**Simple Calculator with Tkinter GUI: A Desktop Application for Basic Arithmetic Operations**

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**Abstract**

The Simple Calculator is a desktop application developed using Python and Tkinter to perform basic arithmetic operations, including addition, subtraction, multiplication, and division. Designed as part of the MITS Internship, the application features a graphical user interface (GUI) that supports both mouse and keyboard inputs, displaying the full mathematical expression (e.g., "5 + 3") before computing the result. The calculator handles errors such as division by zero and invalid inputs through intuitive message prompts. This paper describes the design, implementation, and evaluation of the calculator, highlighting its user-friendly interface, robust functionality, and potential for future enhancements. The project demonstrates proficiency in GUI development, event-driven programming, and error handling, aligning with the internship's objectives of skill development and practical application.

**Keywords**

Calculator, Tkinter, Python, GUI, Arithmetic Operations, Event-Driven Programming

**I. Introduction**

The development of user-friendly applications is a critical aspect of modern software engineering, particularly in educational and professional settings where tools must be intuitive and reliable. The Simple Calculator project, undertaken as part of the MITS Internship, addresses this need by implementing a desktop calculator capable of performing fundamental arithmetic operations. Unlike command-line calculators, this application leverages Python’s Tkinter library to provide a graphical interface, enabling users to interact via on-screen buttons or keyboard inputs. A key feature is the real-time display of the mathematical expression (e.g., "5 + 3") during input, which enhances usability by providing clear visual feedback. The calculator supports digits, decimal points, operators, a clear function, and result computation via the equals button or Enter key, with robust error handling for invalid inputs. This paper outlines the project’s objectives, methodology, implementation, and results, demonstrating its alignment with the internship’s goal of developing practical programming skills.

**II. Methodology**

The development of the Simple Calculator followed a systematic software engineering approach to ensure functionality, usability, and reliability. The methodology encompassed requirement analysis, system design, implementation, and testing phases, as detailed below.

* **Requirement Analysis**: The project requirements were derived from the MITS Internship guidelines, specifying a calculator capable of basic arithmetic operations. Additional features included support for both mouse and keyboard inputs, real-time expression display, and error handling for cases like division by zero.
* **System Design**: The GUI was designed as a 5x4 grid of buttons (digits 0-9, decimal point, operators, equals, clear) with an entry field for display. The system architecture included event handlers for button clicks and keyboard inputs, with logic to track numbers, operators, and expressions.
* **Implementation**: The application was coded in Python using Tkinter for the GUI. The implementation phase focused on creating a responsive interface, robust calculation logic, and error management.
* **Testing**: Functional testing verified correct operation for arithmetic calculations, keyboard inputs (e.g., Enter for equals, Backspace for corrections), and error scenarios. Usability testing ensured the interface was intuitive for end users.

**III. Libraries Used**

The Simple Calculator relies on Python’s standard libraries, ensuring portability and ease of deployment. The libraries used are:

* **tkinter**: Provides the framework for creating the GUI, including windows, buttons, and entry fields. It handles event bindings for mouse and keyboard interactions.
* **tkinter.messagebox**: A submodule used to display error messages, such as “Cannot divide by zero!” or “Invalid input!”, enhancing user feedback.

No external dependencies are required, as Tkinter is included with Python installations, making the application lightweight and accessible.

**IV. Implementation Details**

The Simple Calculator is implemented as a single Python script (calculator.py) encapsulating a Calculator class. The implementation details are as follows:

* **GUI Structure**: The interface comprises an Entry widget for displaying inputs and results, and a 5x4 grid of Button widgets for digits (0-9), decimal point (.), operators (+, -, \*, /), equals (=), and clear (C). The window is sized at 300x400 pixels for clarity.
* **Input Handling**:
  + **Mouse Input**: Button clicks trigger the click method, which processes digits, operators, equals, or clear actions.
  + **Keyboard Input**: The handle\_keypress method binds keys to actions: digits (0-9), decimal point (.), operators (+, -, \*, /), Enter (for equals), ‘C’ (clear), and Backspace (corrections).
* **Calculation Logic**: The application tracks the current number (current), operator (operation), first number (first\_num), and display expression (expression). When an operator is selected, the first number and operator are stored, and the display shows “first\_num operator” (e.g., “5 +”). The second number is appended to the expression, and the result is computed upon pressing equals or Enter.
* **Error Handling**: Try-except blocks validate inputs, preventing crashes from invalid numbers. Division by zero triggers a messagebox error, as do malformed inputs.
* **Code Snippet**: The complete source code is provided below for reference.

