Approximate Program Synthesis

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Writing approximate programs is hard

Precise
Implementation

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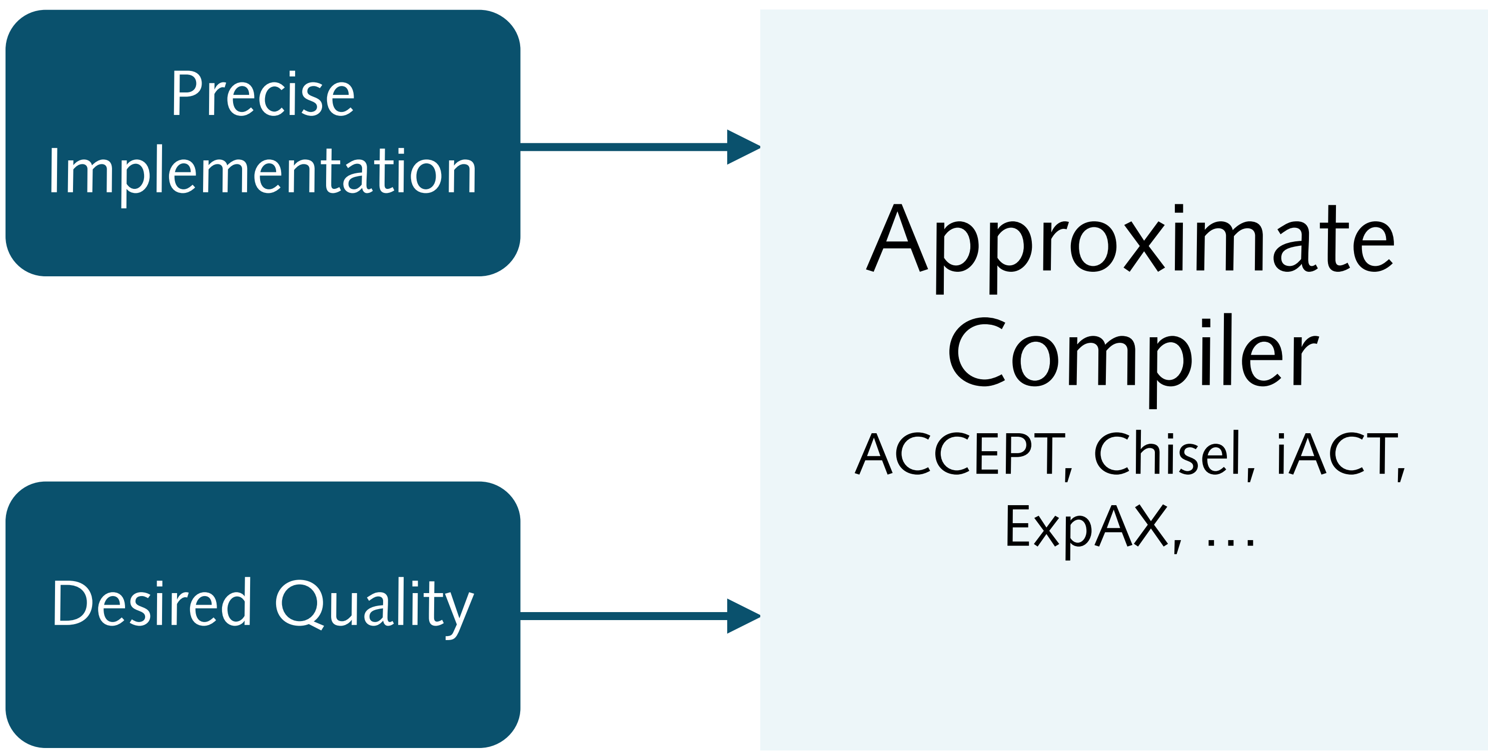
Precise Implementation

Desired Quality

Writing approximate programs is hard



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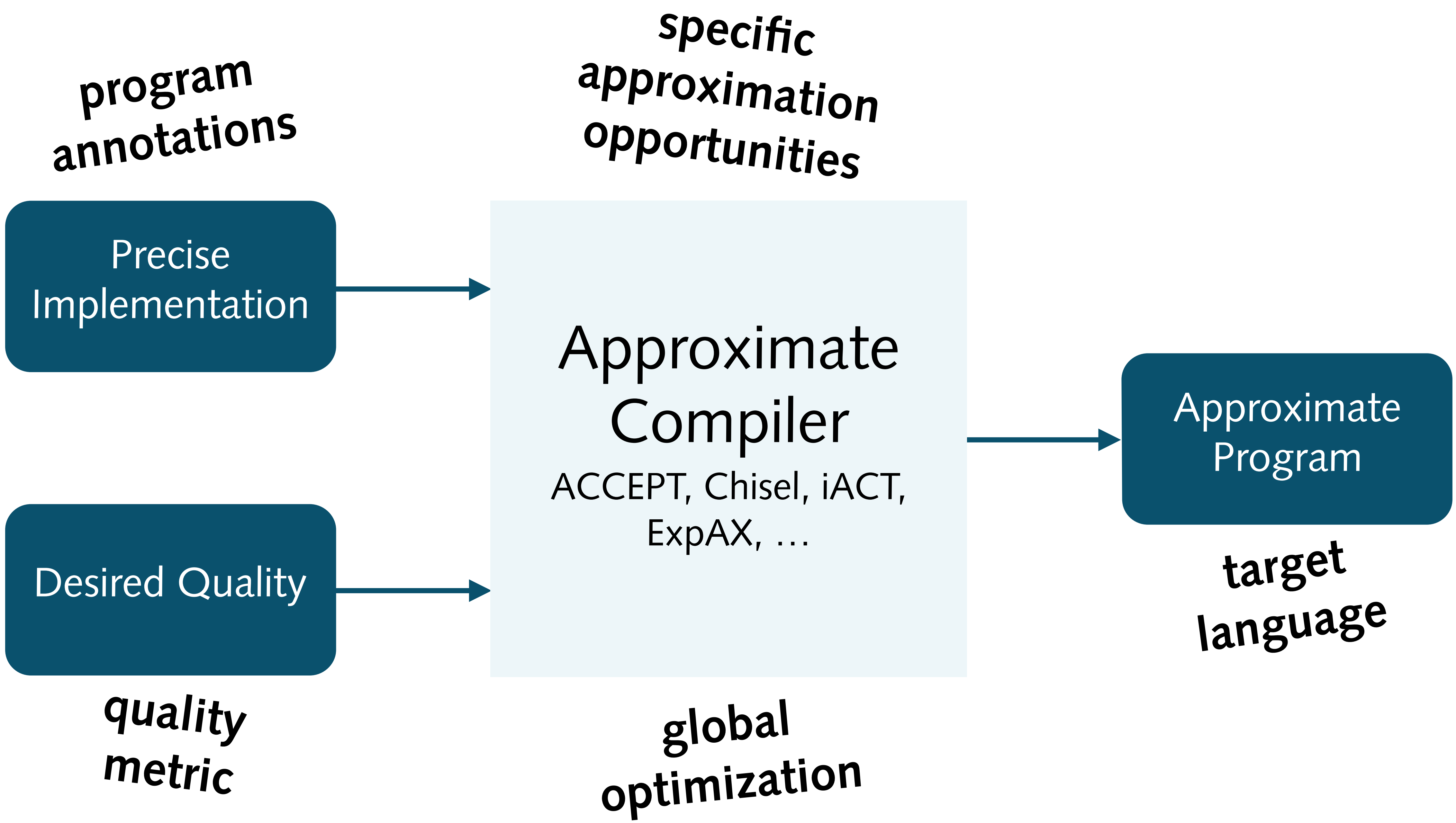
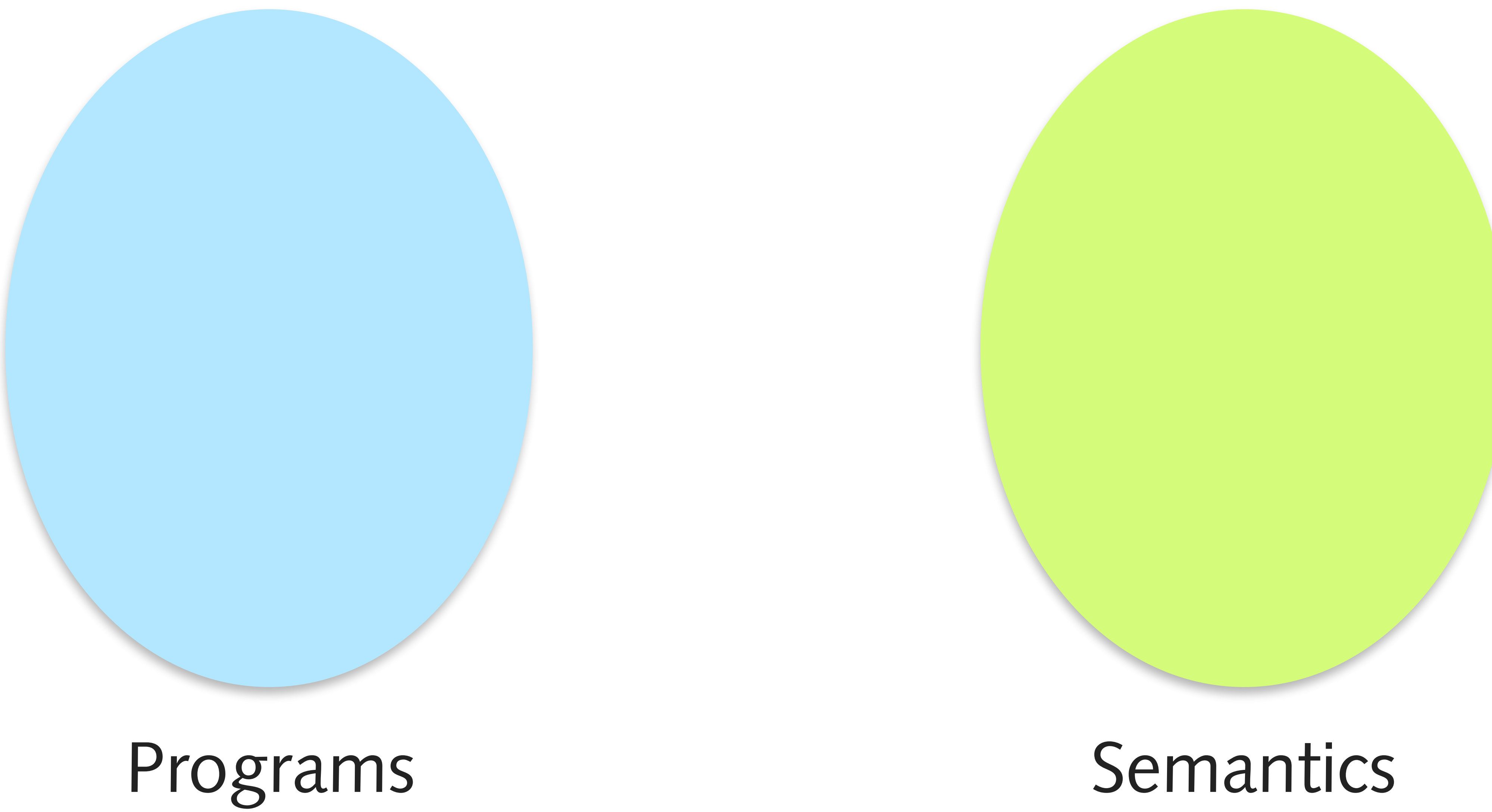


