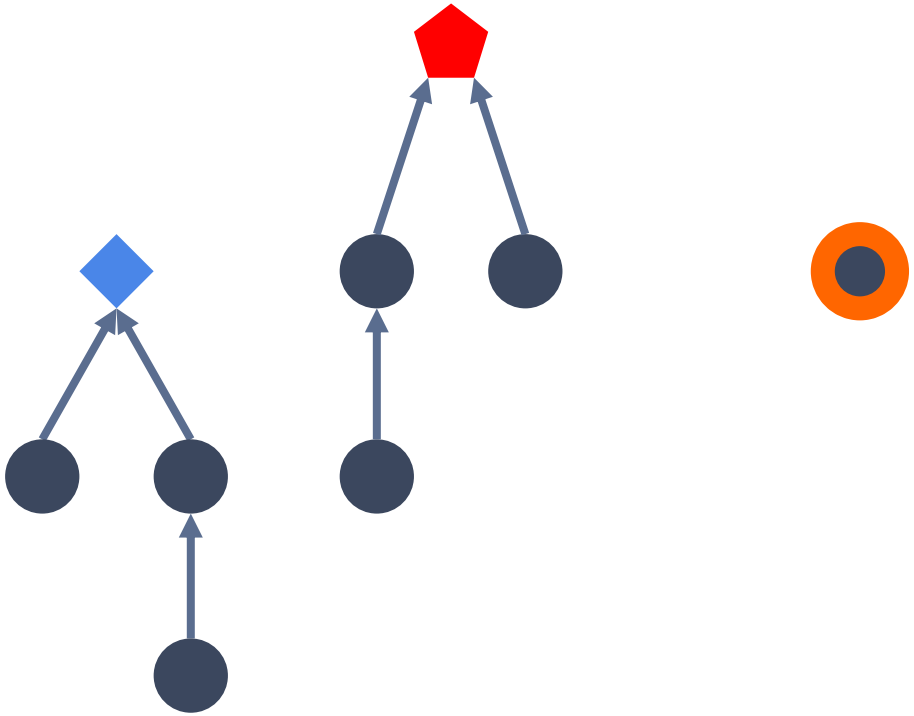

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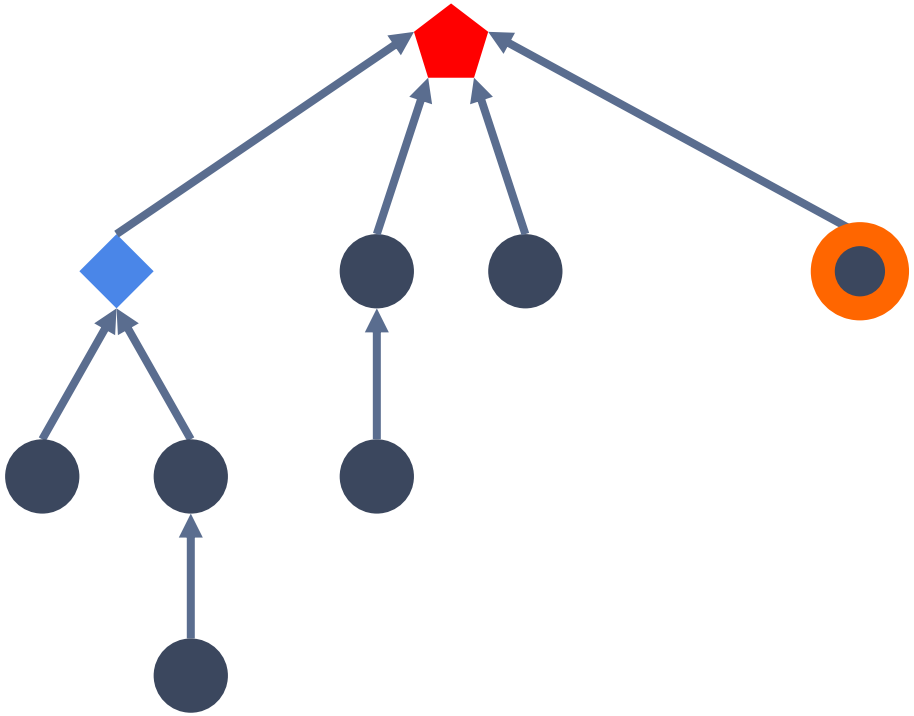

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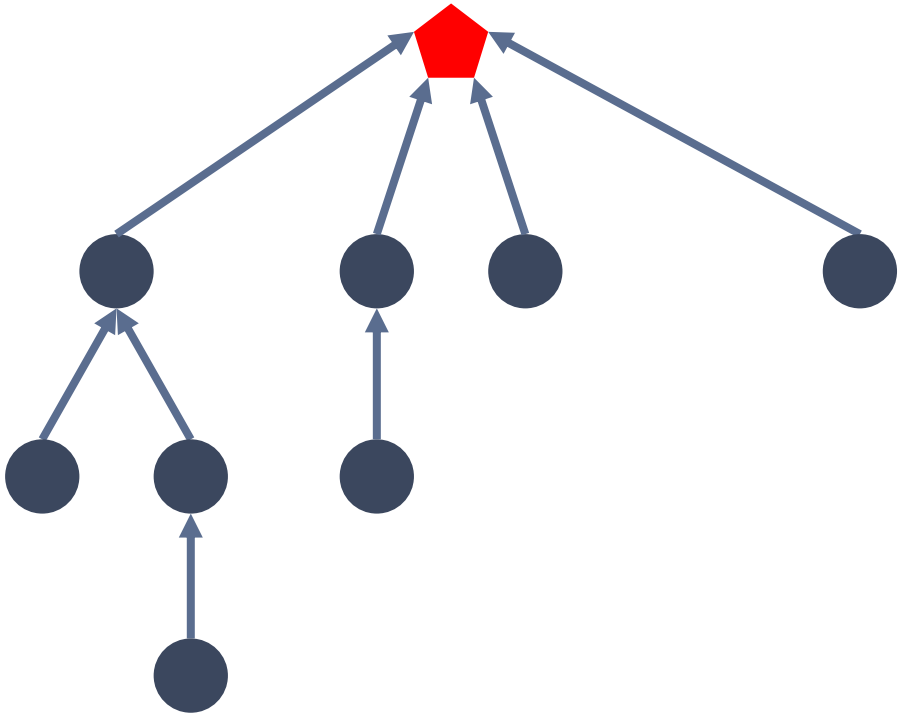

Case Study: Disjoint Set Data Structure

- Finding contiguous regions of an image
  - I used it for this
- Finding connected components
- Finding minimum spanning trees
- Solving symbolic expressions by unification
- Probably more!

The Root of It

- Data
  - Syntax trees ✓
  - File systems ✓
  - …
- Algorithms
  - Barnes-Hut simulation ✗
  - Disjoint sets ✓
  - …

The Root of It

- You can do trees the APL way!
- Consider using parent vectors if you have trees which
  - Are large
  - Are irregular
  - Are often traversed bottom-up
- You could* speed up your program and/or make it easier to understand
  - *your mileage may vary, always profile

Read My Tutorial!

asherbhs.github.io/apl-site/trees/intro.html

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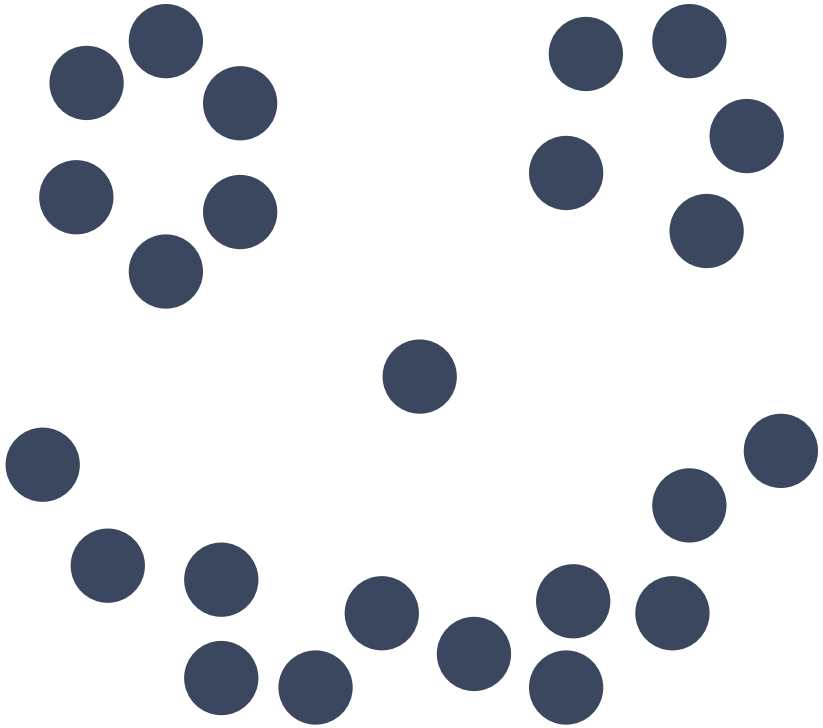

