A Pointer Tracking Memory Model for KLEE

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https://comsys.rwth-aachen.de 1st KLEE Workshop, London, UK, 2018-04-20

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Motivation

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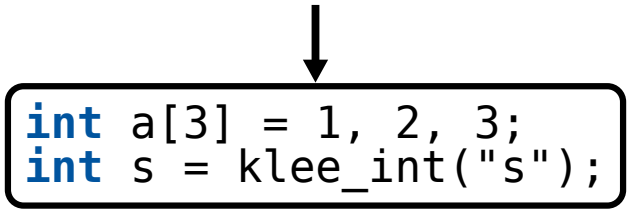

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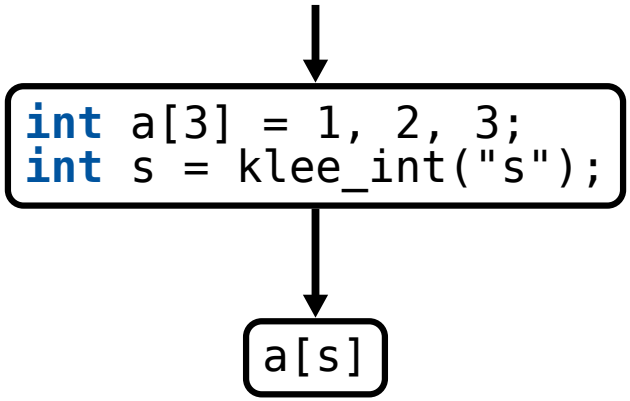

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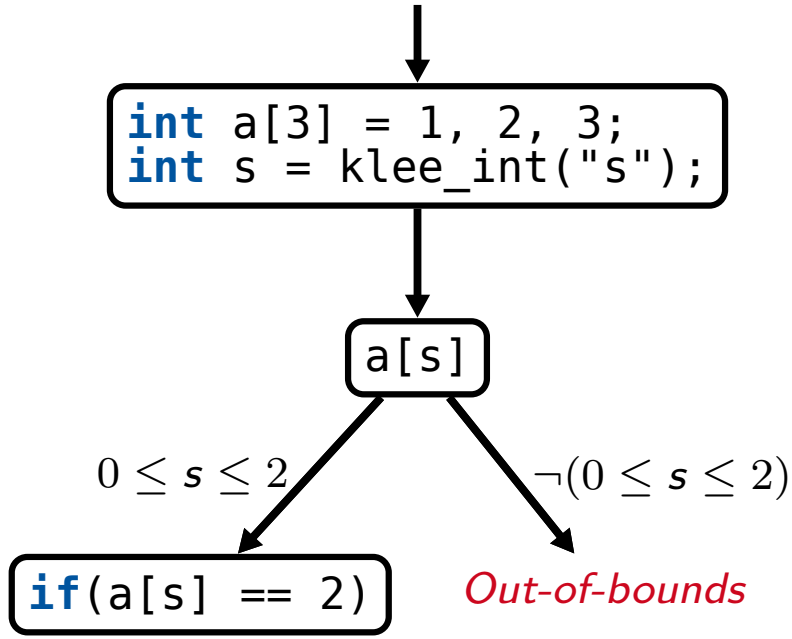

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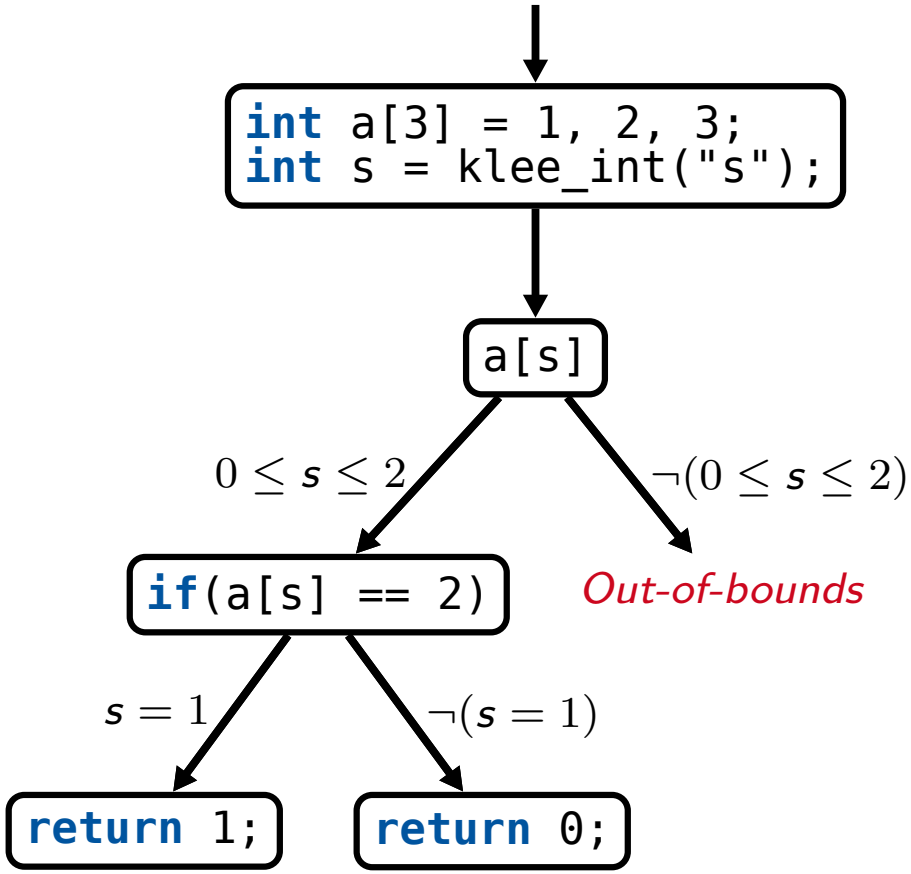

