

EZMath

Computational Mathtyping

Piaoyang Cui, Yi Wang,
Shangjin Zhang, Zhejiao Chen

Motivation

- Academic paper usually has many mathematical functions and calculations
- Trivial to write C++ functions for functions in paper by hand
- Hard to calculate function return values and complicated matrix calculations
- Careless typing and logical error eg: matrix dimension

```
gcd(a,b) = \begin{cases}
a & a==b \\
gcd(a-b, b) & a>b \\
gcd(a, b-a) & b>a
\end{cases}
```

```
\begin{bmatrix}
3.3 & 4.4 \\
5.5 & 6.6
\end{bmatrix}
```

Overview

- Compile to C++, translate functions in LaTeX to C++ functions
- Catch careless mistakes eg. two matrices can not be multiplied, divide by zero, etc
- Interpret and calculate values in report.tex
- Syntax: LaTeX with slight additional rules
- Terminology: Variable \leftrightarrow Float, Matrix
Formula, Piecewise formula

GCD

\$\$

`%Formula Definition`

```
gcd(a,b) =  
  \begin{cases}  
    a & a == b \\  
    gcd(a-b, b) & a > b \\  
    gcd(a, b-a) & b > a  
  \end{cases}
```

`%Formula overloading`

```
gcd(a,b,c) = gcd(a, gcd(b,c))
```

`%Evaluation`

```
m = gcd(10,20,30) * \begin{bmatrix} %Matrix Definition  
  1 & 2 \\  
  3 & 4  
\end{bmatrix} ^ {T} %Transpose
```

\$\$

GCD OUT

title{(No Title)} author{Unknown Author}

Formula Definitions

$\text{gcd}(a, b) = \{$

a , if $a=b$. Or

$\text{gcd}(a-b, b)$, if $a>b$. Or

$\text{gcd}(a, b-a)$, if $b>a$.

$\}$

$\text{gcd}(a, b, c) = \text{gcd}(a, \text{gcd}(b, c))$

Variable Definitions

$c = 10$

Matrix Definitions

$m = \{$

$([(50), (20)])$,

$([(100), (70)]]$

$\}$

Tricky Example

\$\$

$f(x) = \begin{cases}$

$\prod_{j=1}^{100} \left\{ \sum_{i=1}^j \left(\sin i^2 + \cos \left(\frac{i}{2} \right)^5 \right) \right\} \times e \quad \& \quad x > 1 \quad \backslash \backslash$

$f(x - 1) * (\log\{x\}) + (5 > x * 3) \quad \& \quad \sin\{x\} == \cos\{x\}$

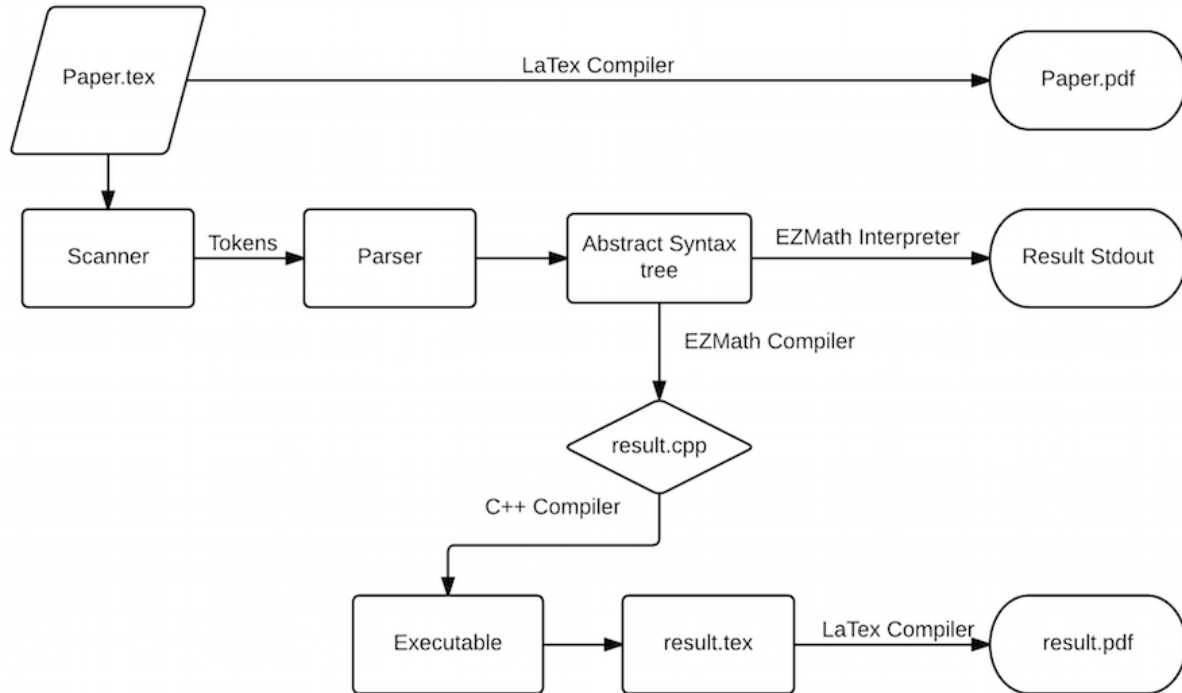
\end{cases}

\$\$

EZMath Compiler

$$f(x) = \begin{cases} \left(\prod_{j=1}^{100} \sum_{i=1}^j \left(\sin i^2 + \cos \left(\frac{i}{2} \right)^5 \right) \right) * 2.71828 & x > 1 \\ f(x - 1) * (\log_{10} x) + (5 > x * 3) & \sin x == \cos x \end{cases}$$

