Numerical Program Optimization for High-Level Synthesis

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Introduction

Floating-point operations...

- are easy to use

  High dynamic range

- are ubiquitous

  Altera introduced new FPGAs (Arria 10 and Stratix 10) with hardened floating-point DSP elements

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  Altera introduced new FPGAs (Arria 10 and Stratix 10) with hardened floating-point DSP elements

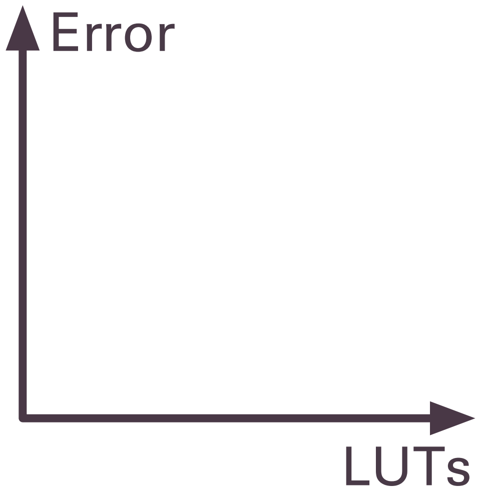
However, floating-point operations

- use a lot of resources
- have round-off errors

Introduction

Our tool exploits the rules of equivalence to **automatically** optimize the structure of numerical programs, for example:

- $(a + b) + c \equiv a + (b + c)$
- $(a + b) * c \equiv a * b + a * c$
- and many more



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GCC / LLVM /
Vivado HLS
-ffast-math

- Simple transformations
- What about accuracy?

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Arithmetic Expressions

- Deep transformations
- Resource usage & Accuracy!

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SOAP2
Full
Programs

- Full program transformations

Example

Program

```
if (x < 20) {
    x = x + (y + 500);
} else {
    x = (x + y) + 500;
}
```