Synthesis: write programs automatically



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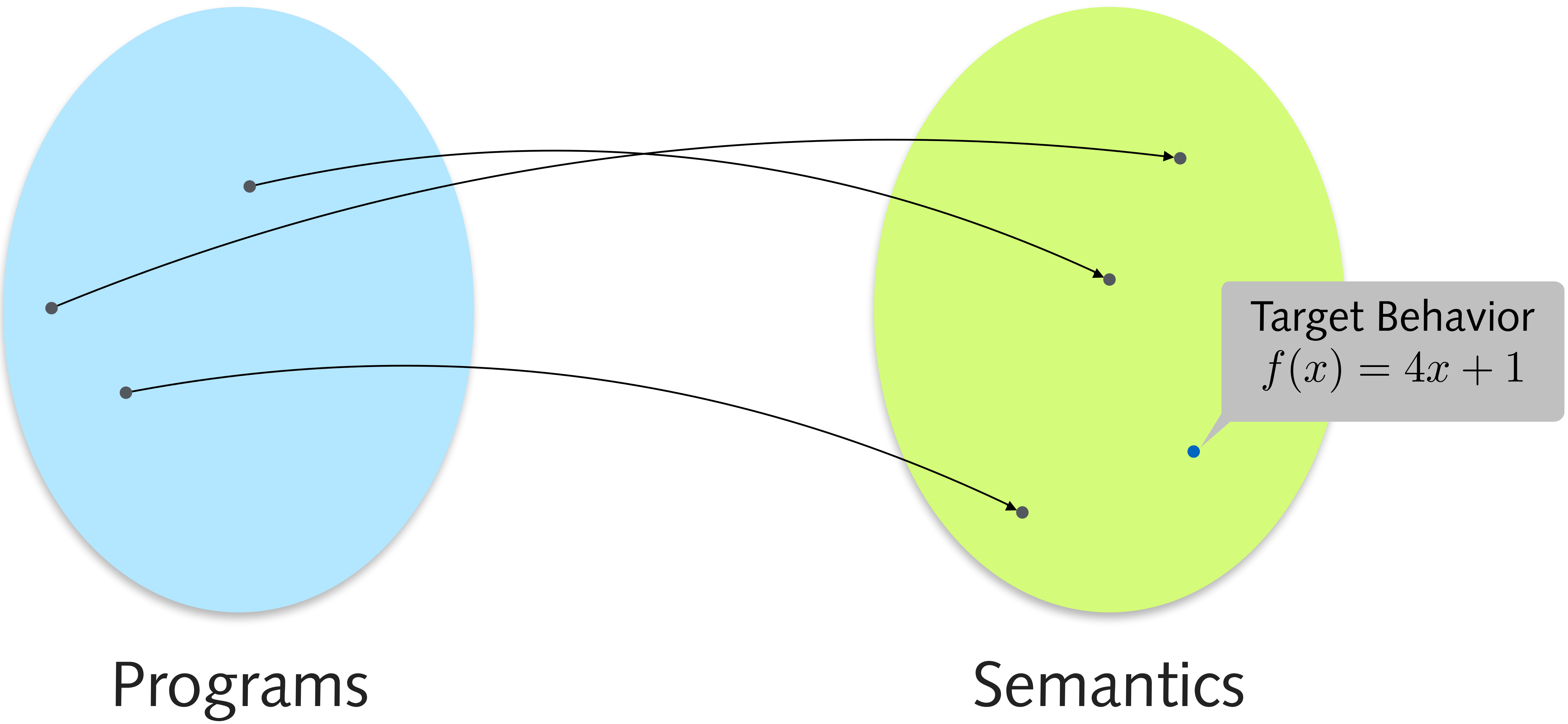