Work Flow



Σ & Π

$$\left[\begin{array}{l} \sum_{i=1}^n i * (i - 1) \\ \prod_{i=1}^n i * (i - 1) \end{array} \right] = \left[\begin{array}{l} \text{\sum}_{i=1}^n \{ i * (i - 1) \} \\ \text{\prod}_{i=1}^n \{ i * (i - 1) \} \end{array} \right]$$



```
[(int bottom, int top)
{
double sum=0; for(int i=bottom; i<top+1;i++) sum+=i*(i-1); return sum;
}
((int)(1), (int)(n));
```

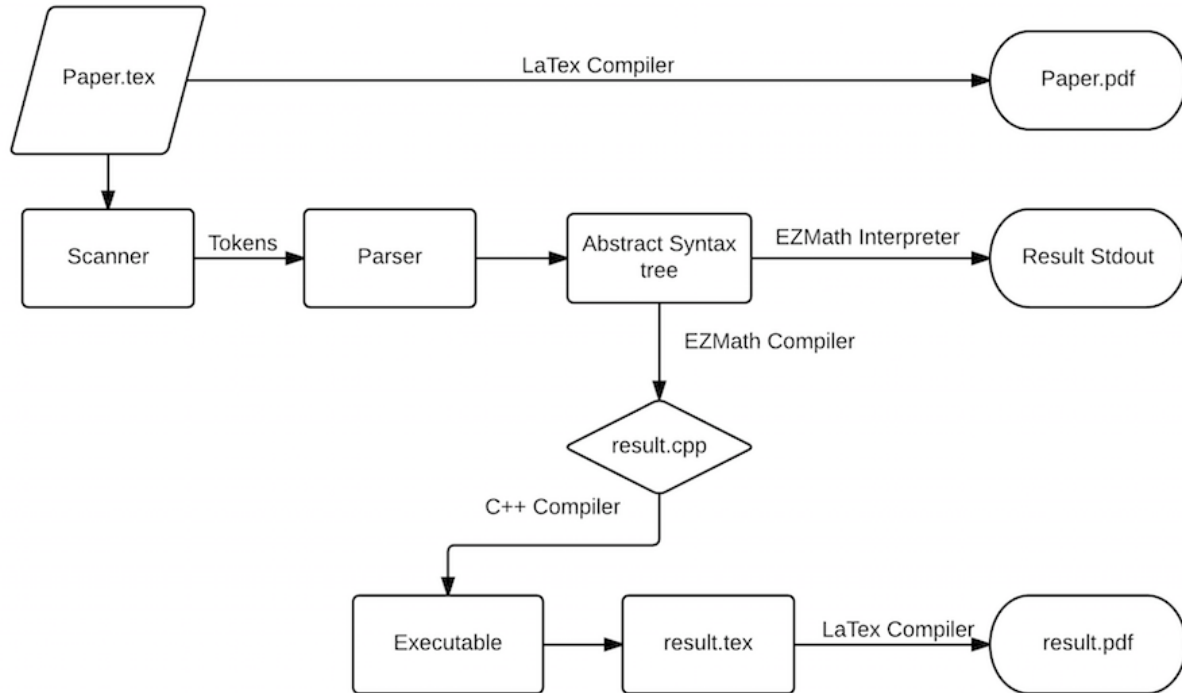

Piecewise

$$\left[\gcd(a, b) = \begin{cases} a & a == b \\ \gcd(a - b, b) & a > b \\ \gcd(a, b - a) & b > a \end{cases} \right] = \left[\begin{array}{l} \gcd(a, b) = \\ \begin{cases} a & \& a == b \\ \gcd(a - b, b) & \& a > b \\ \gcd(a, b - a) & \& b > a \end{cases} \\ \end{array} \right]$$



```
double gcd(double a, double b){
    if(a==b) return a;
    if(a>b) return gcd(a-b, b);
    if(b>a) return gcd(a, b-a);
    throw std::runtime_error("Illegal parameter in piecewise function gcd");
}
```

Pretty Printing



Summary

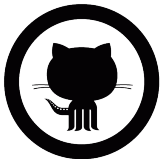
- Pure readable LaTeX text to reusable C++ code
- Automatic analysis of original paper: title, author, definitions, and computation
- Target for non-CS users, easy to use, pretty format
- Smoothy conversion: anonymous constructors, anonymous function (C++11) → reduce messiness

Future Work

- Code Optimization: Matrix computation, compress code, tail recursion
- Performance: Profiling, JIT. *Now: ~0.0007s for final.tex*
- More mathe formulas
- Anonymous function, higher-order function

Lessons Learned

- LRM: focus on the motivation, while keep open
- Get Things Right v.s. Get Things Done
- Debate with words v.s. Debate with code
- Collaboration: Github, Slack, ShareLatex, Coderpad, Google Doc



Q & A

Thanks for watching...
Ask us anything!