Example

Specification

```
float x, y;
assume(0 <= x <= 500);
assume(err(x) == 0);
assume(0 <= y <= 30);
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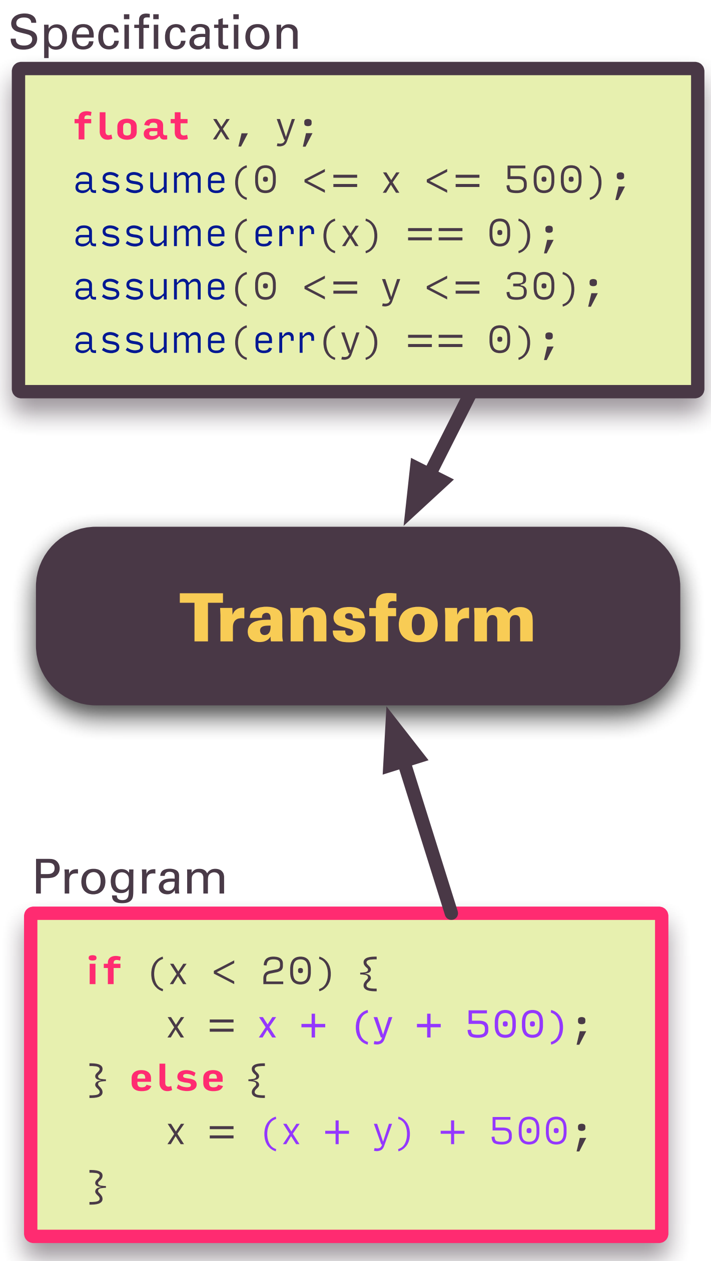

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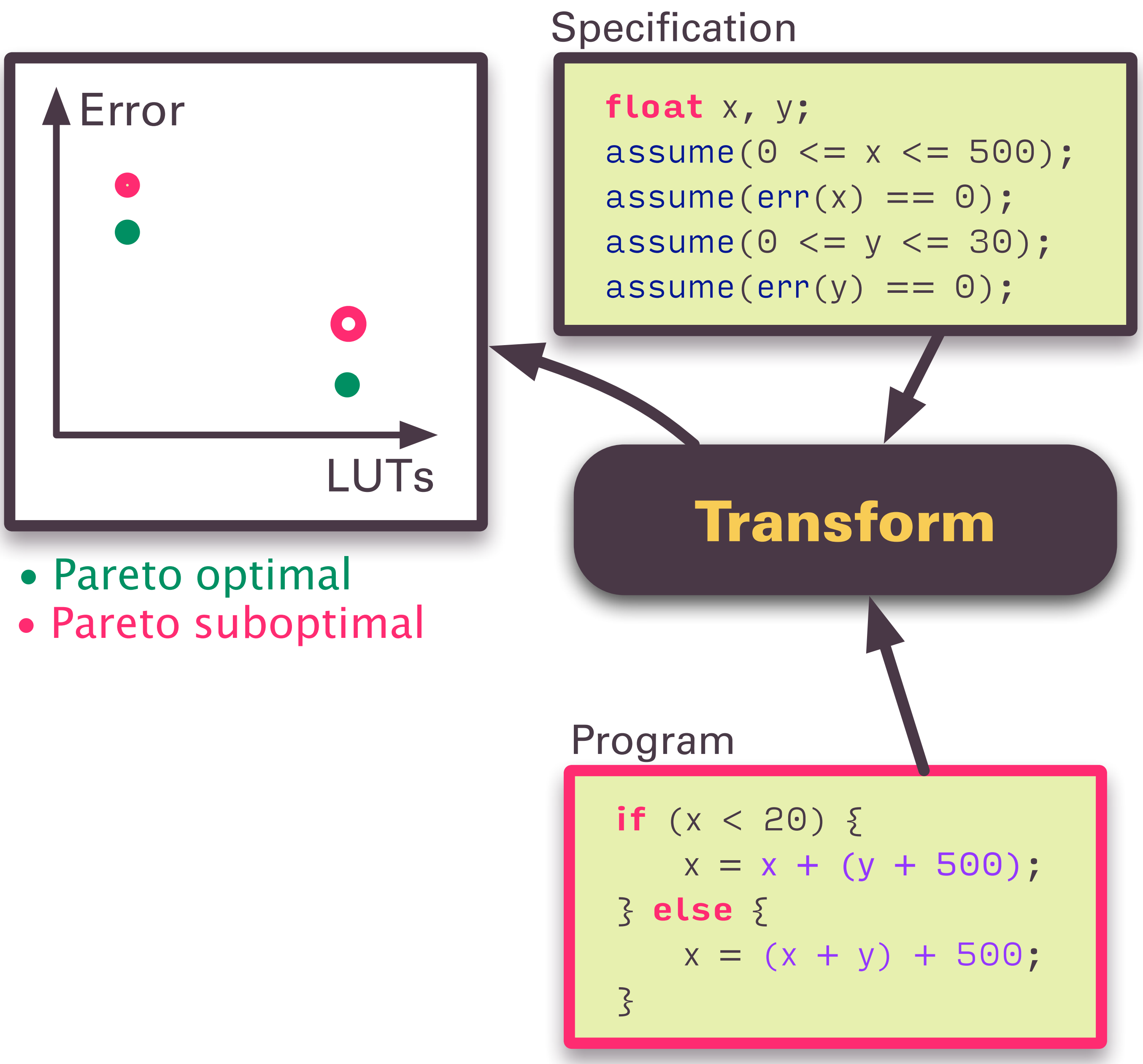

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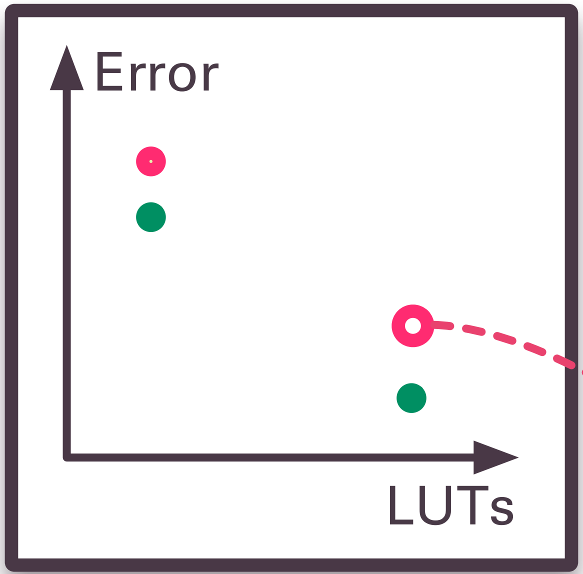

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● Pareto suboptimal

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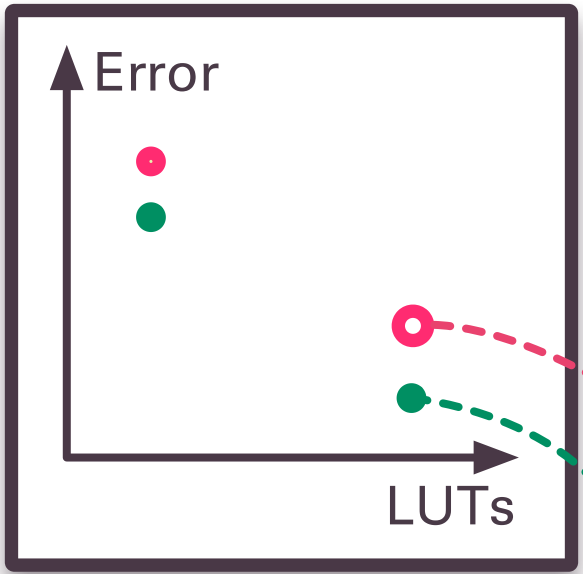