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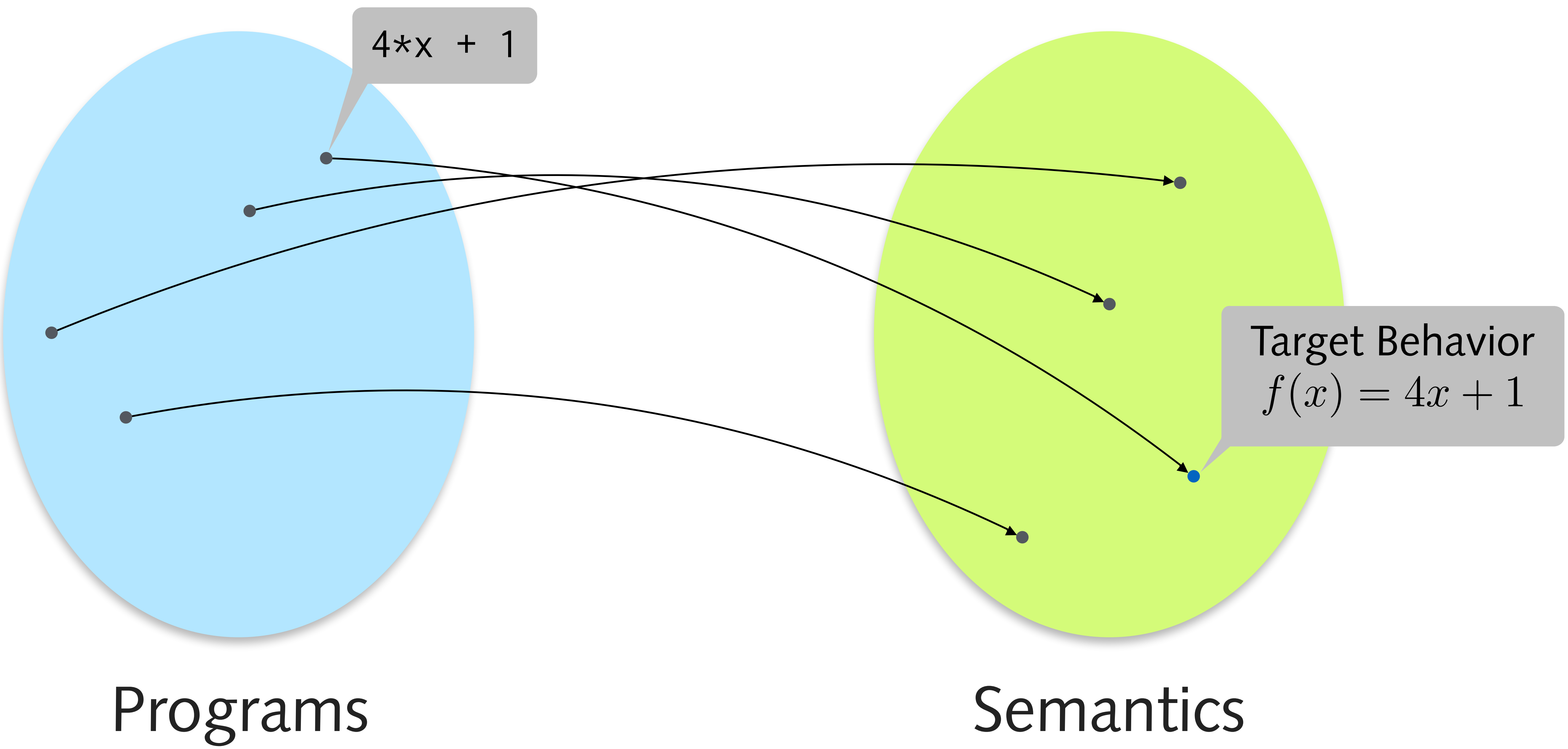

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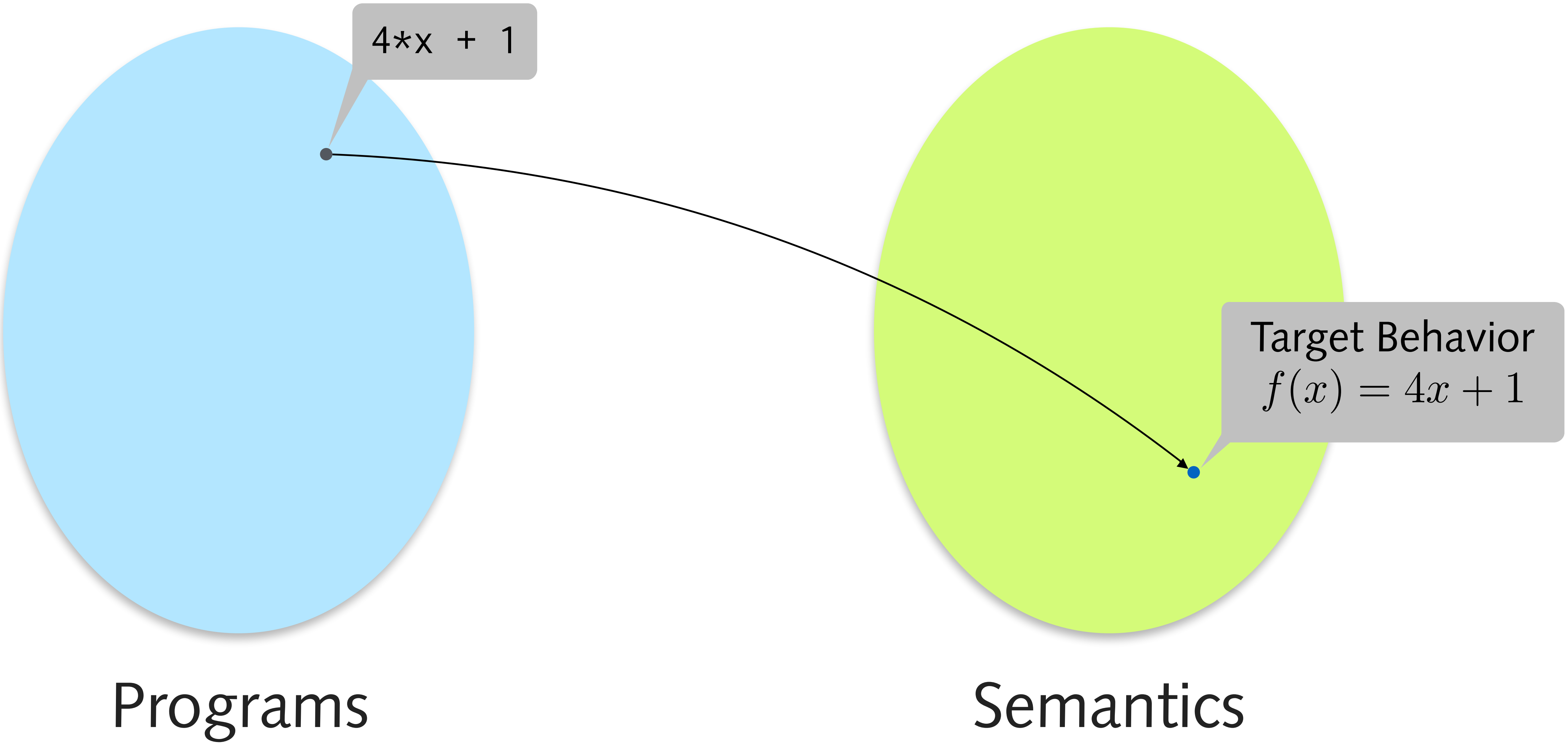