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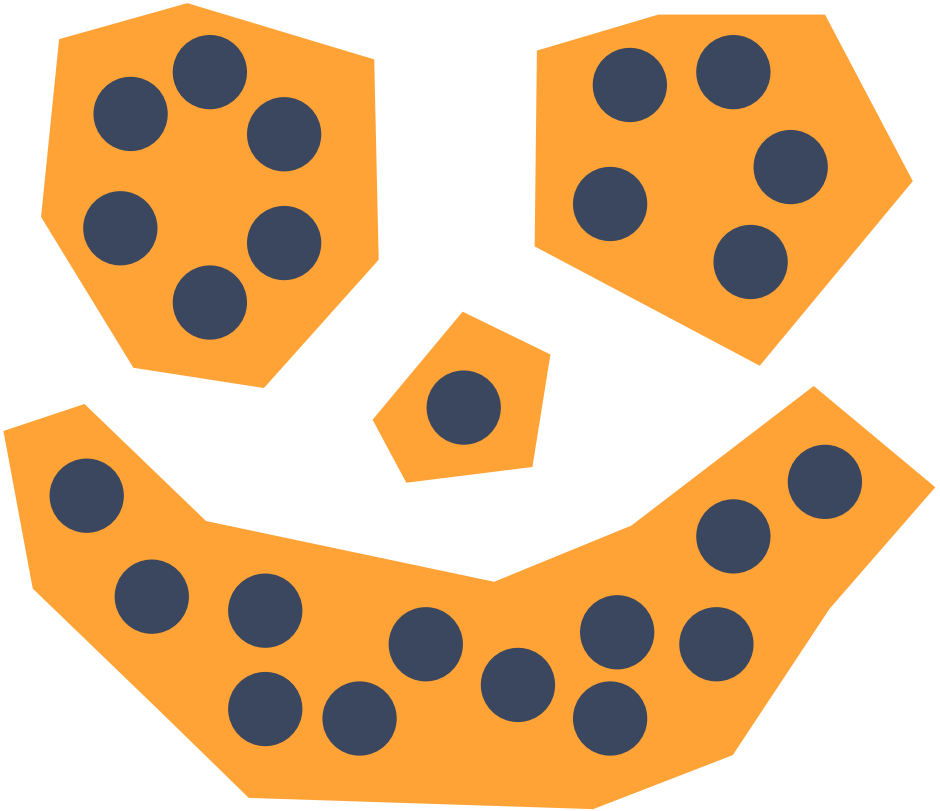

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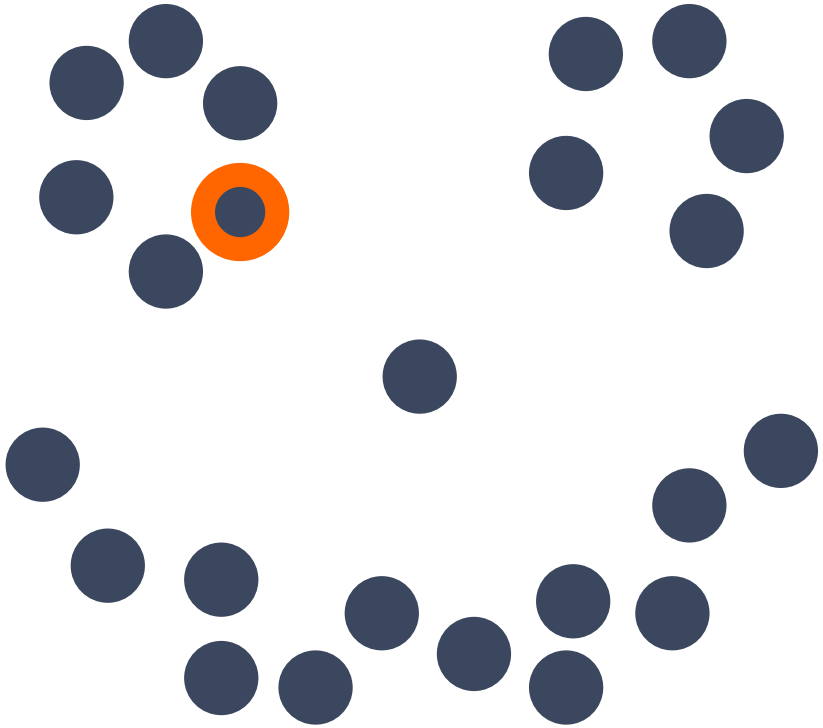

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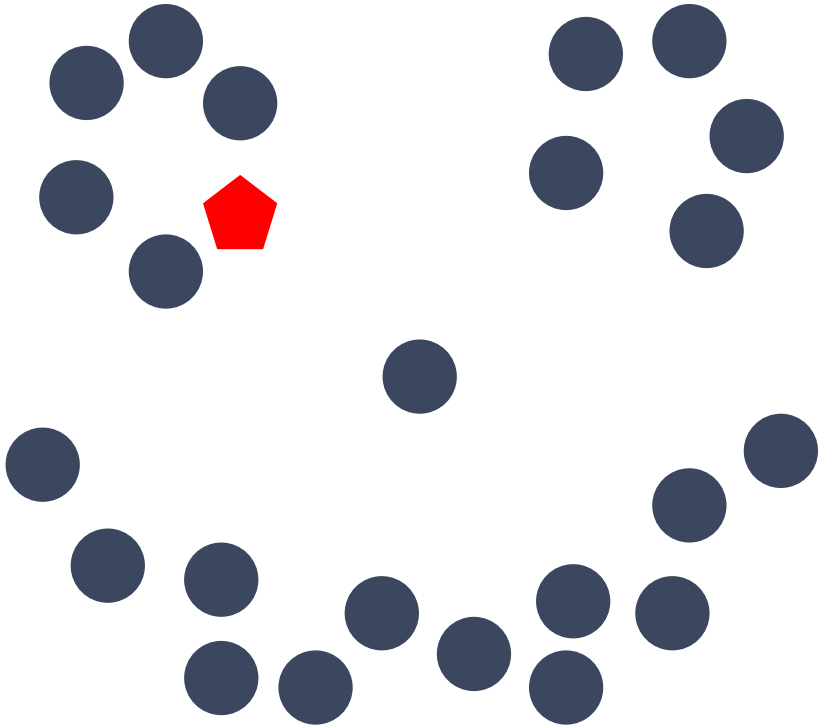

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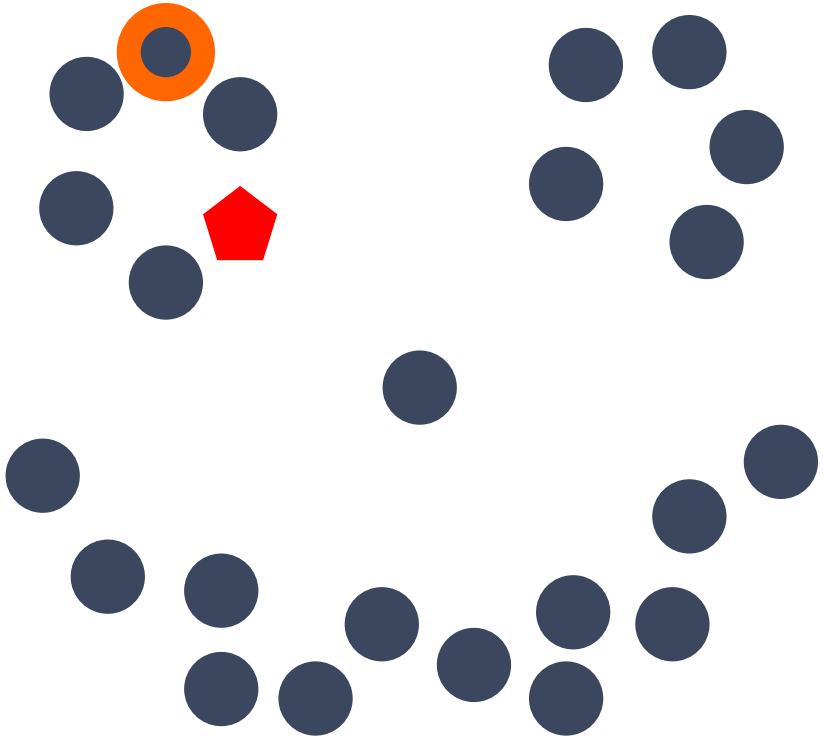