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Fewest resources but less accurate

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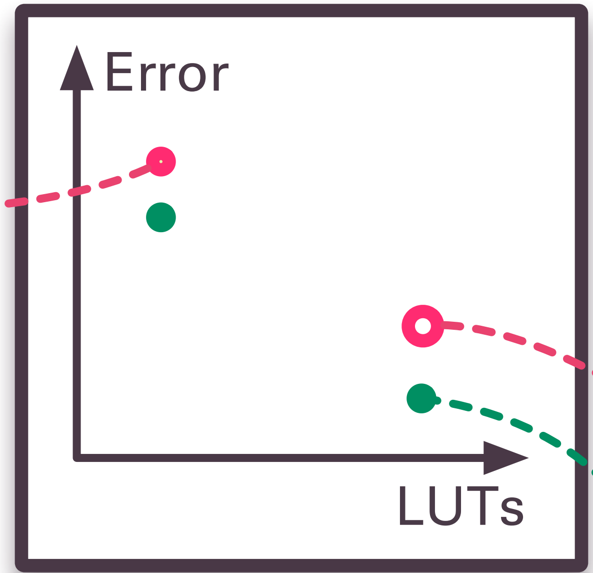

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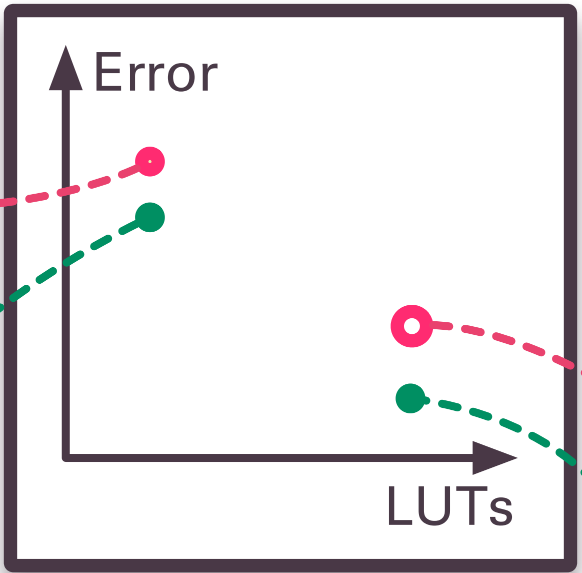

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And there is more...

There are a lot of things we did not cover:

- how we do that
  a more complex example program
- work flow
  how it fits in the traditional HLS work flow
- results
  ~60% better accuracy

All of these above are in the poster!

Thank you!

Join us in the poster session