Partial Derivative Calculator

Calculus III - Honors By Contract Project

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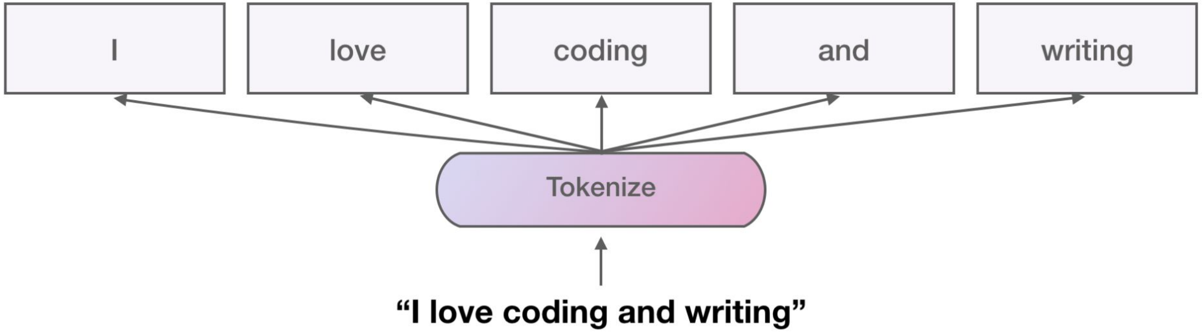
Importance of Partial Derivatives

- Derivative of multivariable function
- Allows us to define the gradient and directional derivative
- Real life example

Motivation

- Visualization and understanding
- Project-based learning
- Practice and reinforcement

Process - Tokenizer



Breaks a stream of text into tokens, usually by looking for whitespace (tabs, spaces, new lines).

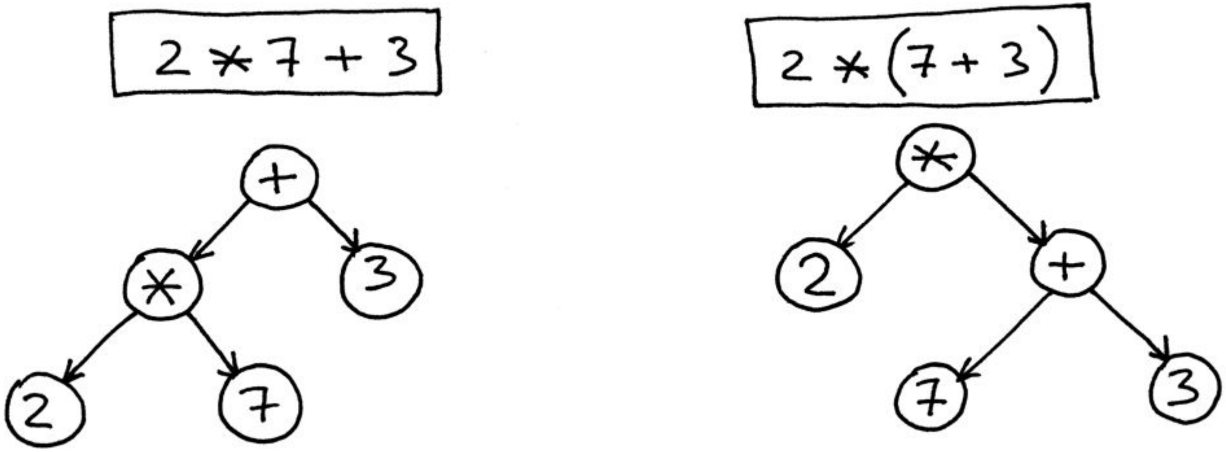
Process – Parser

Parsing token classifications

TOKEN	CLASS
x	identifier
+	addition operator
z	identifier
=	assignment operator
11	number

Takes the tokenized expression, verifies syntax, creates a structured representation (the AST) that can be further processed and evaluated.