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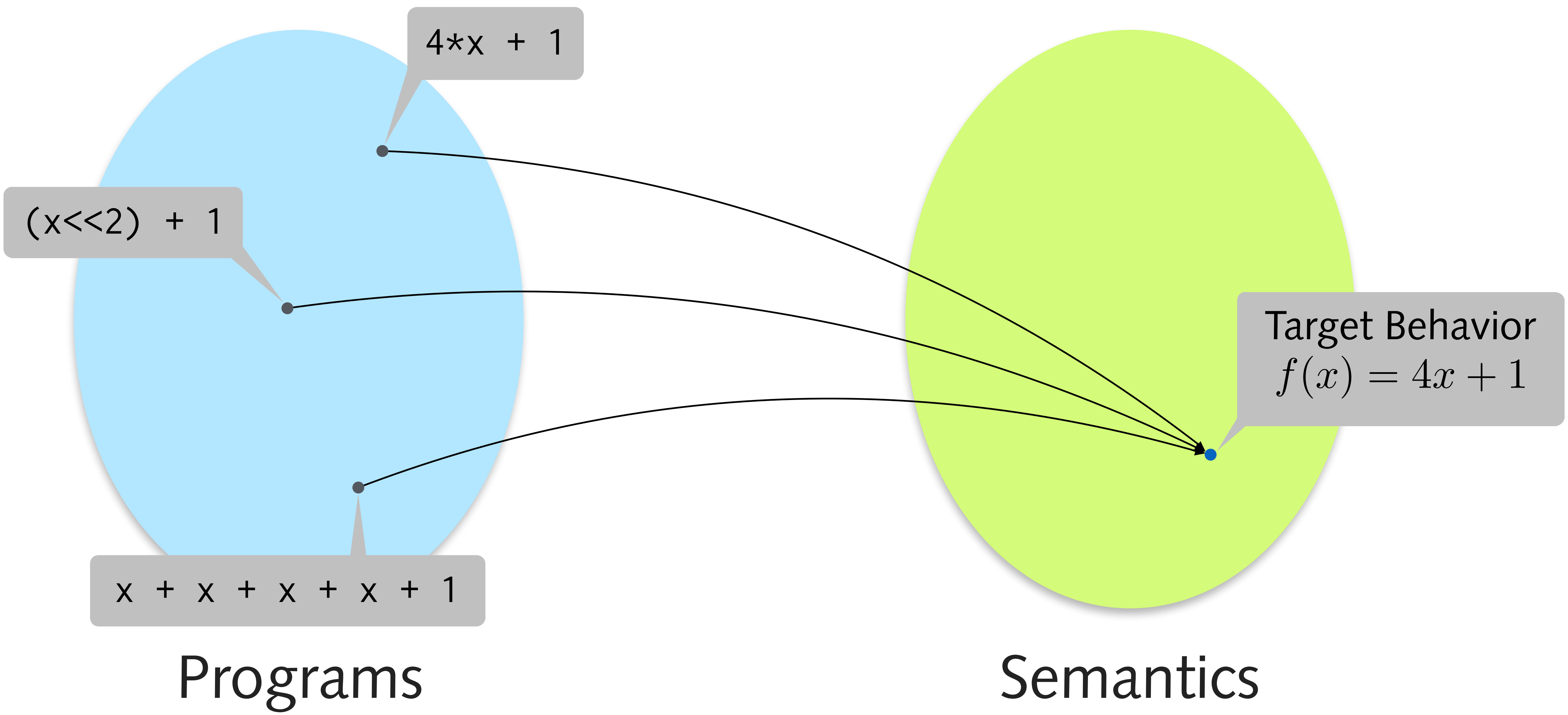
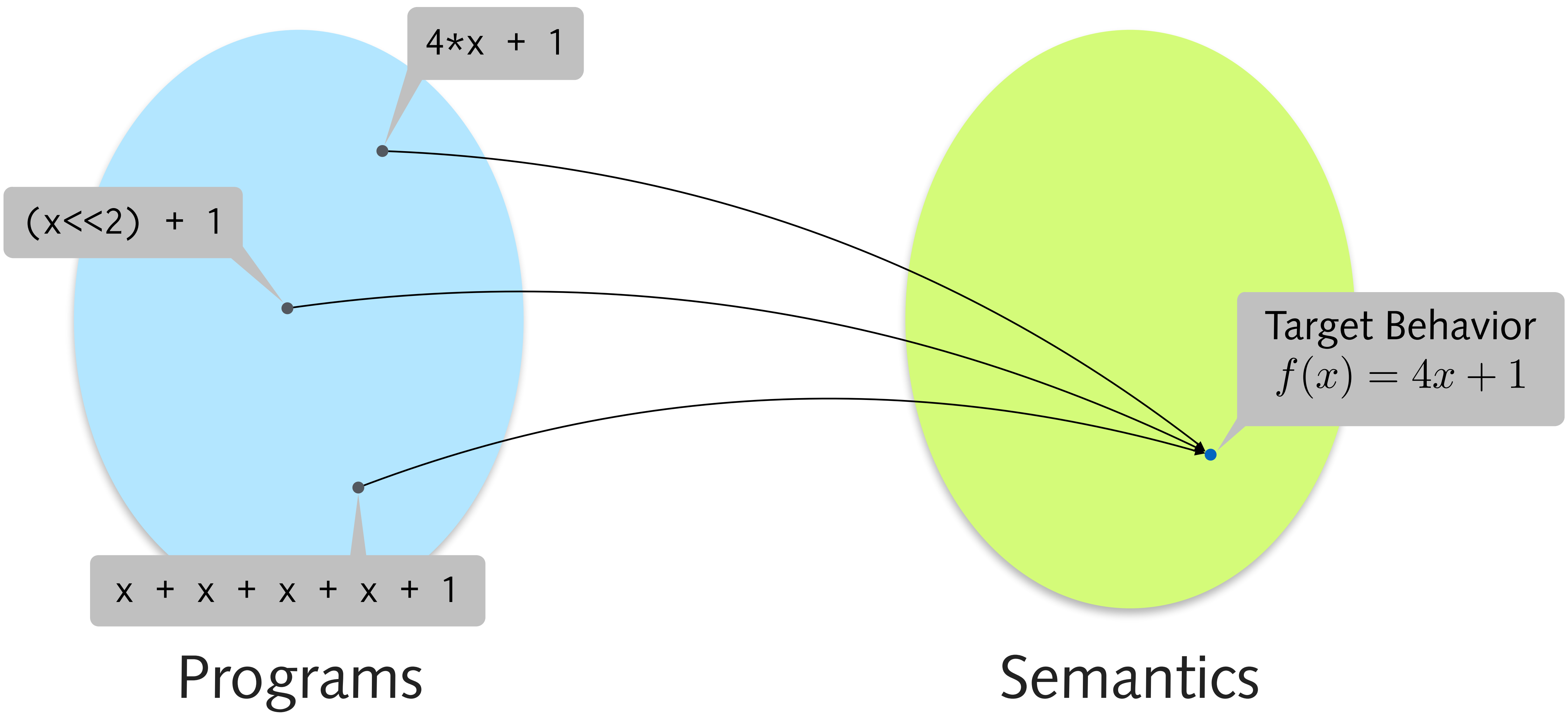


Synthesizing approximate programs



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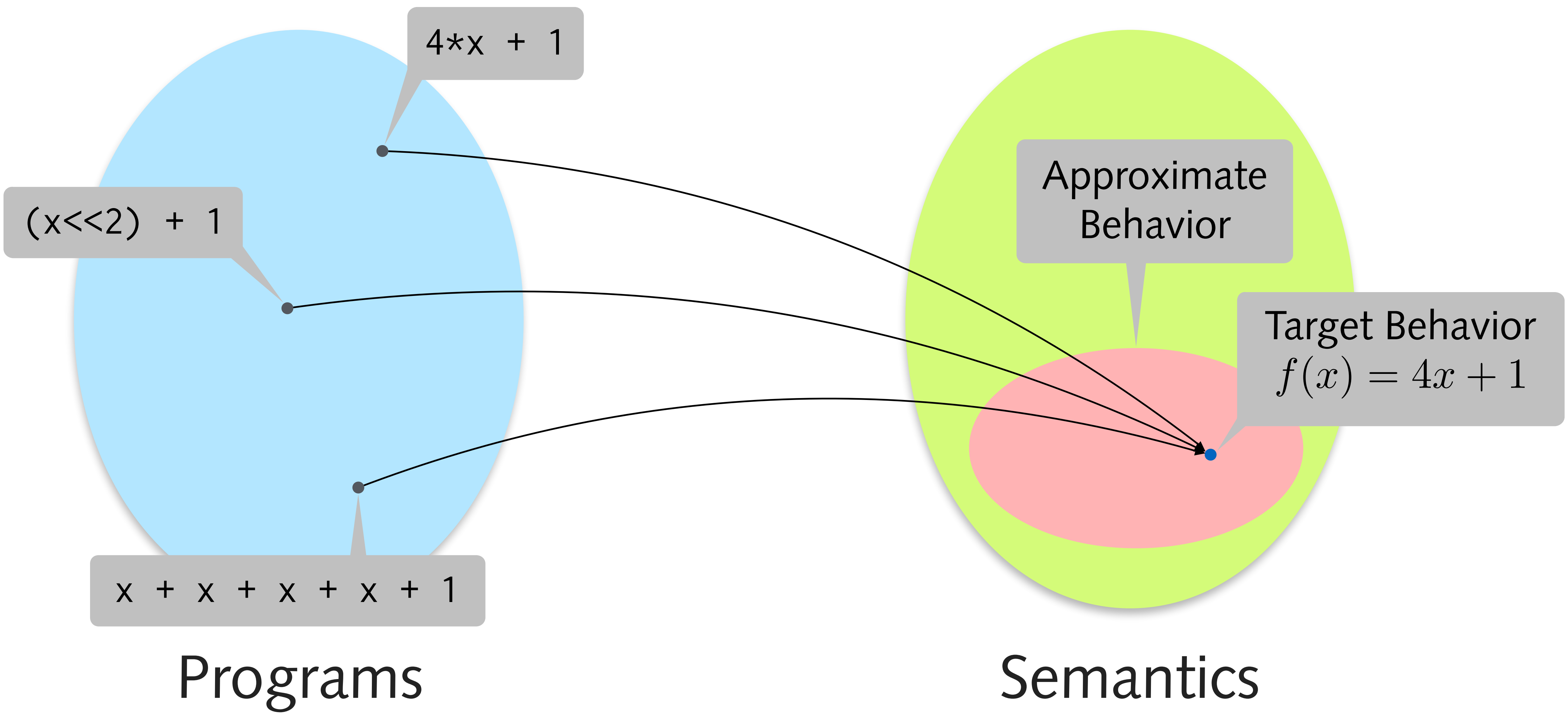