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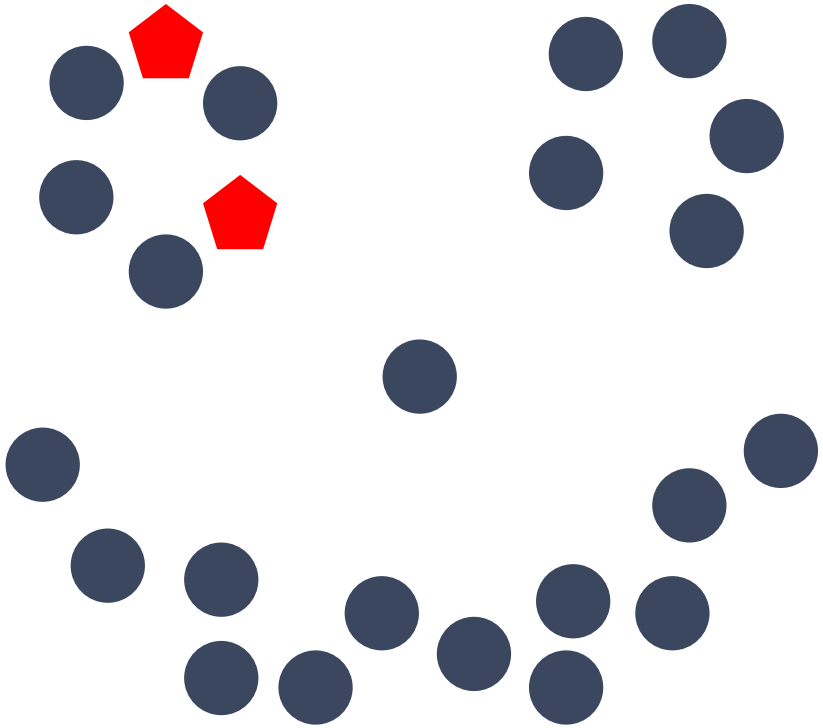

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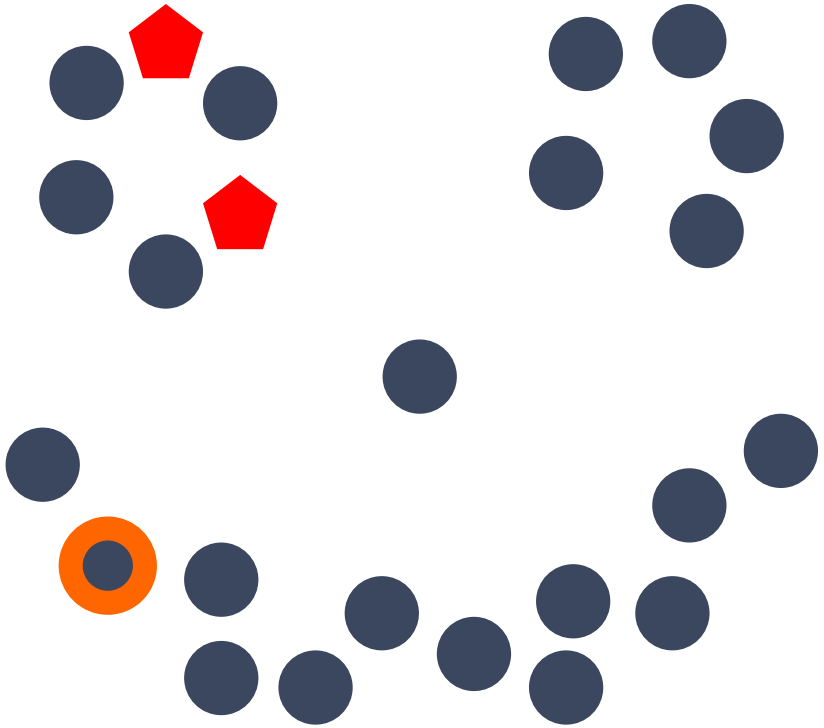

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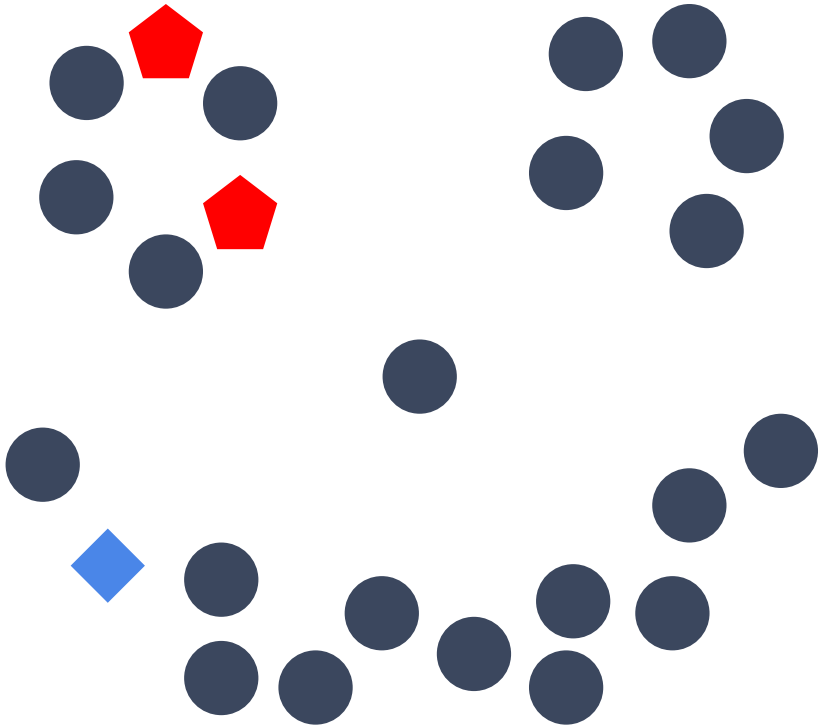

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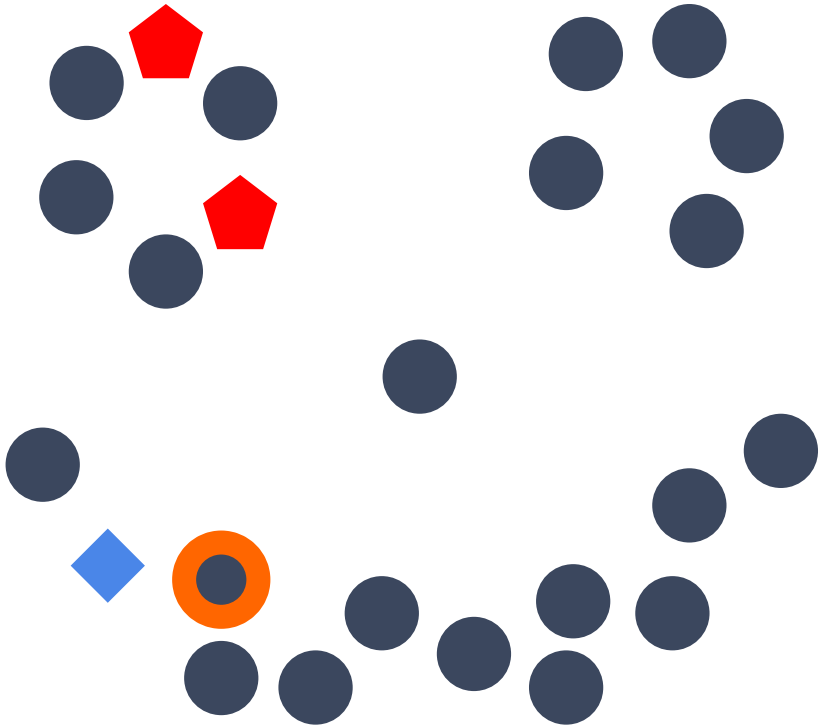

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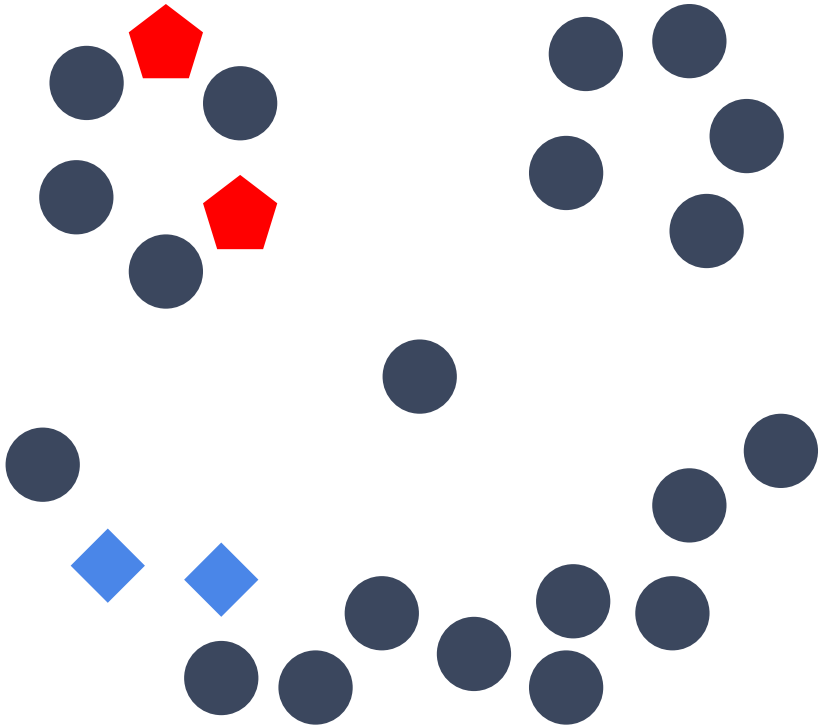