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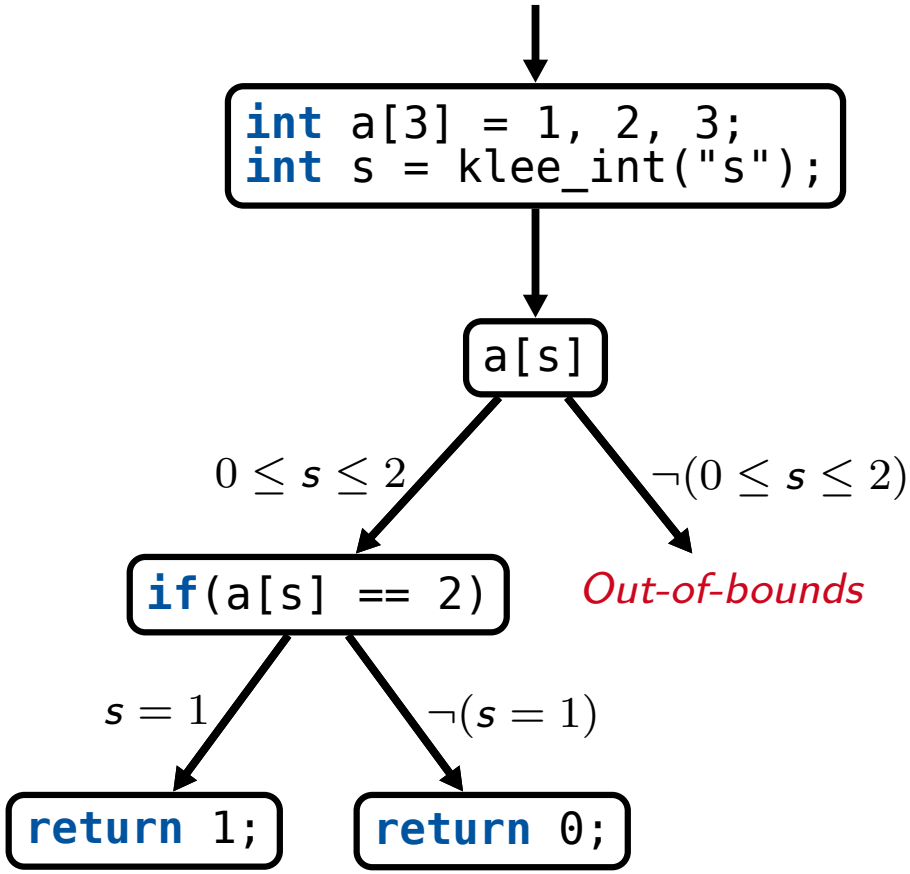
Expected: 3 Test Cases

Actual: *17* Test Cases



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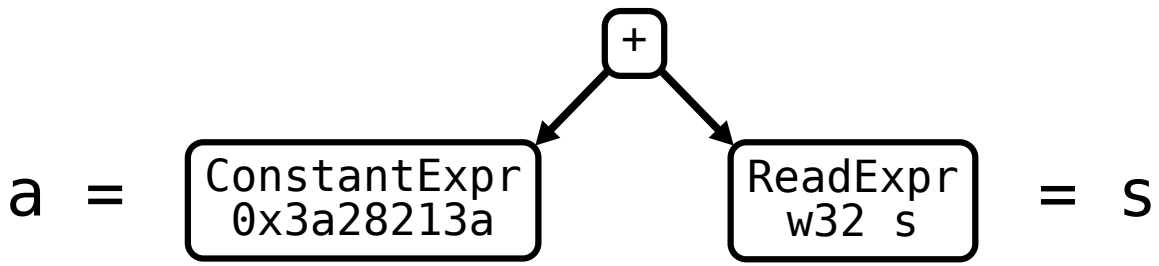

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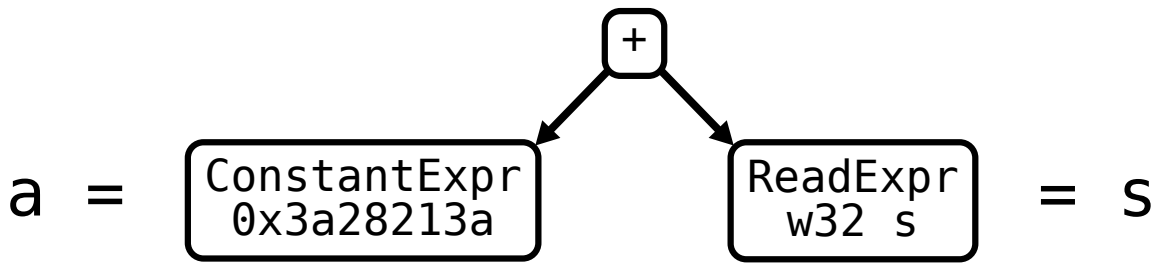

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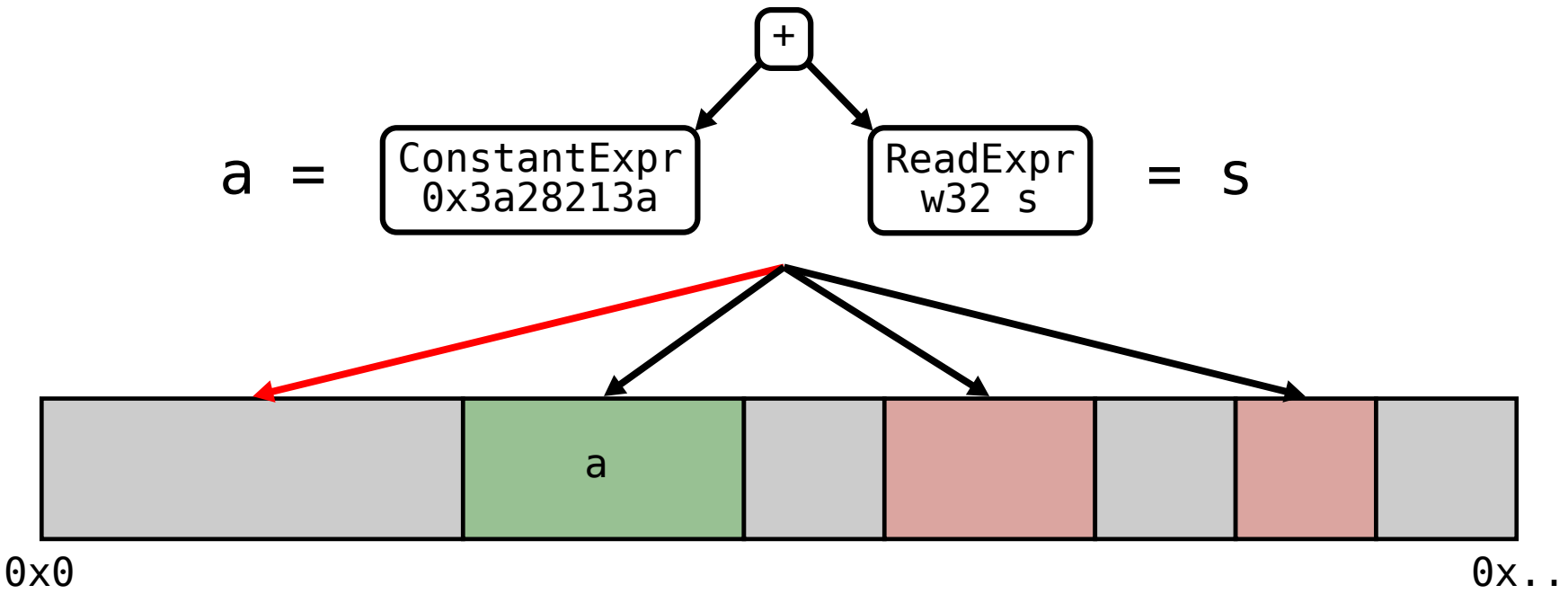

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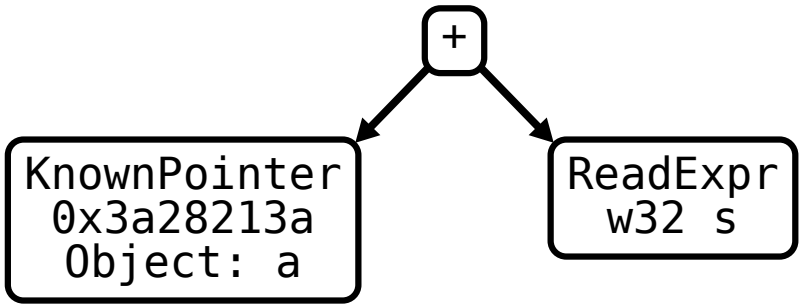