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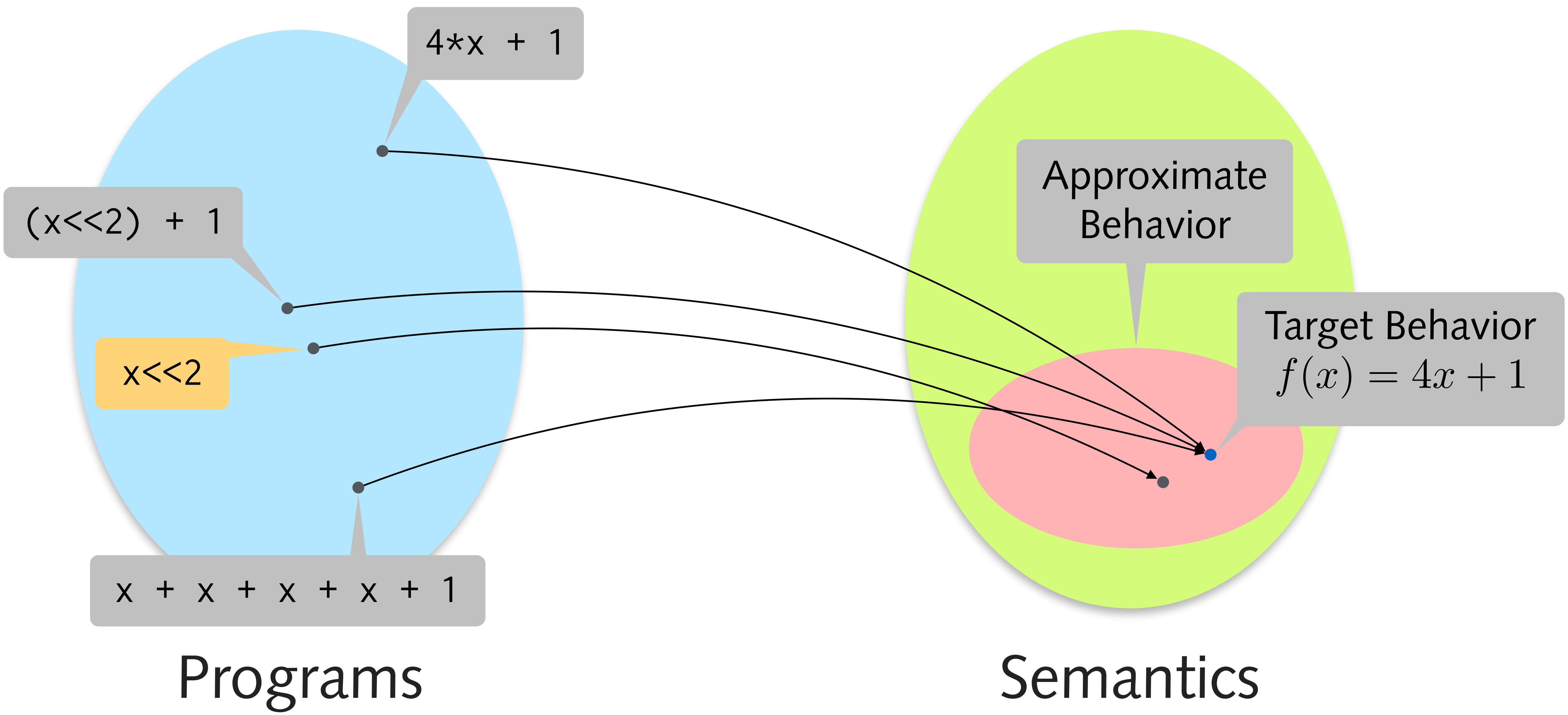

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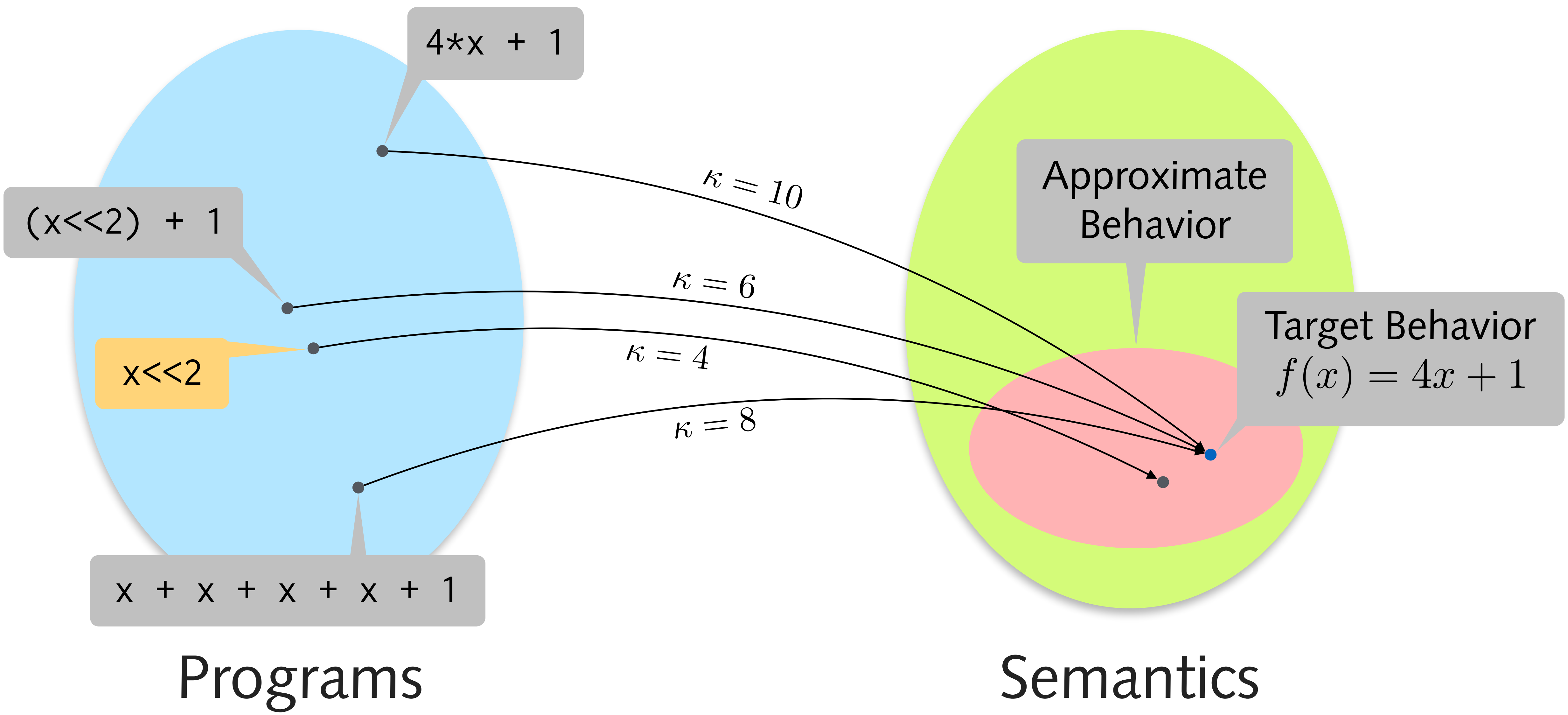