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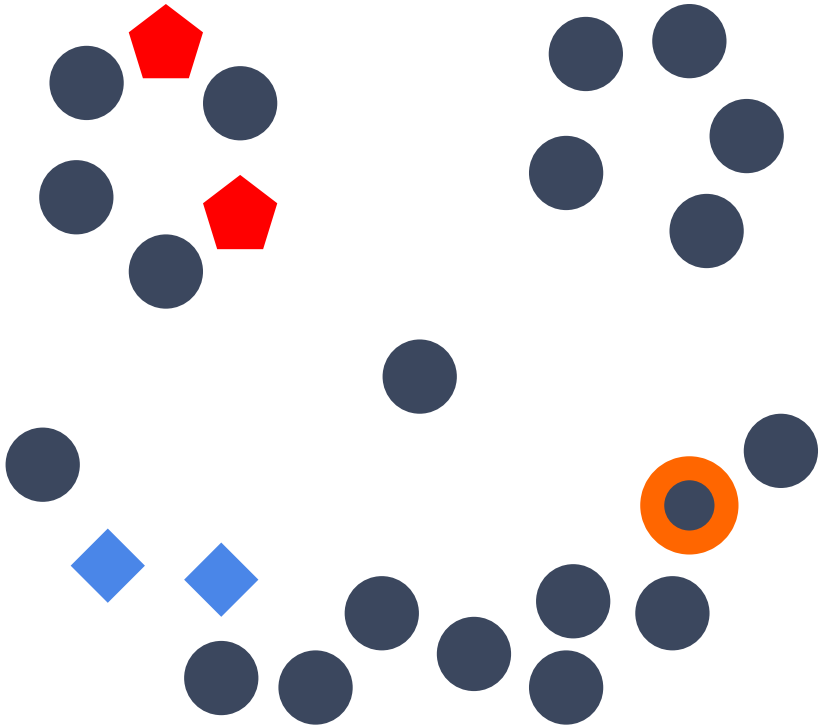

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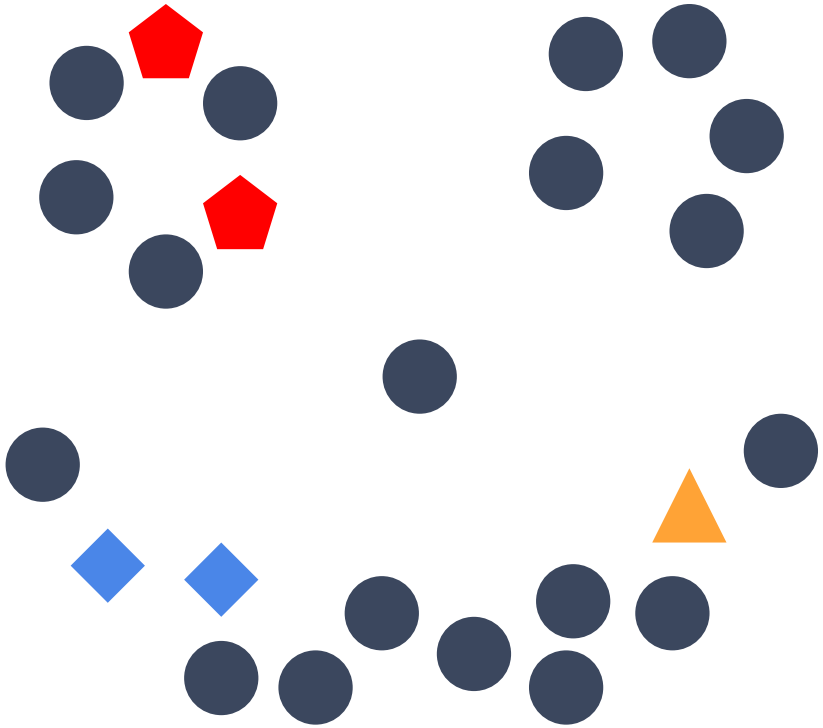

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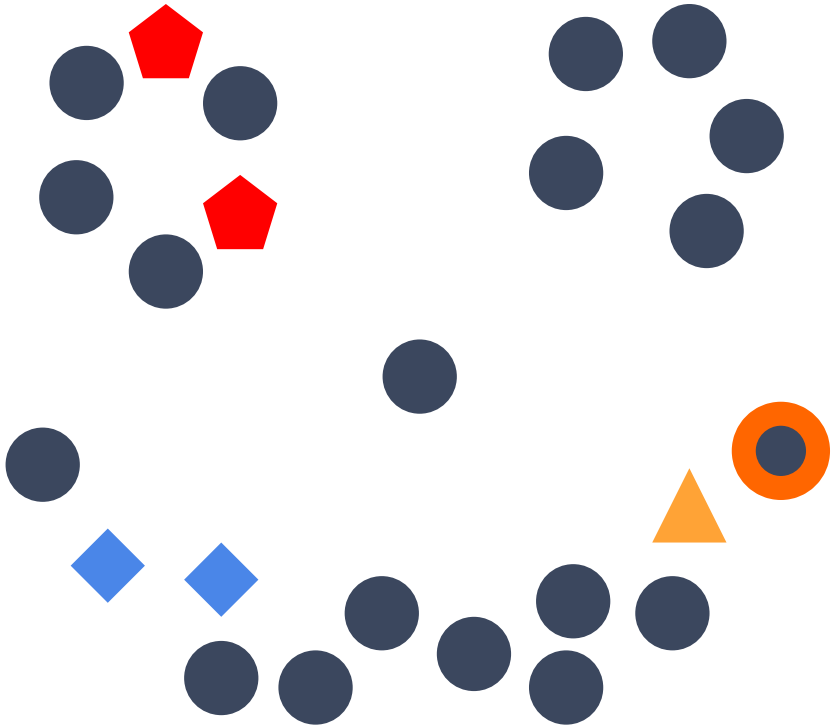

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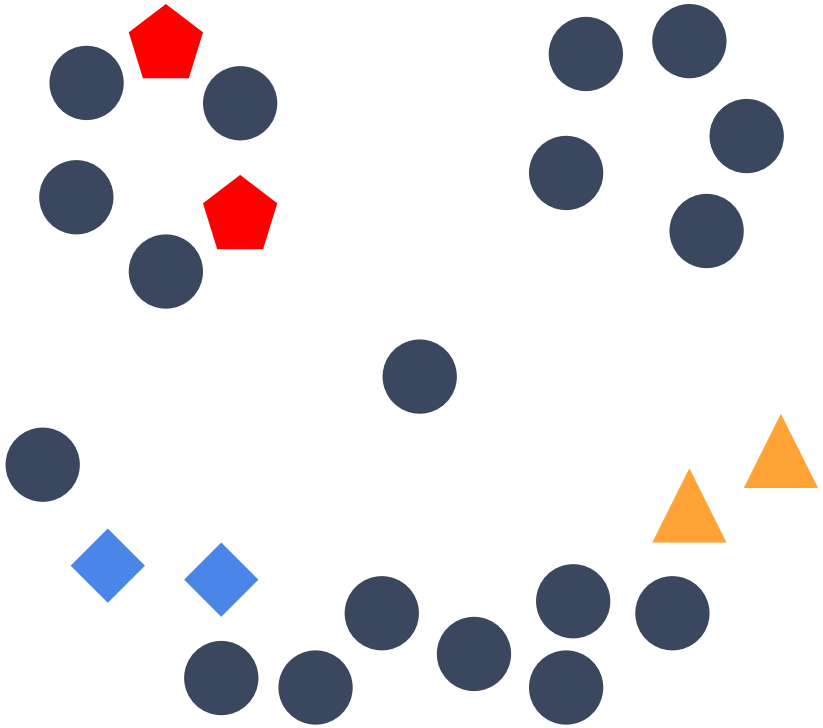