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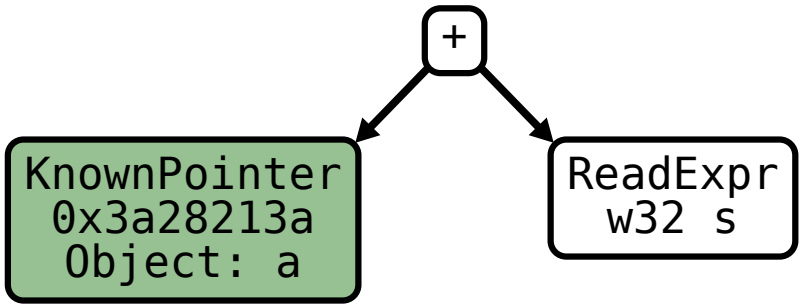

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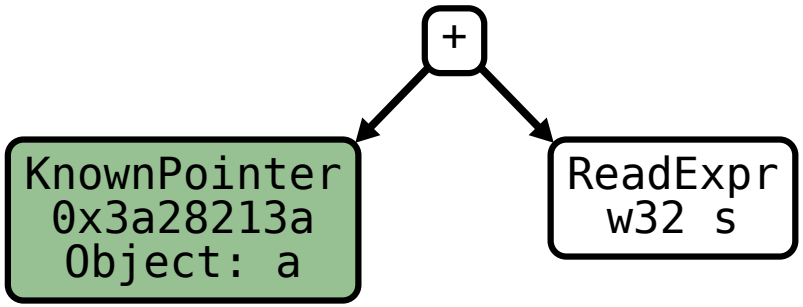

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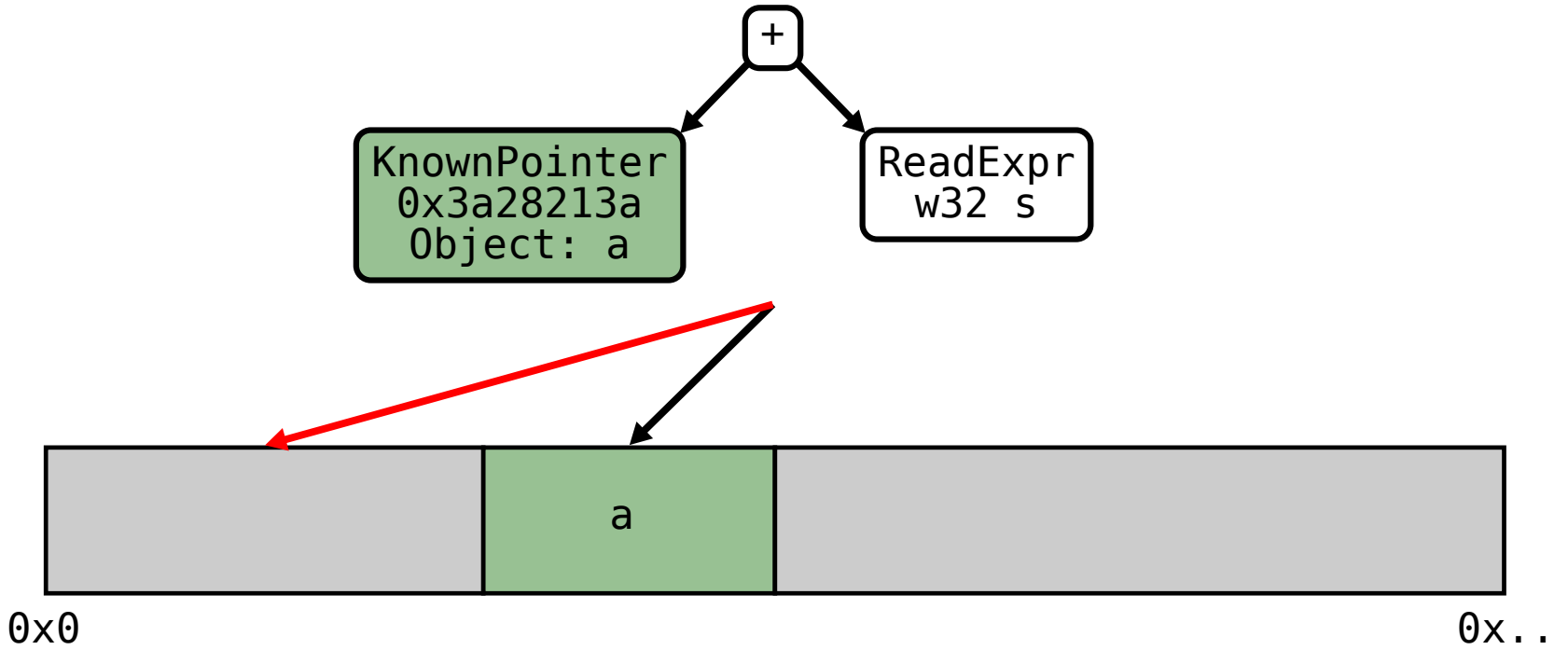

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- `KnownPointer` and `KnownValue` not expressive enough

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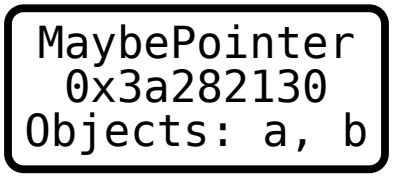

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```
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Objects: a, b
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- Remember information about all involved objects
- No clear association with one specific object

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`ConstantExpr`

A value that might be a pointer into any object, or might not be a pointer at all. Results from external function calls.

Old Memory Model

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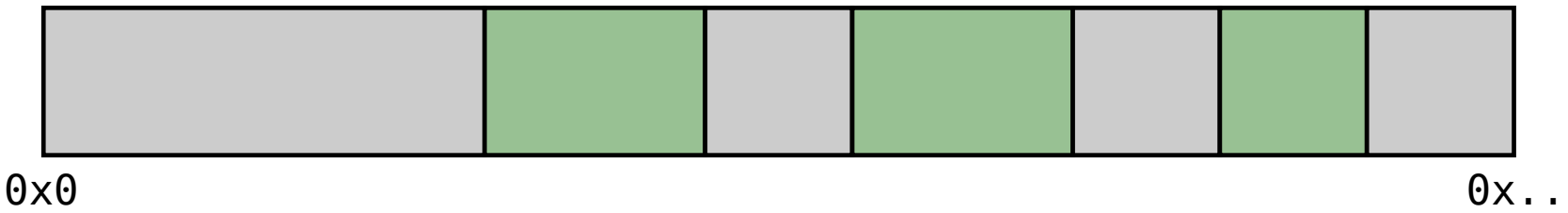