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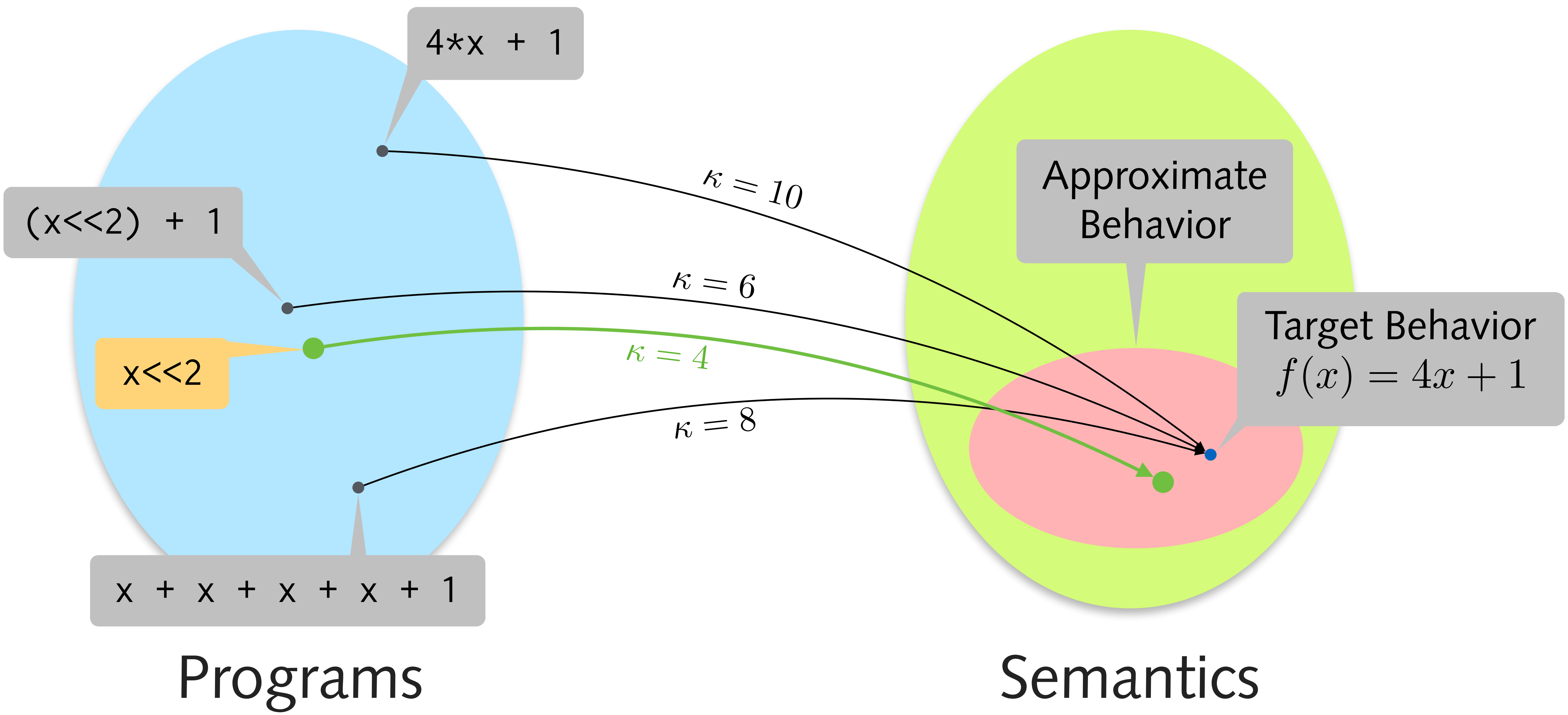

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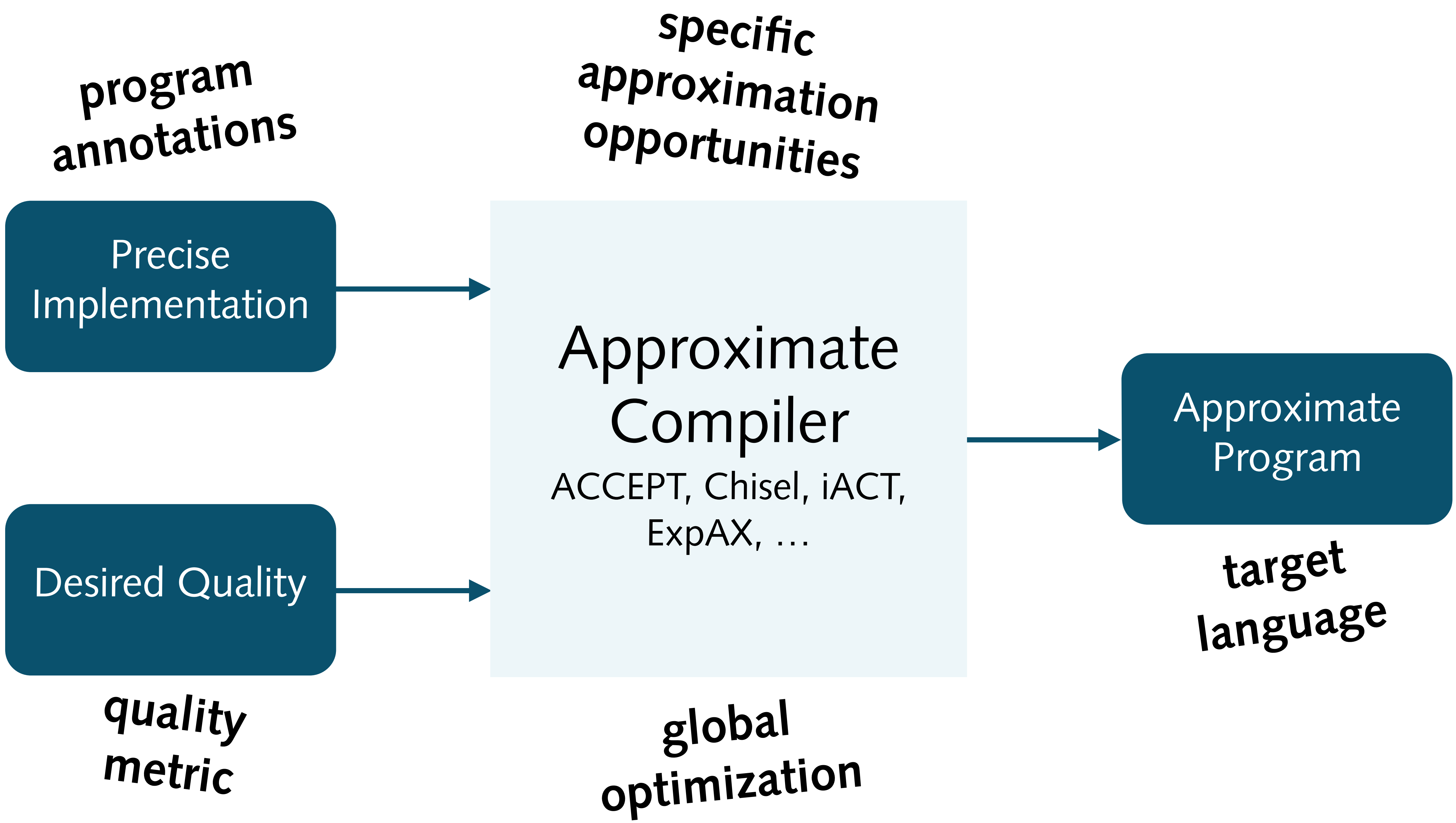

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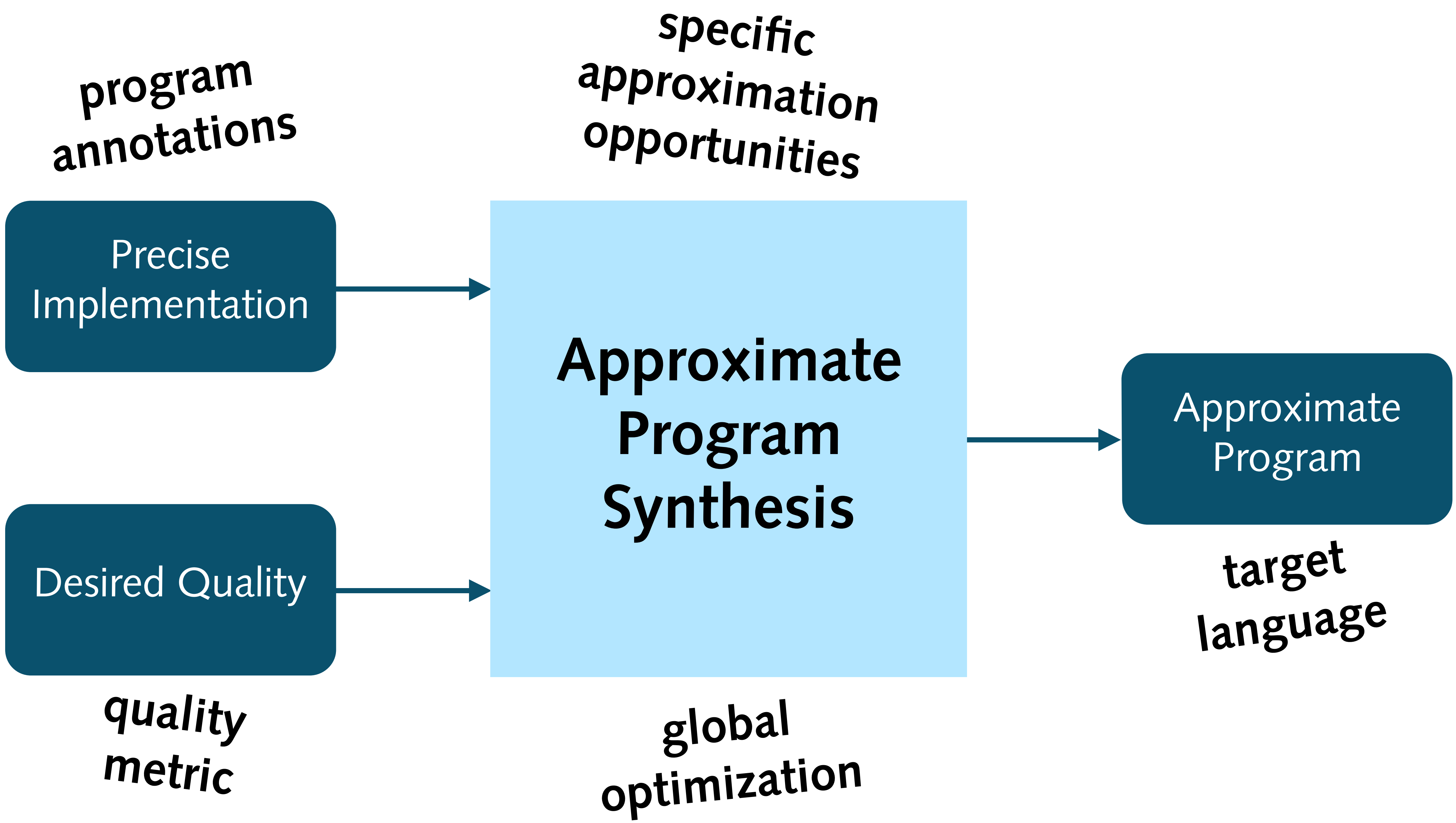