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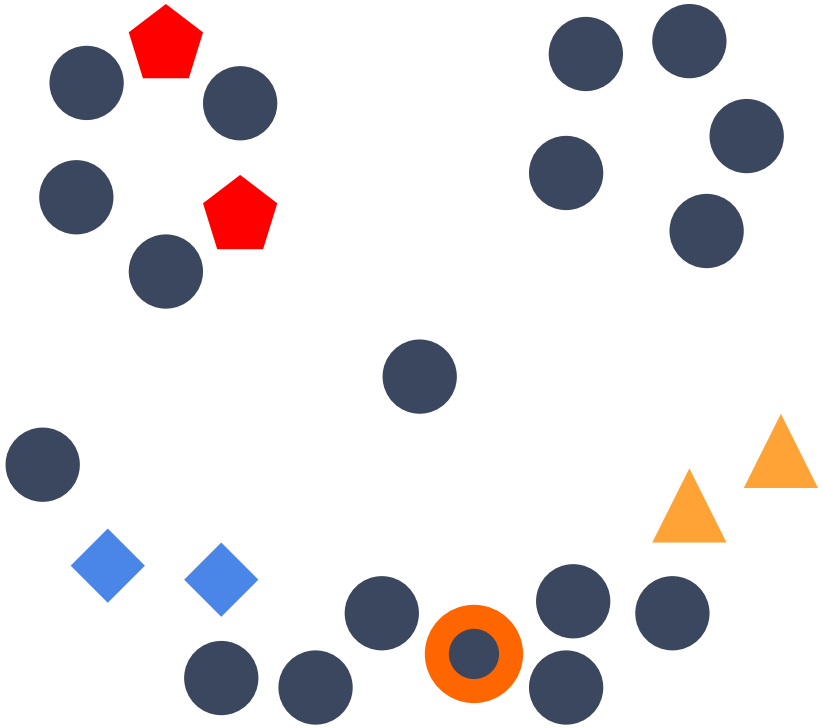
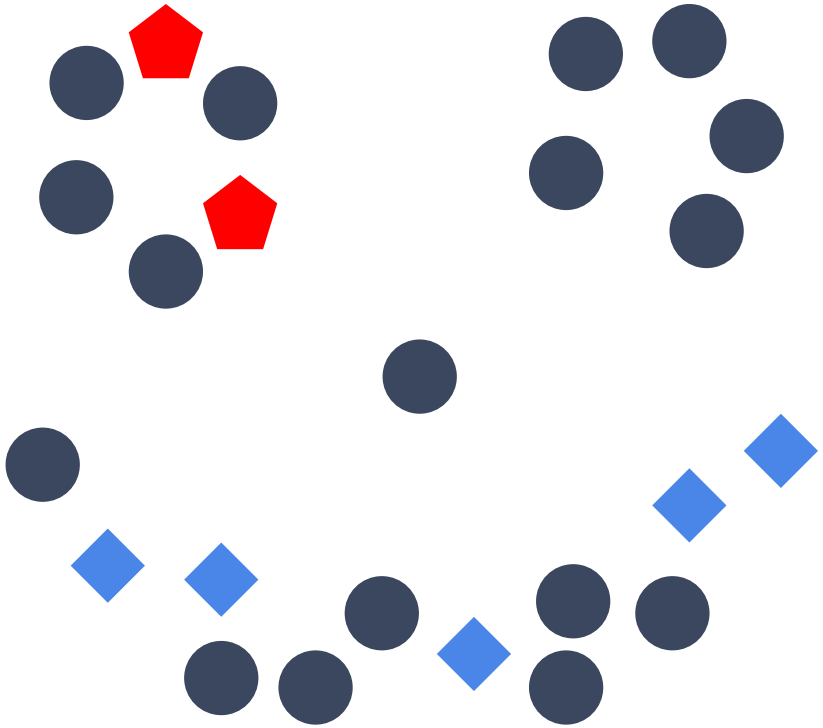


Case Study: Disjoint Set Data Structure



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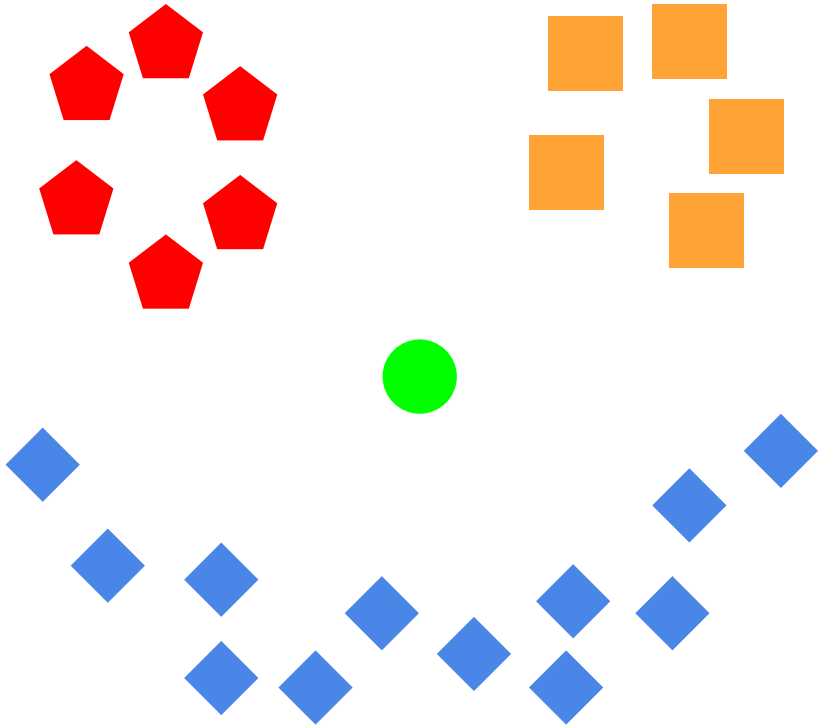

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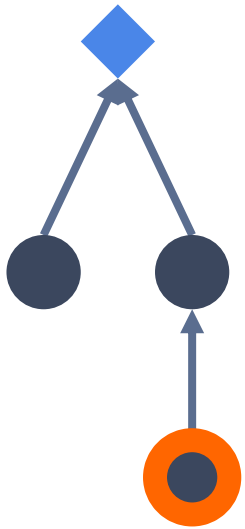

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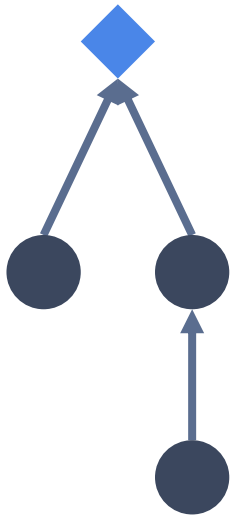

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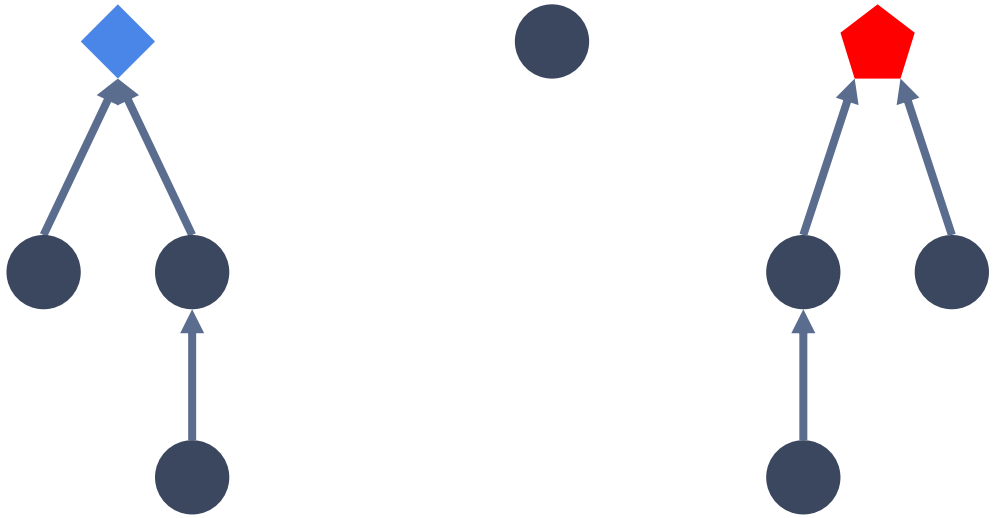