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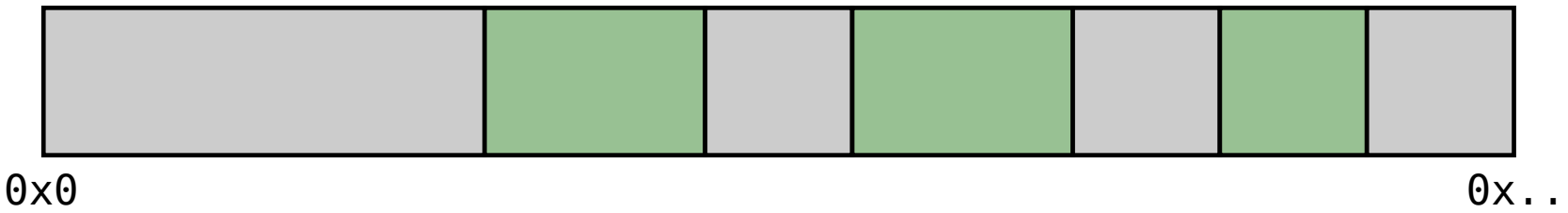

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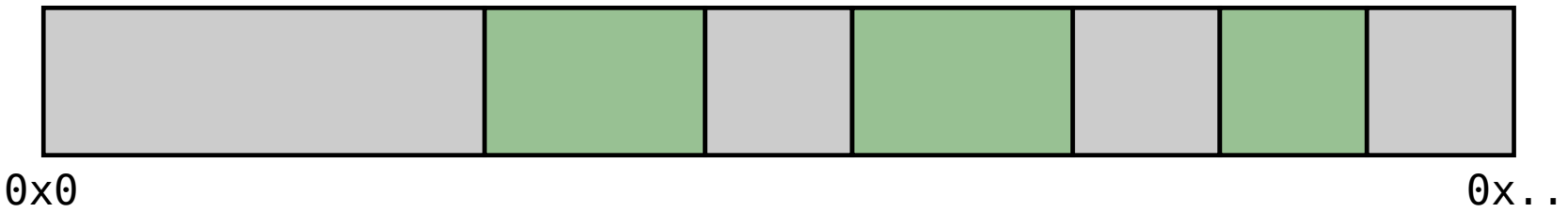

- Address resolution based solely on values
- No idea which values are pointers

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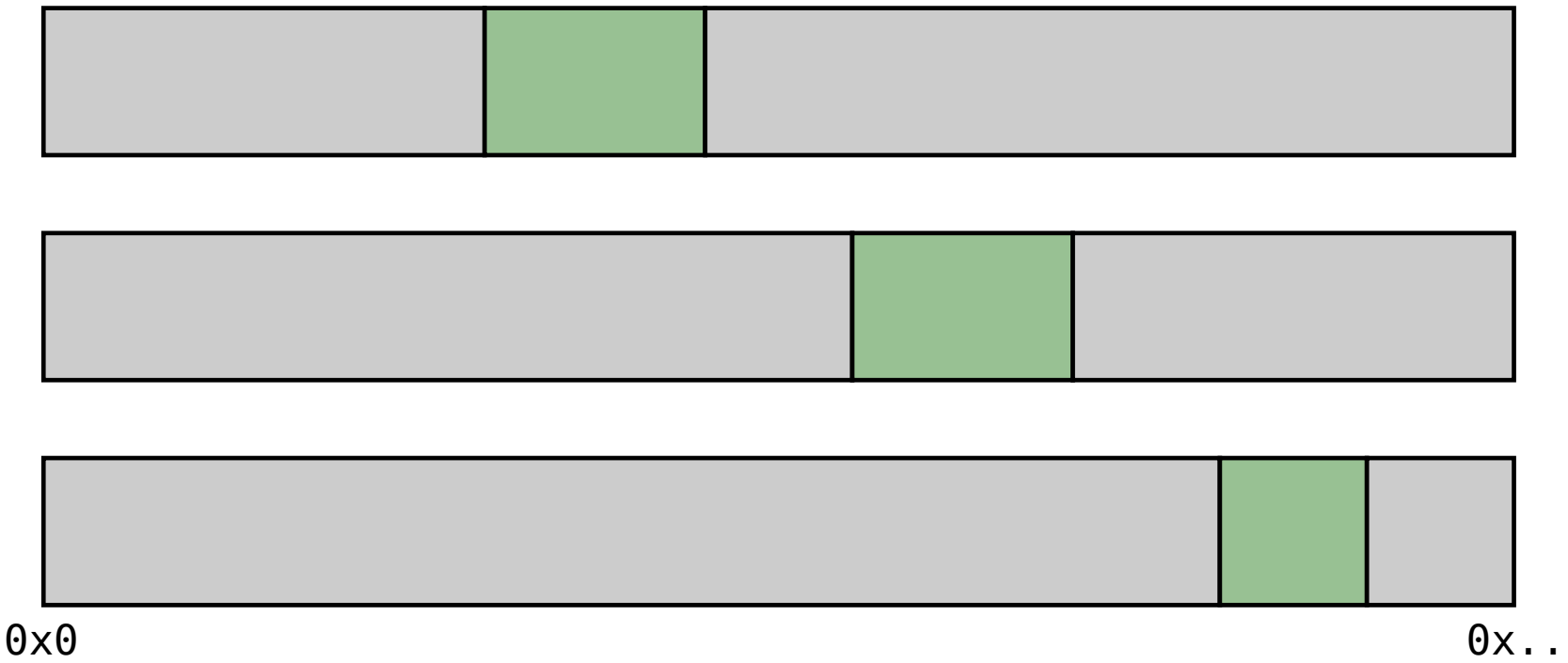
Now: One full-size address space per object