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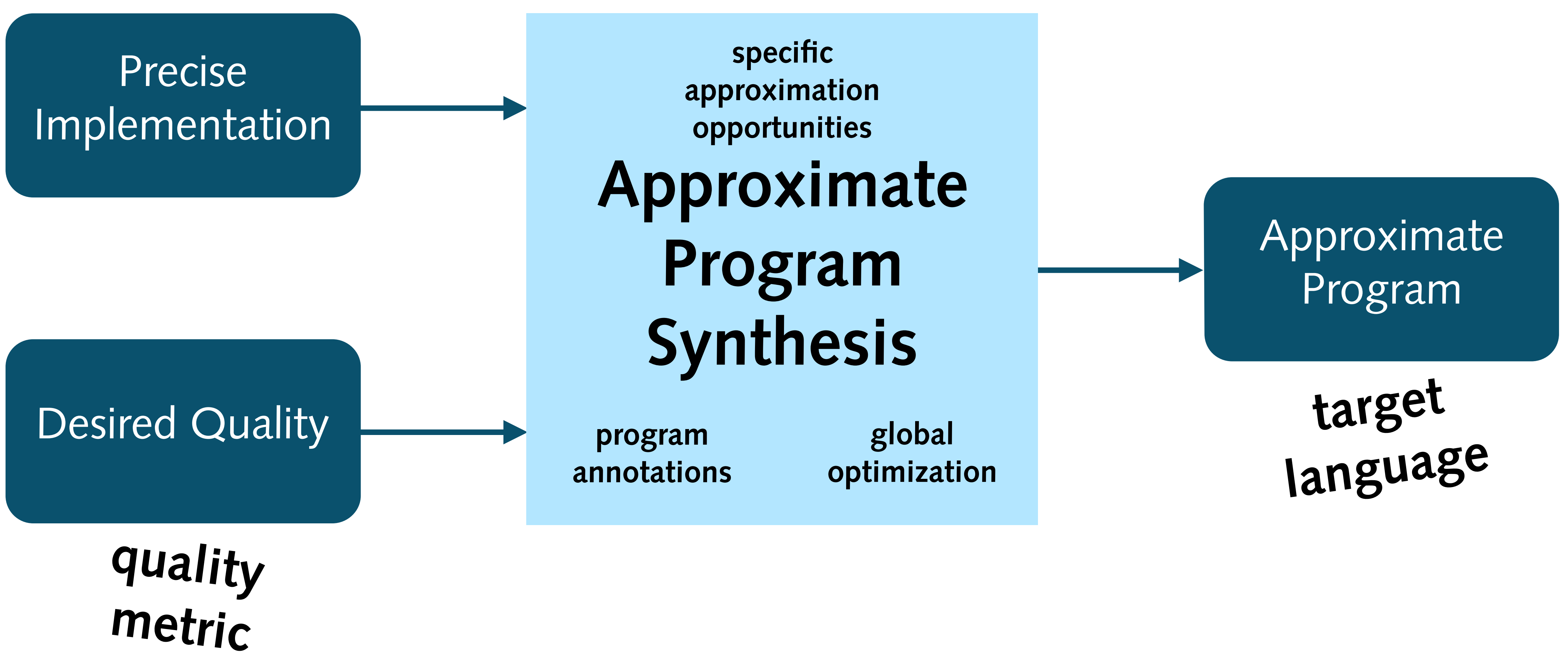

Existing synthesizers don't scale enough

Approximate benchmarks

- fft
- kmeans
- inversek2j
- sobel

† Alur et al. *Syntax-Guided Synthesis*. FMCAD 2013.

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Off-the-shelf synthesizers†

- Symbolic
- Stochastic
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assert $\forall p, c.\ |\texttt{dist}(p, c) - \texttt{f}(p, c)| < 50\%$

Reference program

Program being synthesized

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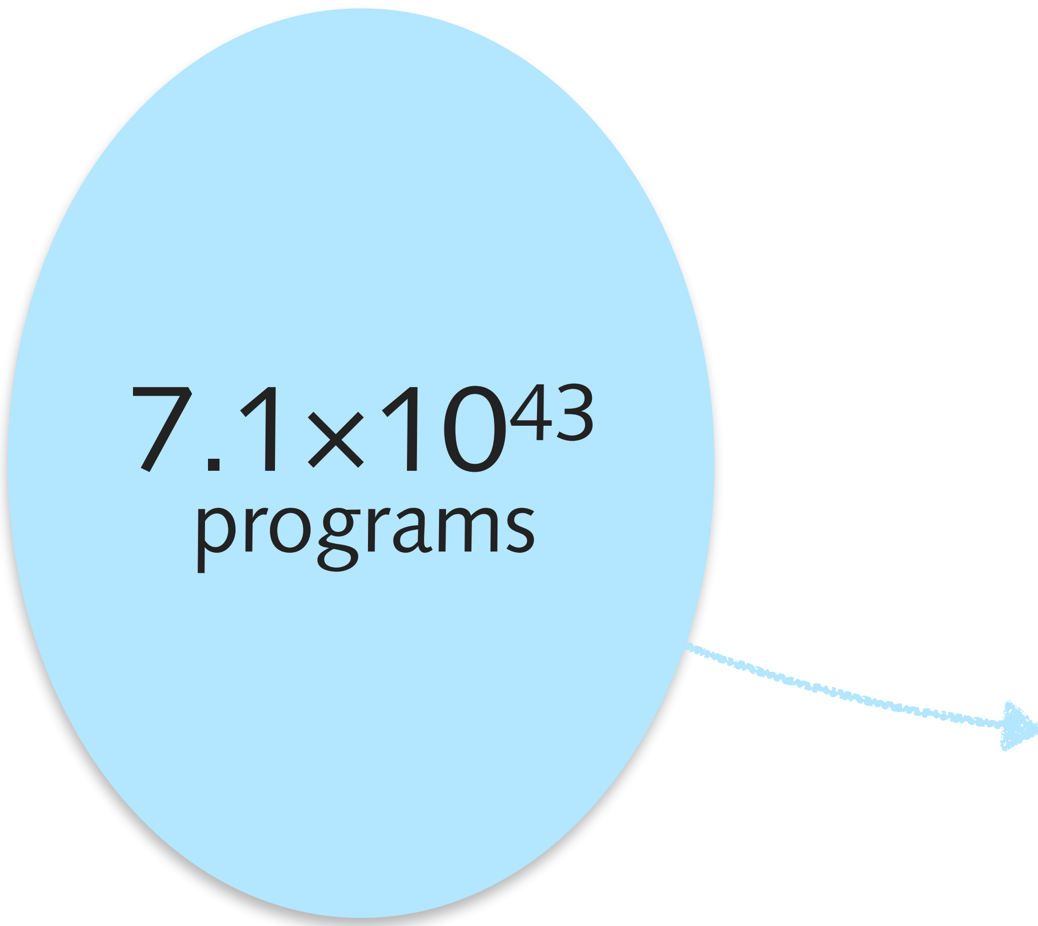
Use reference programs to guide synthesis