Case Study: Disjoint Set Data Structure

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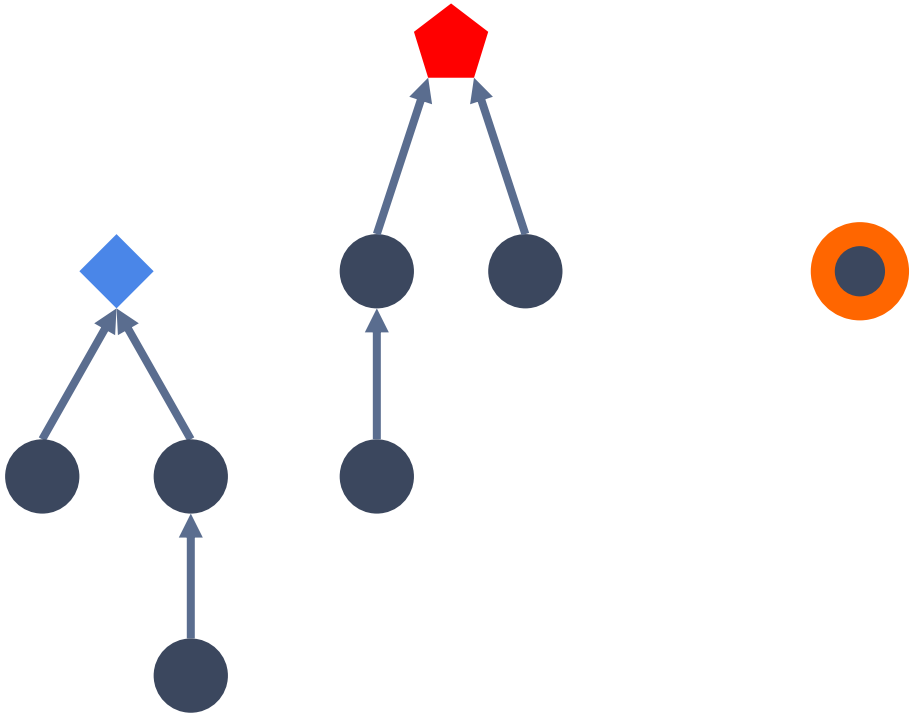

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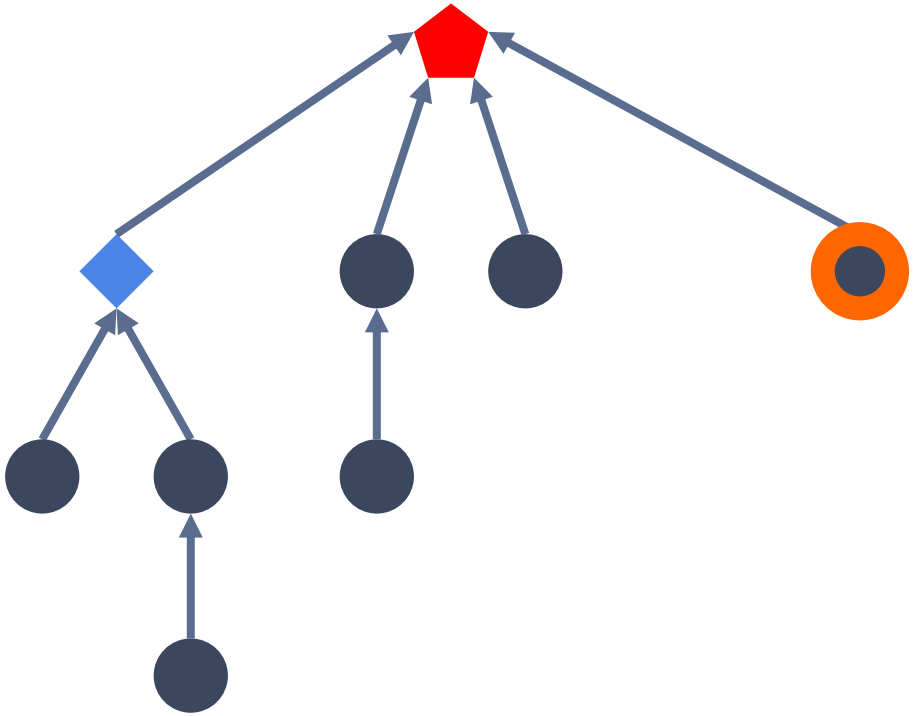

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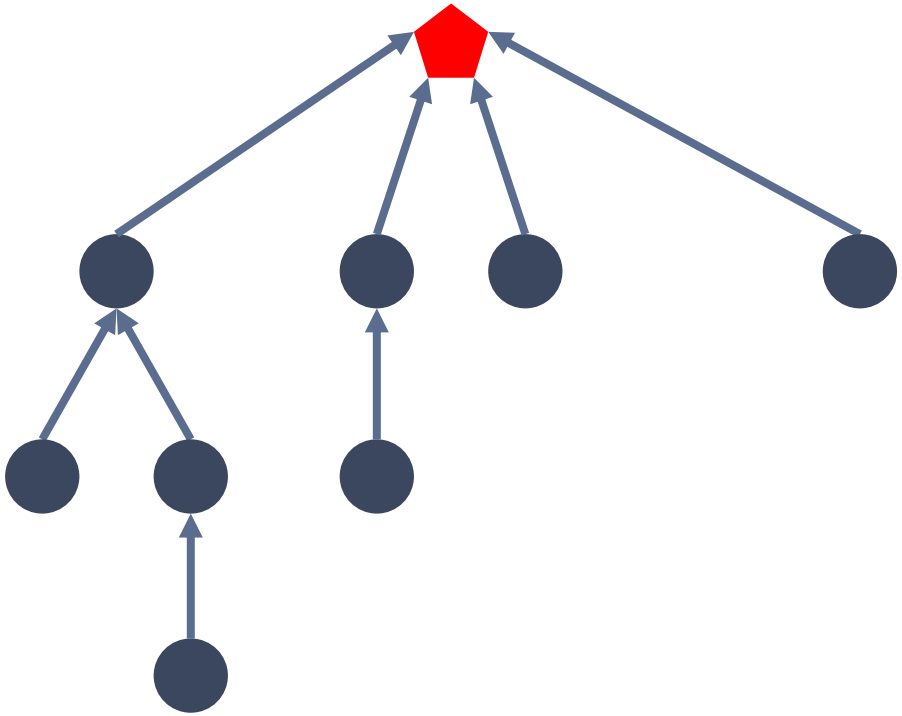