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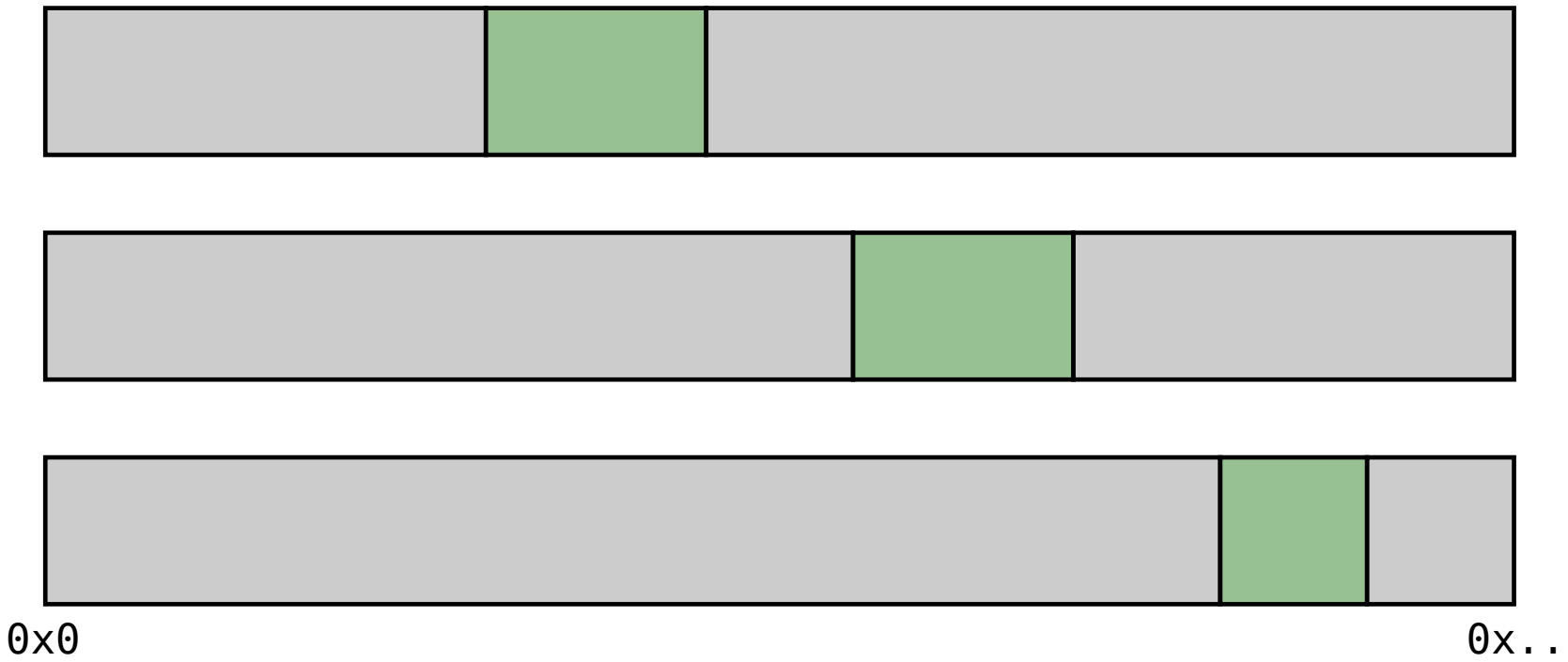

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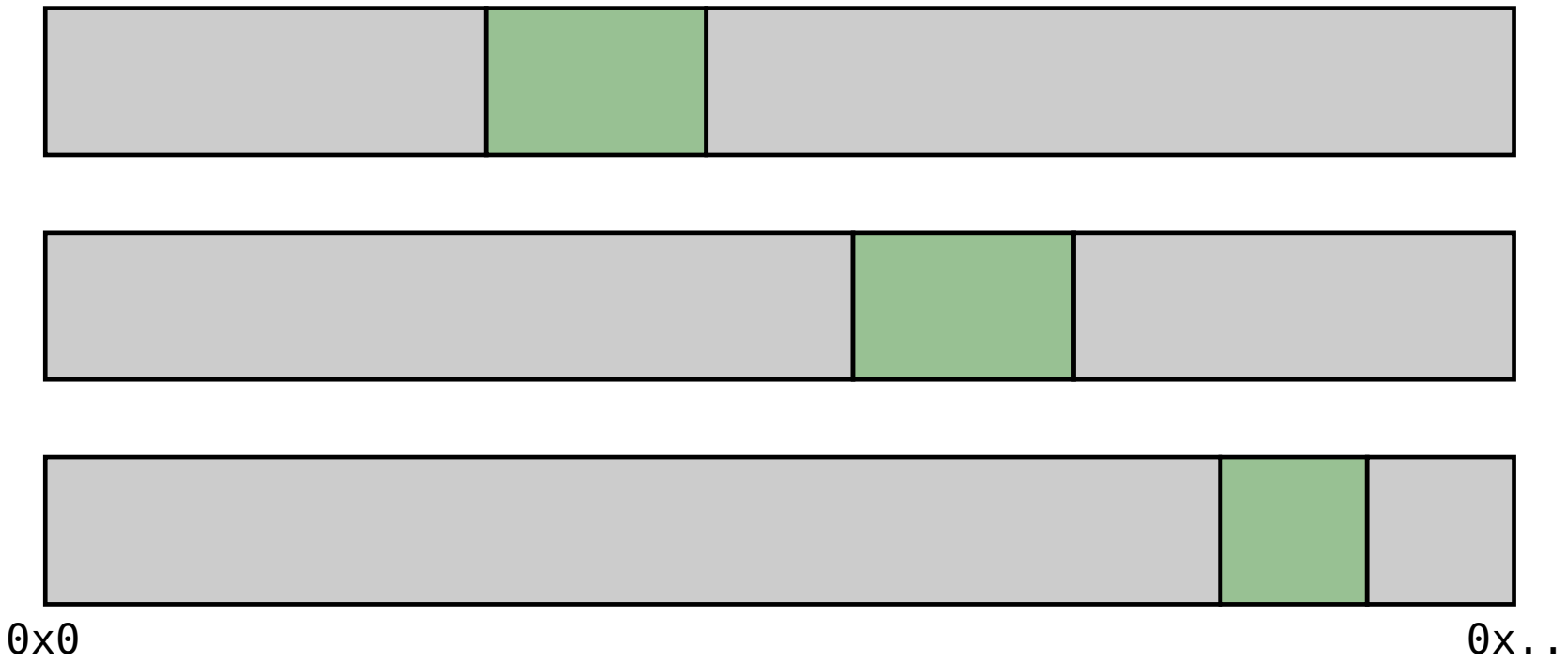

- Address resolution based on tracked pointers
- Much better knowledge about pointers and pointees

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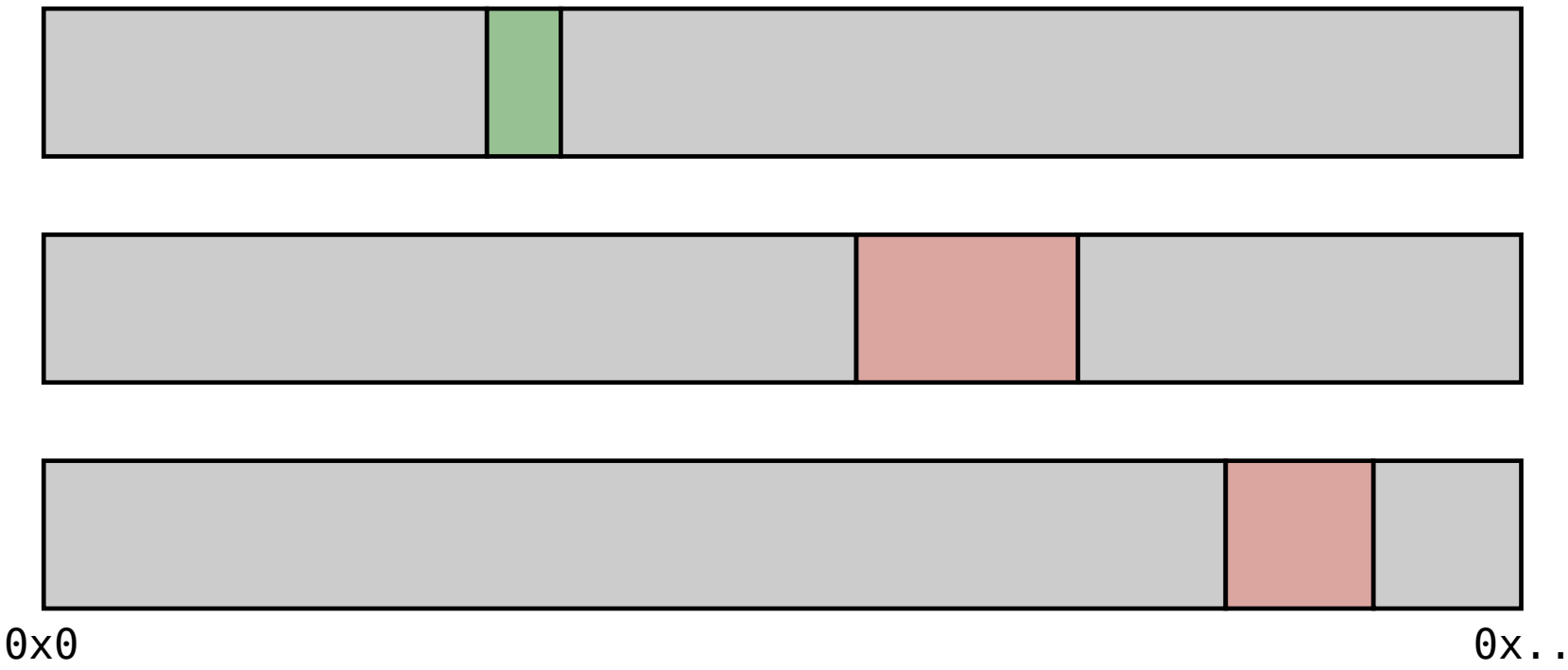