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7.1×10^{43}
programs

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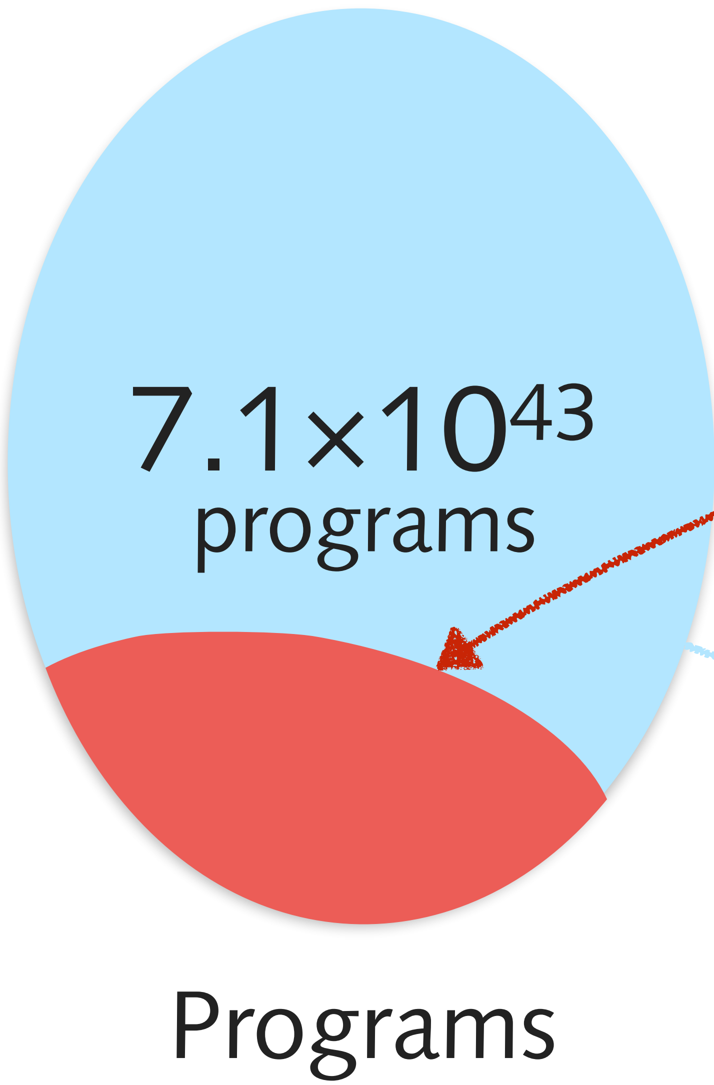


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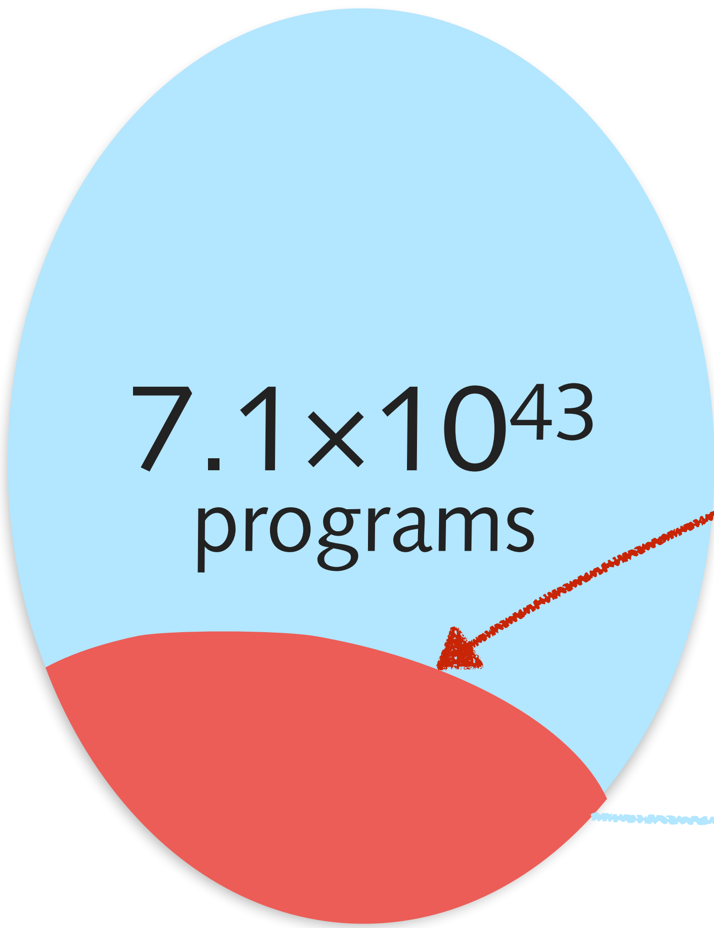

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Synthesis produces good approximations

Spec: < 50% average error

Benchmark	Speedup	Error
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fft_c	12.0×	28.9%
dist3	1.6×	14.9%
$sobel_x$	10.6×	0%
$sobel_y$	10.7×	0%
$inversek2j_1$	34.8×	16.3%
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Missed compiler optimization

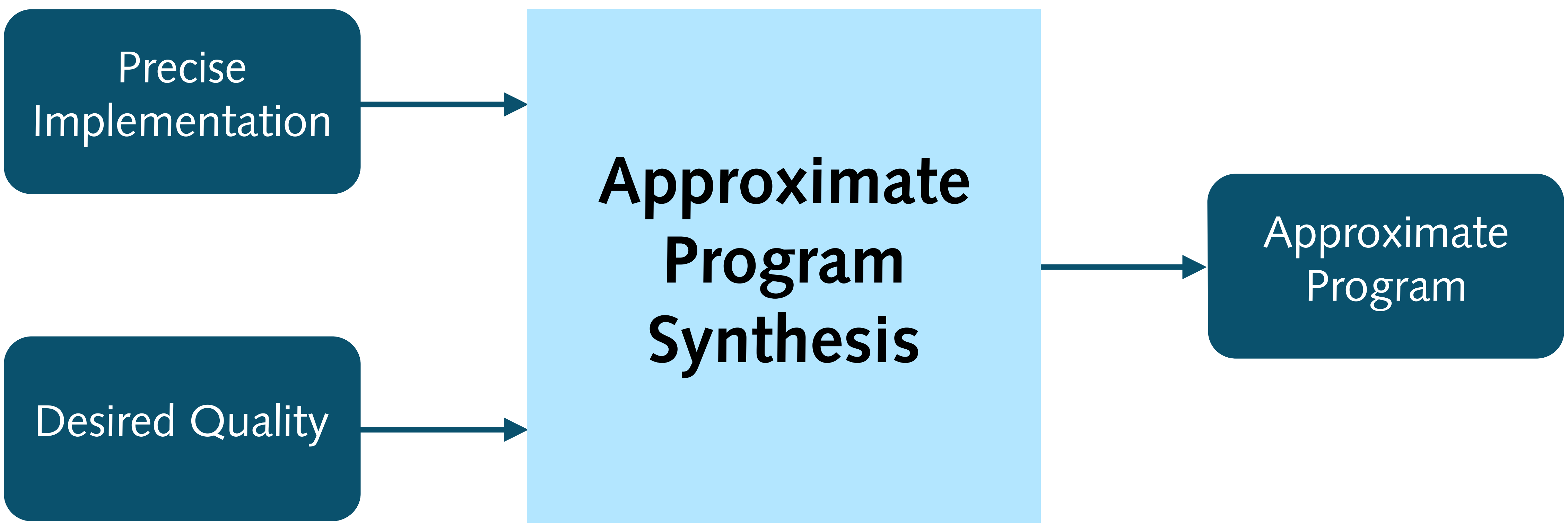
Synthesis produces clever approximations

```
float dist_approx(int a[3], int b[3]) {
    int c1 = abs(b[0] - a[0]);
    int c2 = abs(b[1] - a[1]);
    int c3 = abs(a[2] - b[2]);
    int c4 = c1 | c2;
    int c5 = abs(c3 > c4 ? c3 : c4);
    return (float)c5;
}
```

3D Euclidean distance

1.6× faster, 14.9% error

Thanks!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