Process - Abstract Syntax Tree



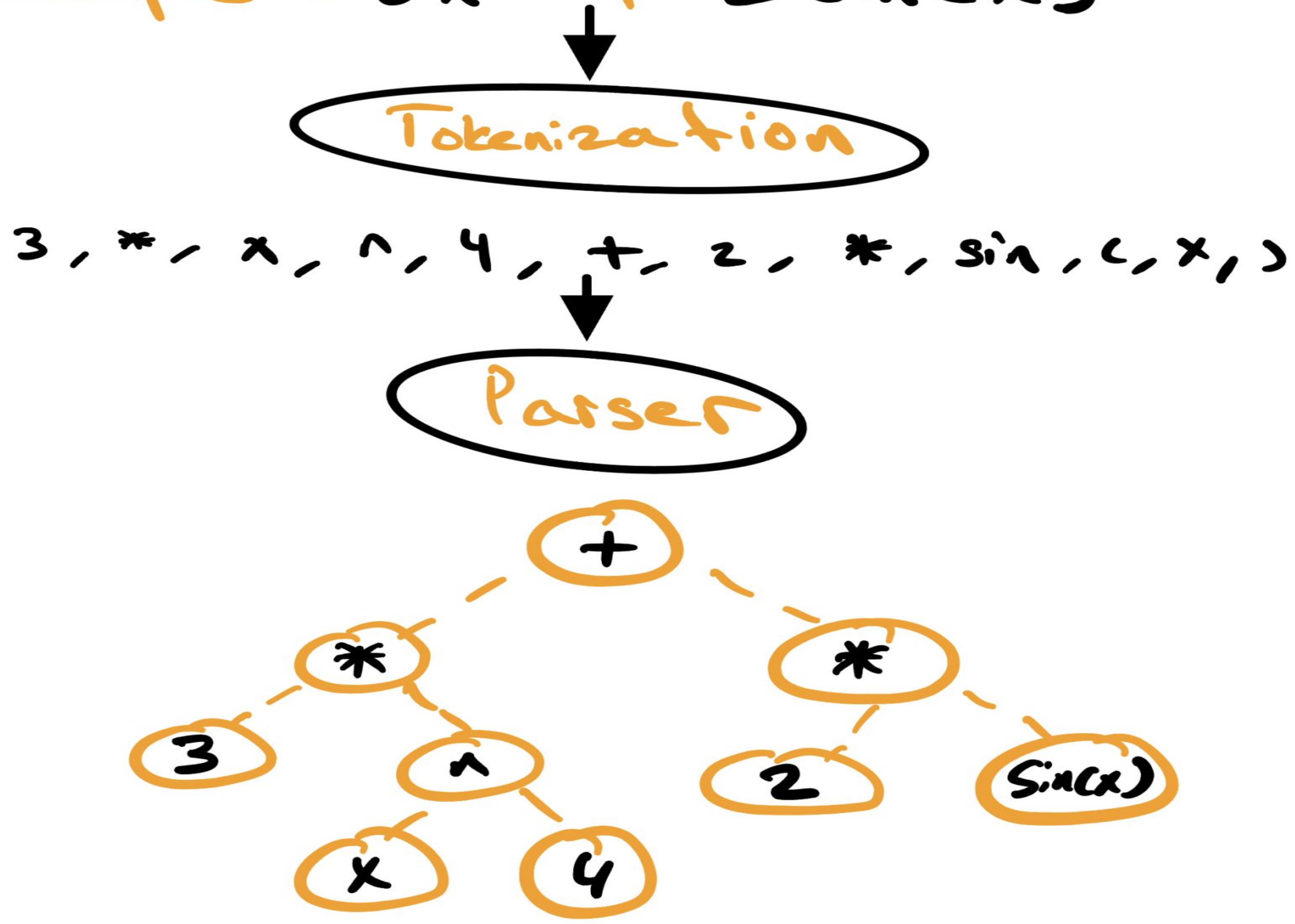
Organizes different components of an expression (numbers, variables, operations) into a branching tree format, where each node in the tree represents a part of the expression.

```java
private Operation getFunction(Token t) throws TokenizerException
{
    FunctionToken token = (FunctionToken) t;
    switch (token.getFunction().getName())
    {
        case "acos": return new Acos(getTree());
        case "asin": return new Asin(getTree());
        case "atan": return new Atan(getTree());
        case "log": return new Log(getTree());
        case "cos": return new Cos(getTree());
        case "sin": return new Sin(getTree());
        case "sqrt": return new Sqrt(getTree());
        case "tan": return new Tan(getTree());
        case "exp": return new Exp(getTree());
        case "abs": return new Abs(getTree());
        default: throw new TokenizerException("Function error");
    }
}
```

```java
private Operation getOperator(Token t) throws TokenizerException
{
    Operation right = getTree();
    Operation left = getTree();

    switch (((OperatorToken)t).getOperator().getSymbol())
    {
        case "+":   return new Addition(left, right);
        case "-":   return new Subtraction(left, right);
        case "*":   return new Product(left, right);
        case "/":   return new Division(left, right);
        case "^":   return new Pow(left, right);
        default: throw new TokenizerException("Function error");
    }
}
```