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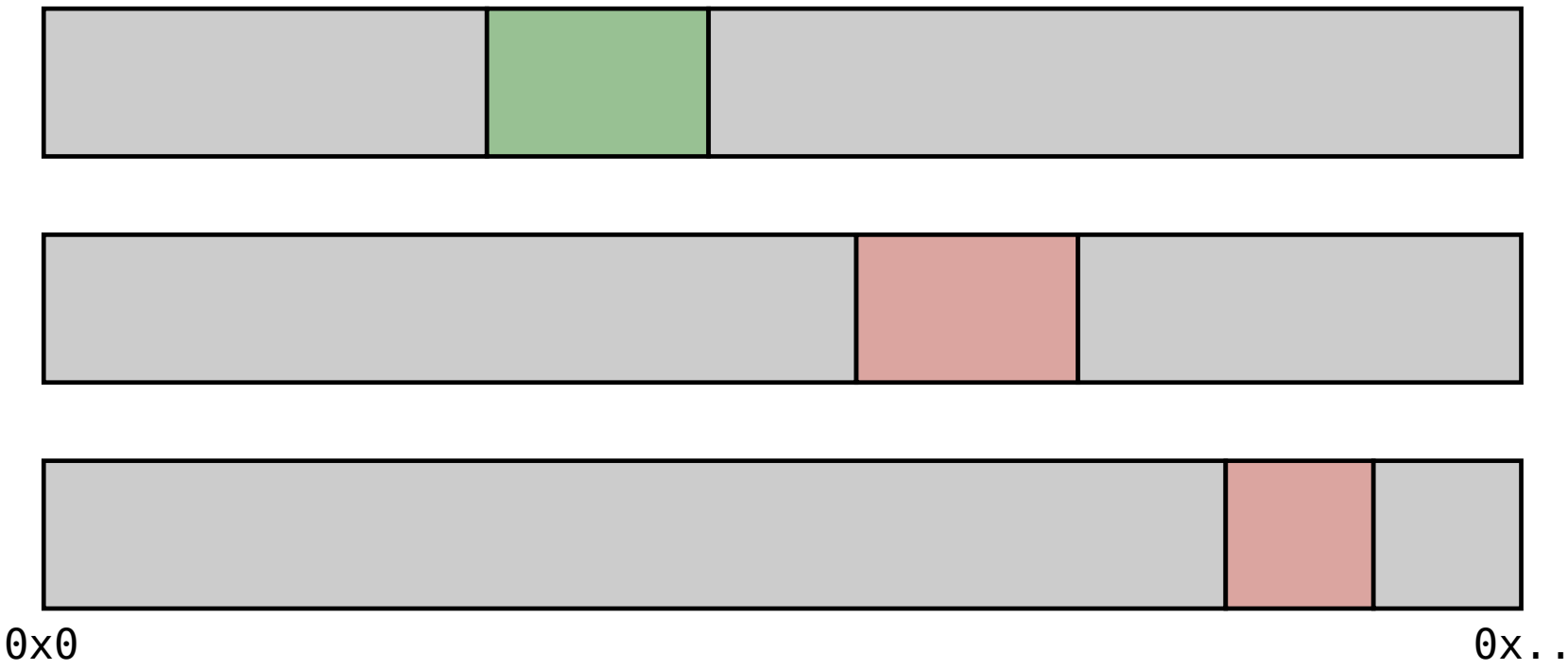

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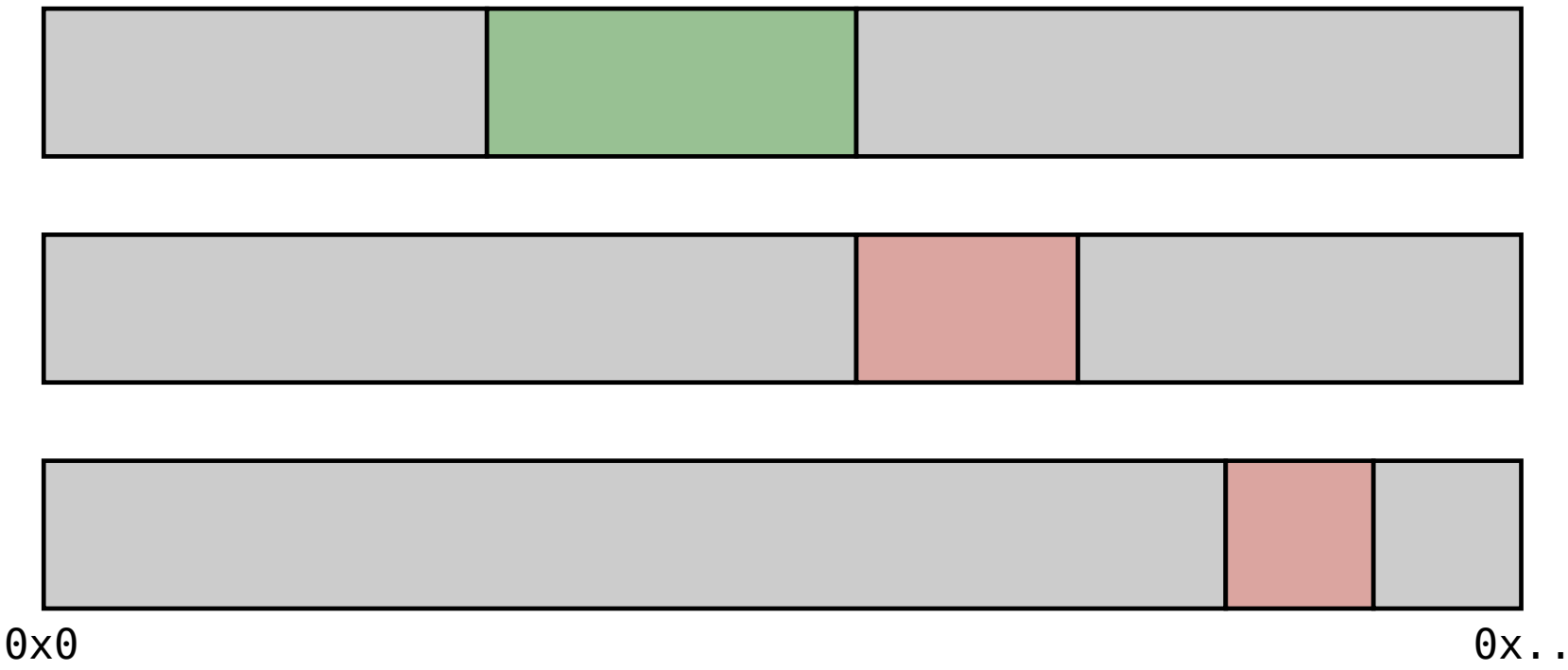

