HOW TO DESIGN PROGRAMS

An Introduction to Programming and Computing

Matthias
Felleisen

Robert Bruce
Findler

Matthew
Flatt

Shriram
Krishnamurthi

Computing

$$2 + 3$$

Computing

$$2 + 3 =$$

Computing

$$2 + 3 = 5$$

Computing

$$2 + 3 \rightarrow 5$$

expression   *result*

Arithmetic is Computing

- Rules for **operators** and **functions**:

$$2 + 3 \rightarrow 5$$

$$4 \times 2 \rightarrow 8$$

$$\cos(0) \rightarrow 1$$

- Rules for combining other rules:

  ○ Evaluate sub-expressions first

$$4 \times (2 + 3) \rightarrow 4 \times 5 \rightarrow 20$$

  ○ Precedence determines sub-expressions:

$$4 + 2 \times 3 \rightarrow 4 + 6 \rightarrow 10$$

Algebra as Computing

○ Definition:

$$f(x) = \cos(x) + 2$$

○ Expression:

$$f(0) \rightarrow \cos(0) + 2 \rightarrow 1 + 2 \rightarrow 3$$

First → uses the **substitution rule** for functions