Example : $3x^{\wedge}4 + 2\sin(x)$



Derive each node

Term: $3 * x^{4}$

$3 \to 0$ constant rule

$x^{4} \to 4 * x^{3}$ power rule

$3x^{4} \to 12 * x^{3}$ constant & product rule

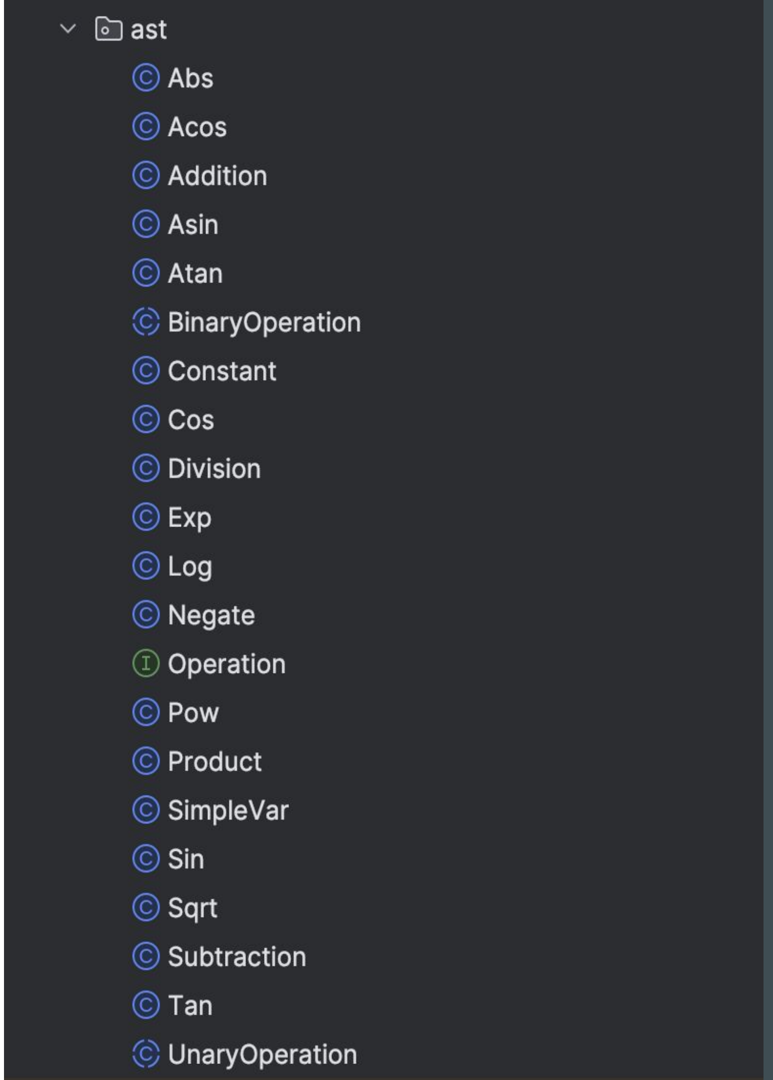
Term: $2 * \sin(x)$

$2 \to 0$ constant rule

$\sin(x) \to \cos(x)$ trig rule

$2 * \sin(x) \to 2 * \cos(x)$ constant & product rule

Derivative = sum of the derivative of both terms: $12 * x^{3} + 2 * \cos(x)$



Problem Solving

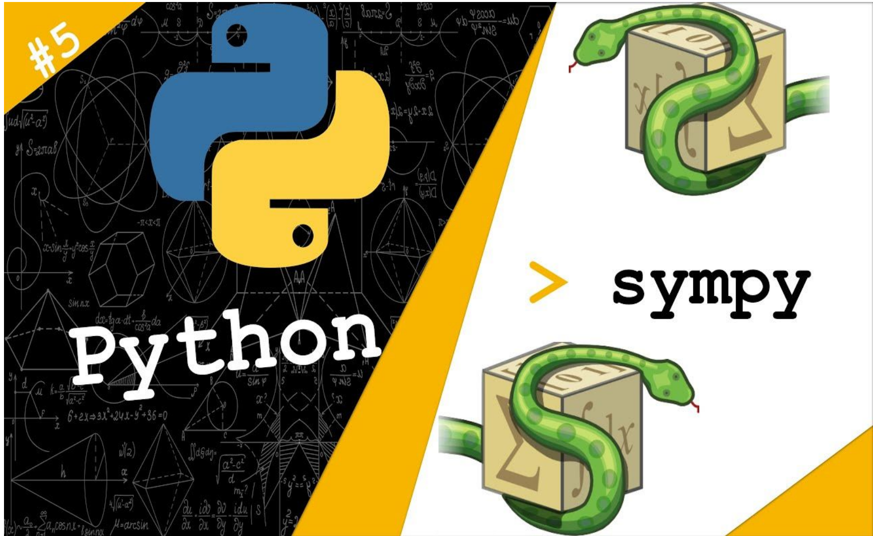
1. Complexity

2. Reliability and performance

3. Extensibility and Community Support

- SymPy is a Python library designed for symbolic mathematics

- Built-in support for recognizing and manipulating multiple symbolic variables.