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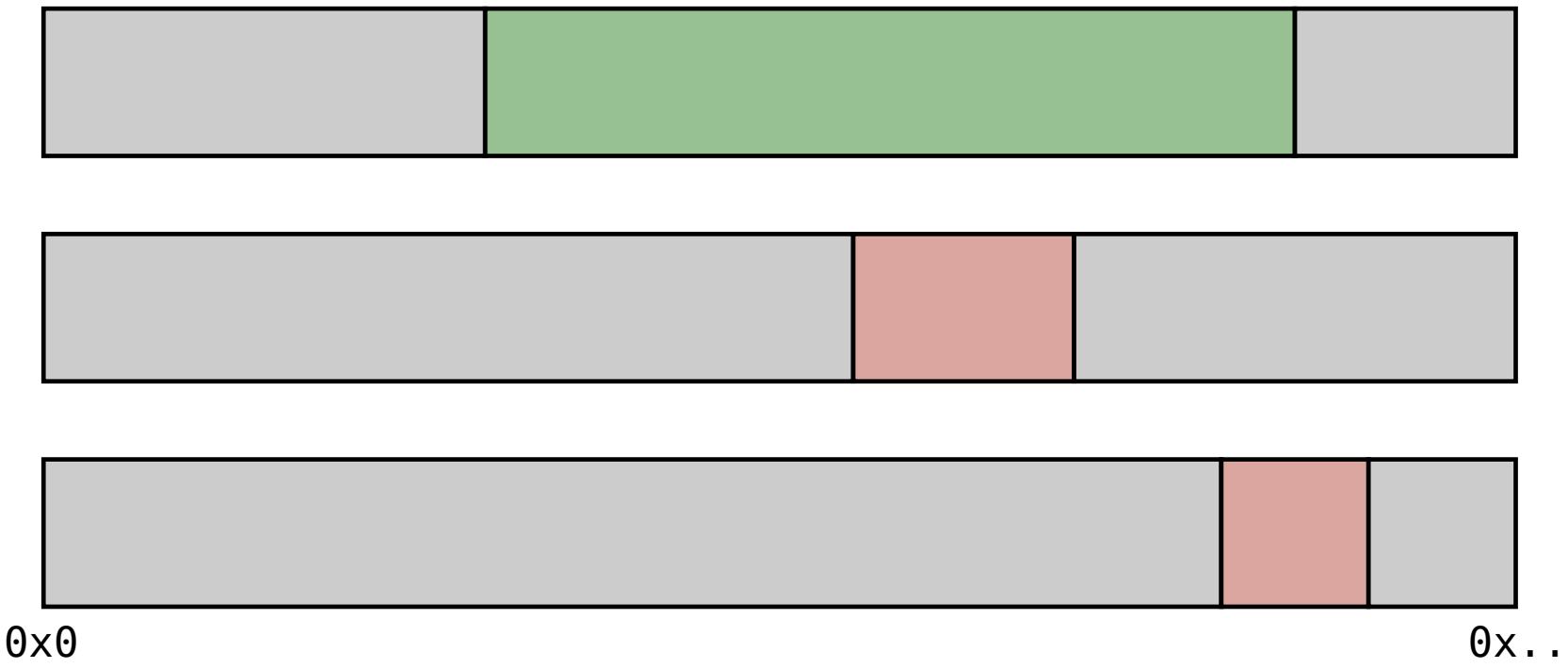

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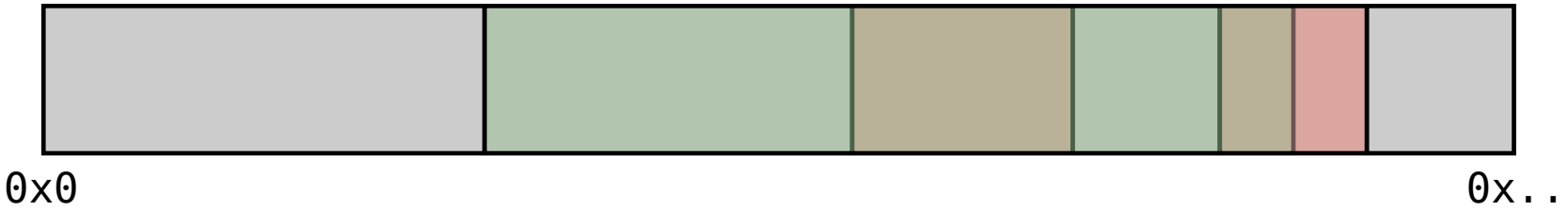

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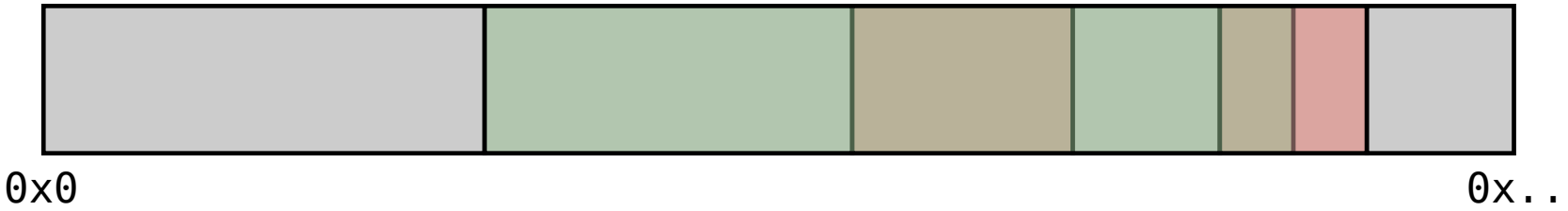