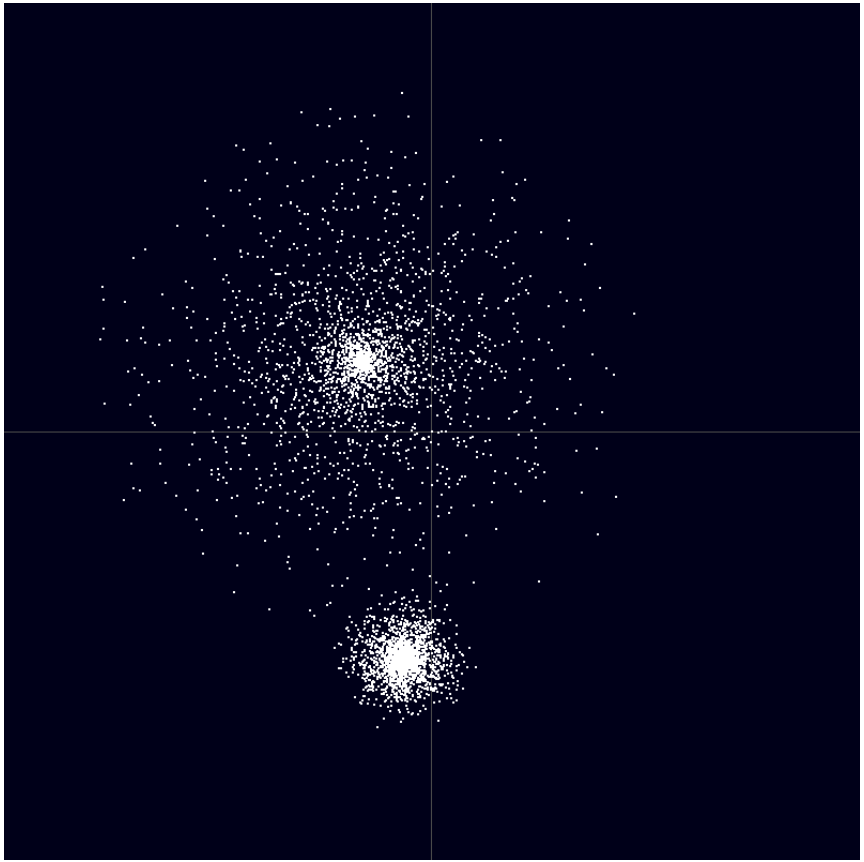

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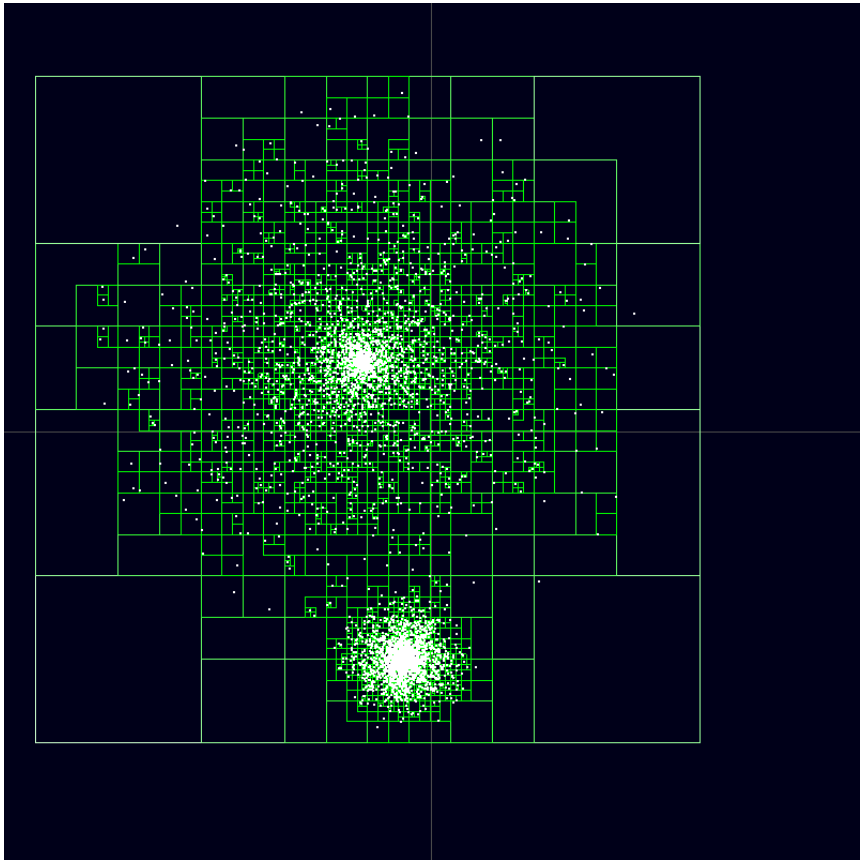

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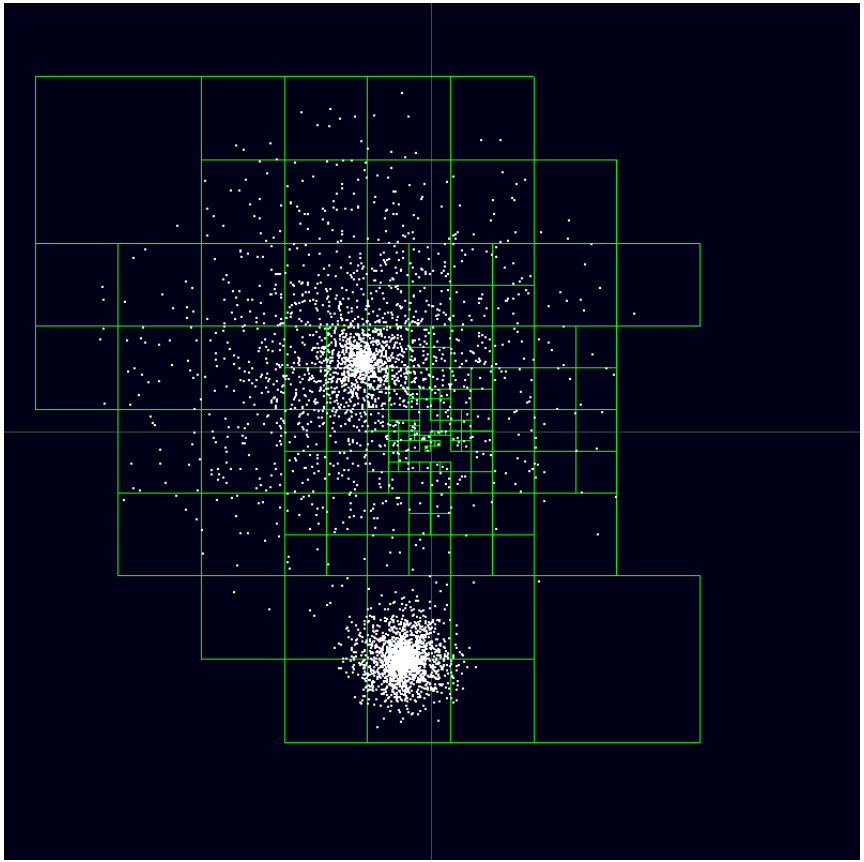