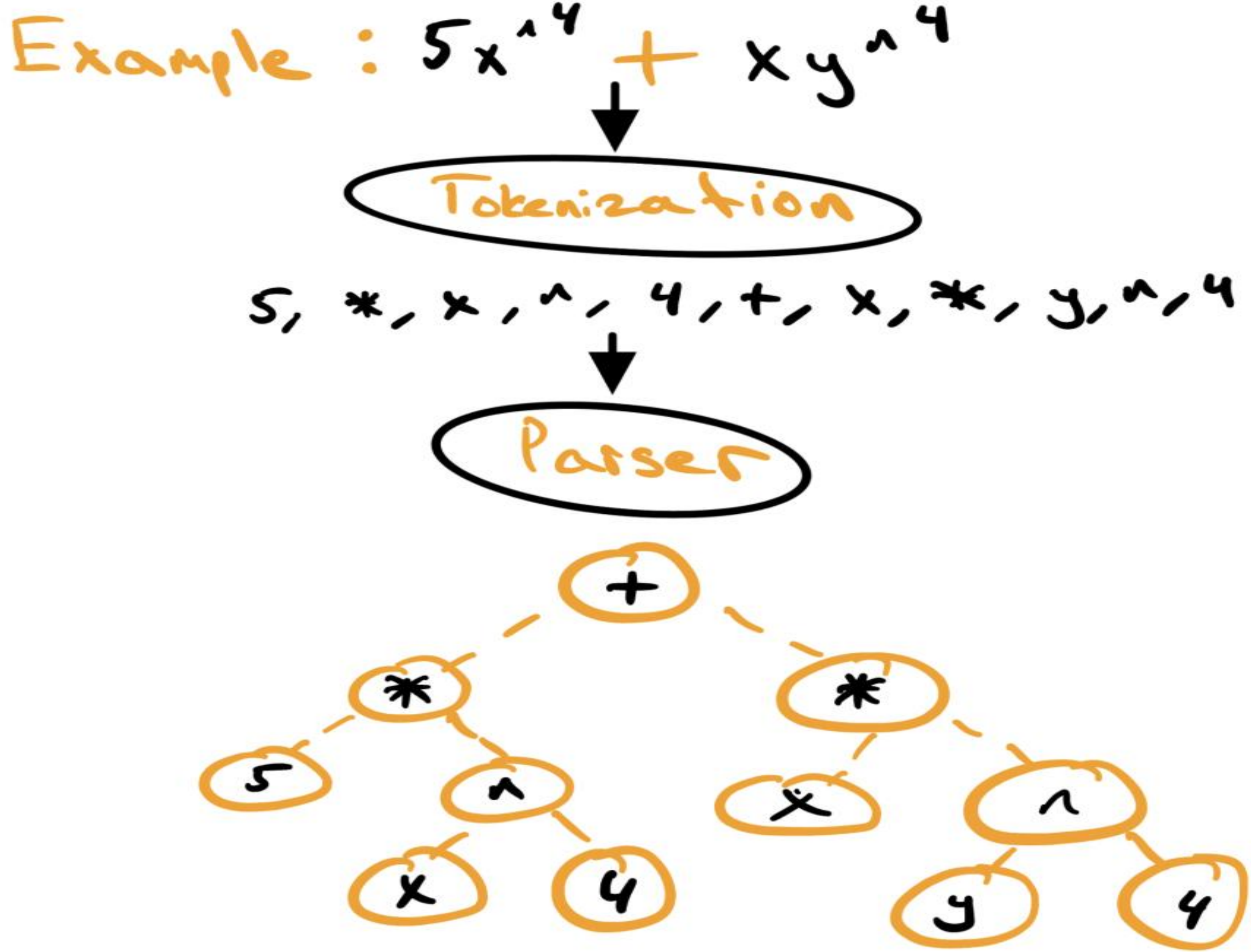
Graphical User Interface

- Easily shareable
- Web-based application so no system requirements or download required on user end.
- Handles capturing inputs, executing the Python code, and rendering the outputs automatically.

Gradio

All Platforms

Open-source Python package that allows you to quickly **build** a demo or web application for your machine learning model, API, or any Python function.


Example : 5x^4 + xy^4
Tokenization
5, *, x, ^, 4, +, x, *, y, ^, 4
Parser
+
*
*
5
^
x
^
x
4
y
4

Derive each Node (with respect to y)

Term: $5 * x^4$

$5 \to 0$ constant rule

$x^4 \to 0$ constant rule (x is now considered a constant)

$5x^4 \to 0$ constant & product rule

Term: xy^4

$x \to 0$ constant rule

$y^4 \to 4y^3$ power rule

$xy^4 \to 4xy^3$ constant & product rule

Derivative = sum of the derivative of both terms: $0 + 4xy^3 = 4xy^3$

Works Cited

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