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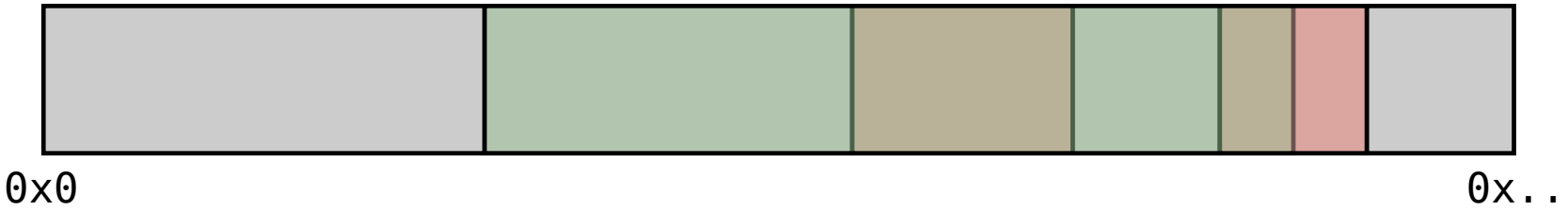

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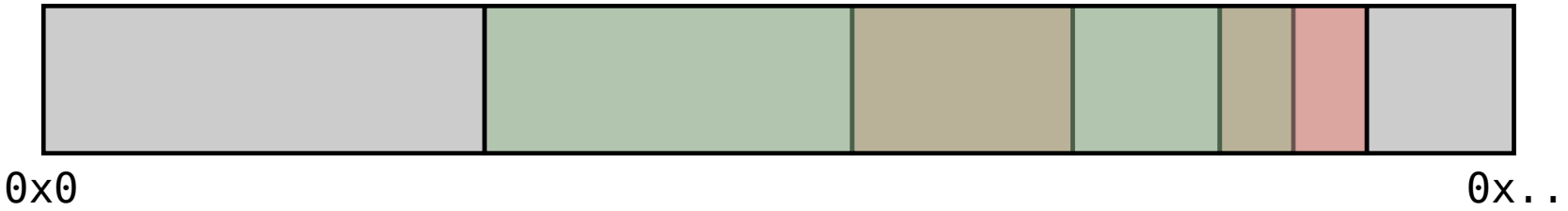

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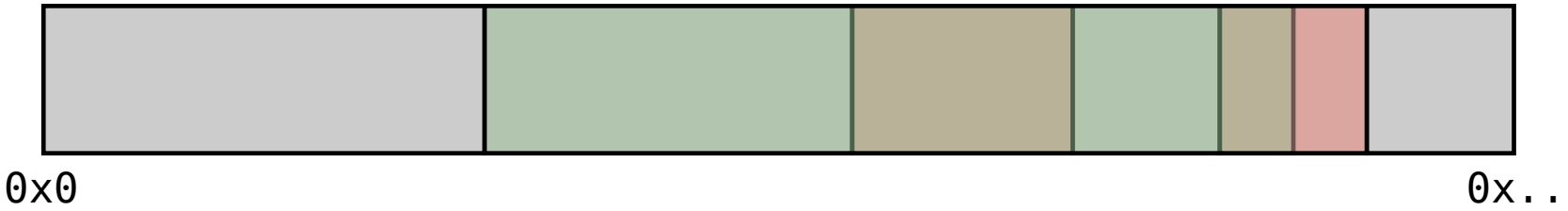

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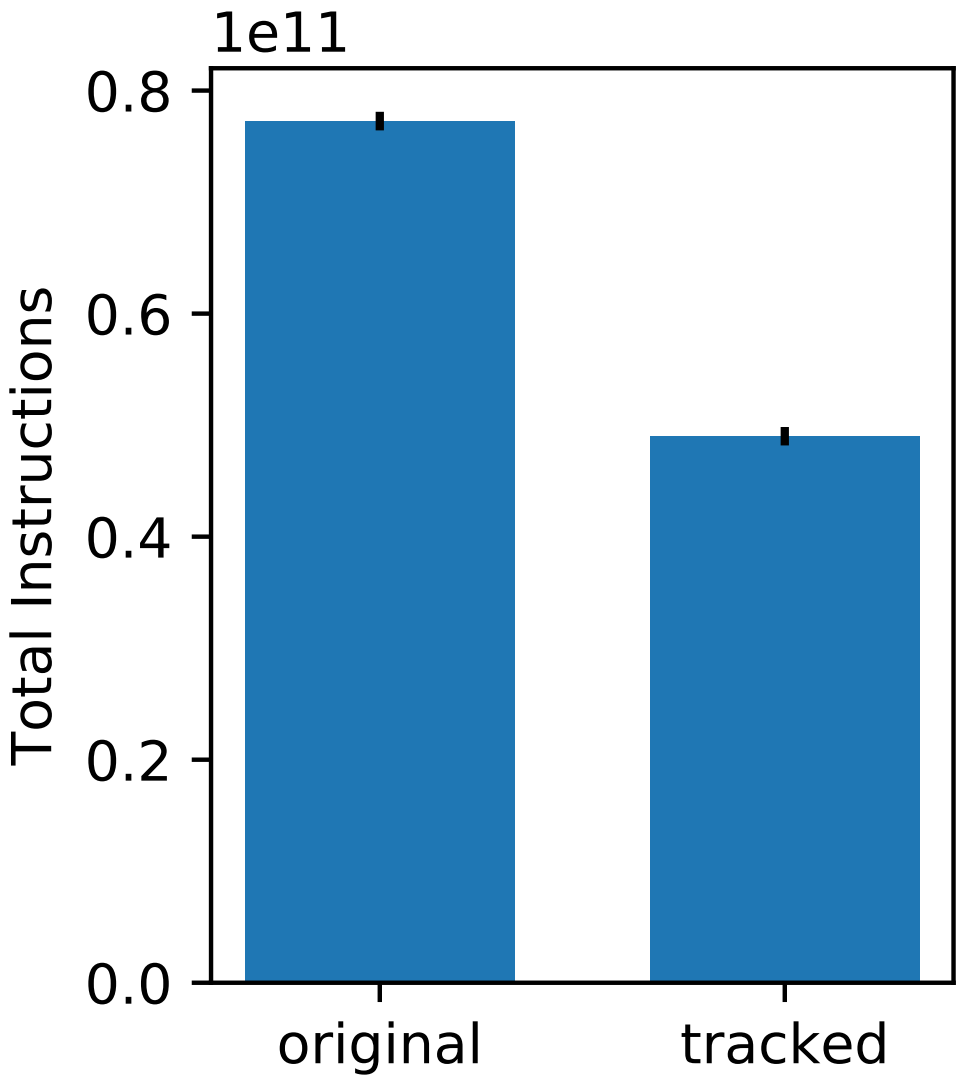
- Does not **easily** work either ("changing the past")

First Experiments

- 25 iterations, one hour each
- Able to run all 107 coreutils
- 80 without `ConstantExprs`
- No `MaybePointers` with more than four objects
- Four subtractions found, all due to one `realloc` in uclibc
- Somewhat high overhead (unoptimized)



Regex_old

```
1 UCHAR_T* old_buffer = cur_buffer;
2 cur_buffer = realloc(cur_buffer, new_size);
3 // ...
4 if(cur_buffer != old_buffer) {
5   int offset = cur_buffer - old_buffer;
6   FIXUP_POINTER(foo, offset);
7   FIXUP_POINTER(bar, offset);
8 // ...
```

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Evaluation:

- Works on the coreutils
- Found one case of an illegal pointer subtraction