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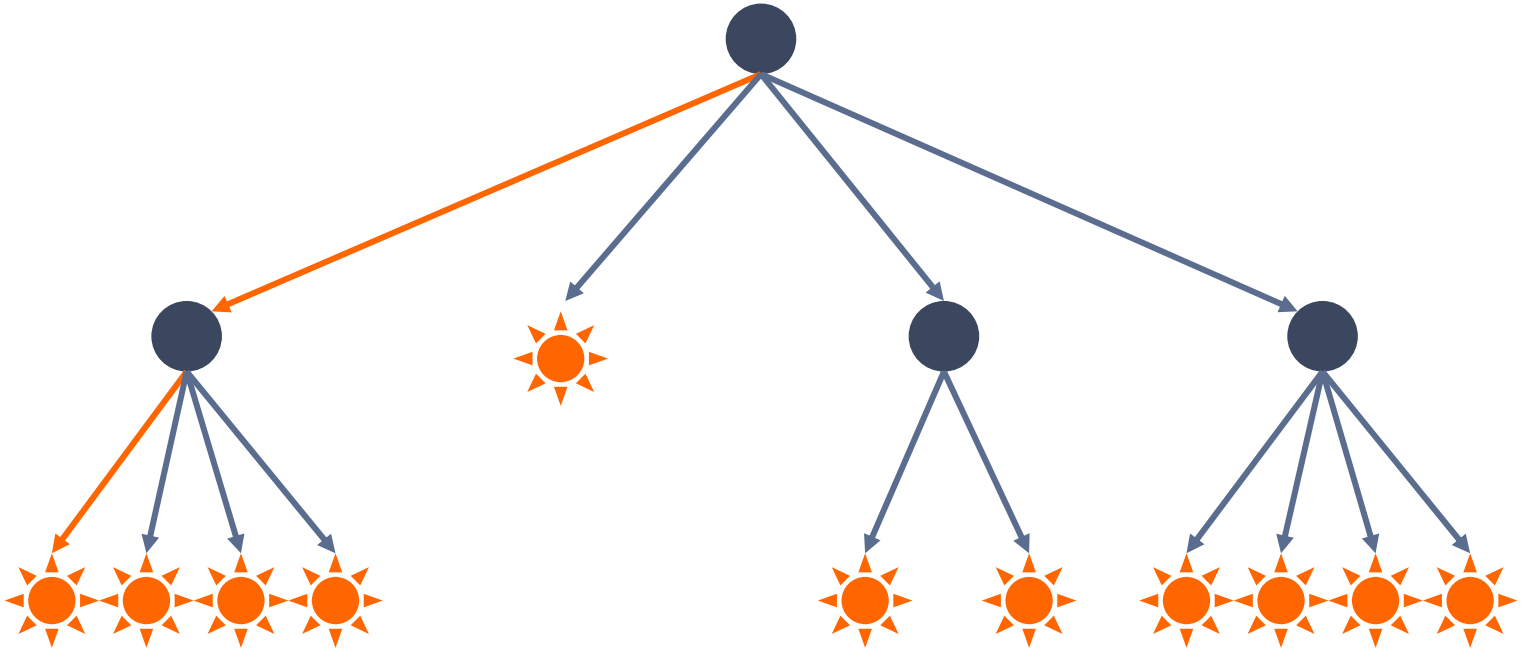
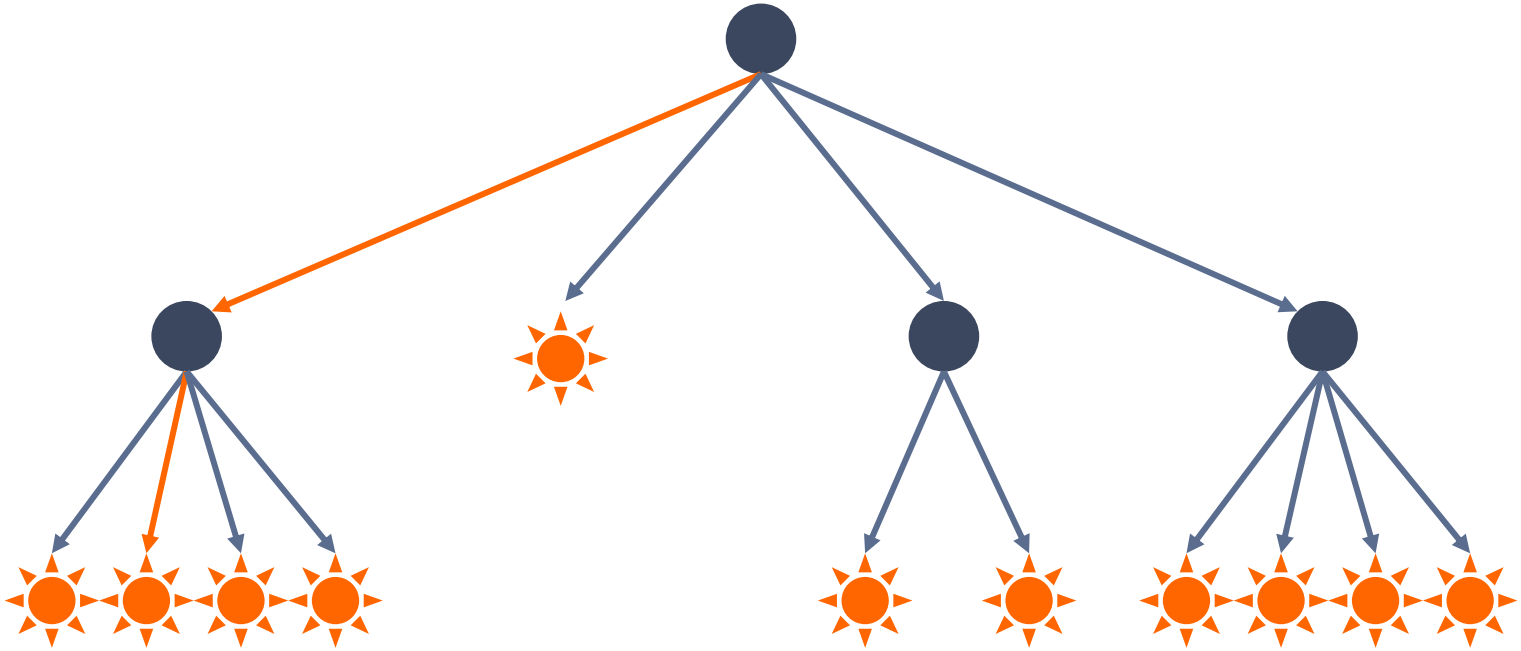
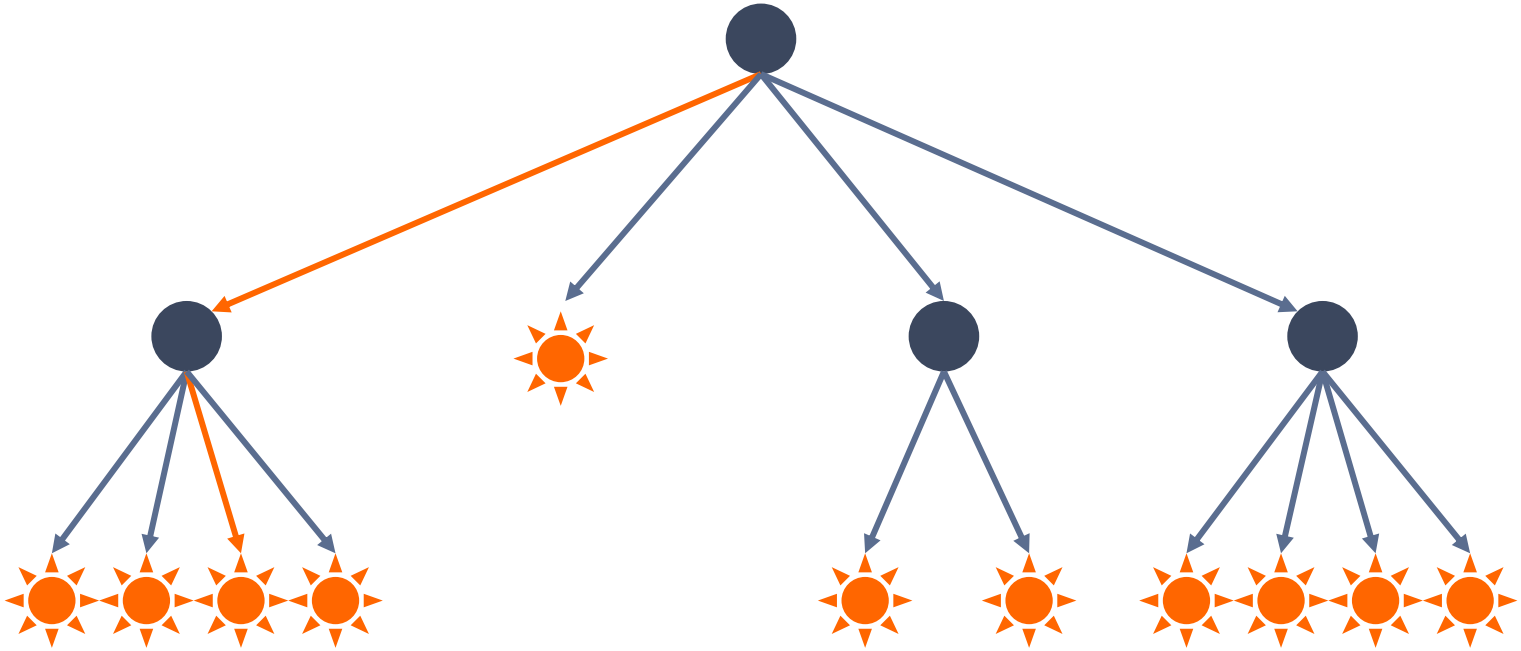


What can Vectorised Trees Do for You?



What can Vectorised Trees Do for You?

DYNA



What can Vectorised Trees Do for You?

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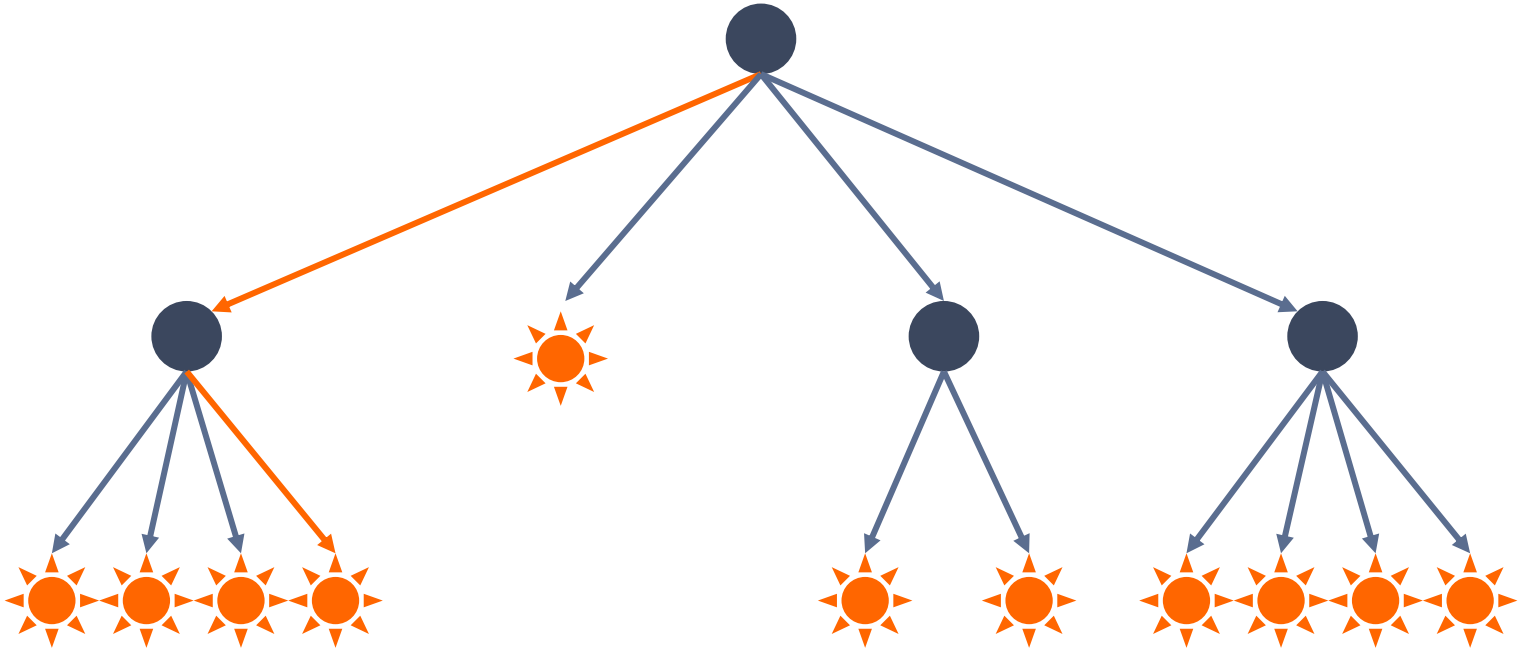

What can Vectorised Trees Do for You?