import tkinter as tk

from tkinter import messagebox

class Calculator:

def \_\_init\_\_(self, root):

self.root = root

self.root.title("Simple Calculator")

self.root.geometry("300x400")

self.display = tk.Entry(root, width=20, font=("Arial", 16), justify="right")

self.display.grid(row=0, column=0, columnspan=4, padx=10, pady=10)

self.display.focus\_set()

buttons = ['7', '8', '9', '/', '4', '5', '6', '\*', '1', '2', '3', '-', '0', '.', '=', '+', 'C']

row, col = 1, 0

for button in buttons:

cmd = lambda x=button: self.click(x)

tk.Button(root, text=button, width=5, height=2, font=("Arial", 14), command=cmd).grid(row=row, column=col, padx=5, pady=5)

col += 1

if col > 3:

col = 0

row += 1

self.current = ""

self.operation = ""

self.first\_num = 0

self.expression = ""

self.root.bind('<Key>', self.handle\_keypress)

def handle\_keypress(self, event):

char = event.char

if char in '0123456789.':

self.click(char)

elif char in '+-\*/':

self.click(char)

elif char.lower() == 'c':

self.click('C')

elif event.keysym == 'Return':

self.click('=')

elif event.keysym == 'BackSpace':

if self.current:

self.current = self.current[:-1]

self.expression = self.expression[:-1]

self.display.delete(0, tk.END)

self.display.insert(tk.END, self.expression)

elif self.operation:

self.operation = ""

self.expression = str(self.first\_num)

self.display.delete(0, tk.END)

self.display.insert(tk.END, self.expression)

def click(self, char):

if char == 'C':

self.current = ""

self.operation = ""

self.first\_num = 0

self.expression = ""

self.display.delete(0, tk.END)

elif char in '0123456789.':

self.current += char

self.expression = self.expression.rstrip() + char

self.display.delete(0, tk.END)

self.display.insert(tk.END, self.expression)

elif char in '+-\*/':

if self.current:

try:

self.first\_num = float(self.current)

self.operation = char

self.expression = f"{self.first\_num} {char} "

self.current = ""

self.display.delete(0, tk.END)

self.display.insert(tk.END, self.expression)

except ValueError:

messagebox.showerror("Error", "Invalid number!")

elif self.operation and not self.current:

self.operation = char

self.expression = f"{self.first\_num} {char} "

self.display.delete(0, tk.END)

self.display.insert(tk.END, self.expression)

elif char == '=':

if self.current and self.operation:

try:

second\_num = float(self.current)

result = None

if self.operation == '+':

result = self.first\_num + second\_num

elif self.operation == '-':

result = self.first\_num - second\_num

elif self.operation == '\*':

result = self.first\_num \* second\_num

elif self.operation == '/':

if second\_num != 0:

result = self.first\_num / second\_num

else:

messagebox.showerror("Error", "Cannot divide by zero!")

if result is not None:

self.current = str(result)

self.expression = str(result)

self.display.delete(0, tk.END)

self.display.insert(tk.END, self.expression)

self.operation = ""

self.first\_num = result

except ValueError:

messagebox.showerror("Error", "Invalid input!")

self.current = ""

if \_\_name\_\_ == "\_\_main\_\_":

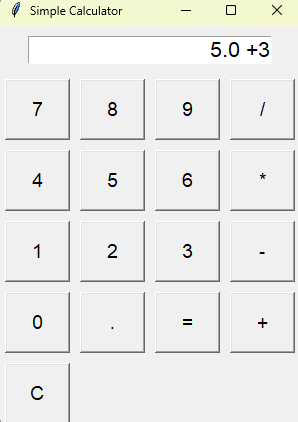
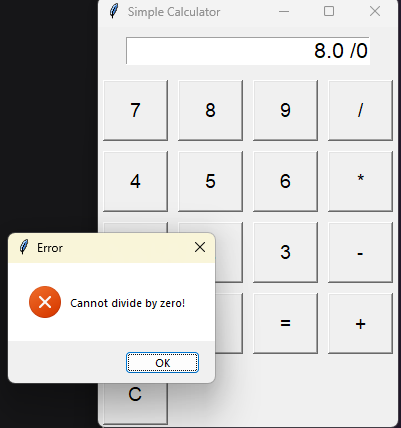
root = tk.Tk()

app = Calculator(root)

root.mainloop()

**V. Results and Output**

The Simple Calculator delivers a functional and intuitive user experience, with the following key outputs:

* **Graphical Interface**: A 300x400-pixel window with a display field and a 5x4 button grid, styled with Arial font for readability.
* **Expression Display**: The calculator shows the full expression during input (e.g., “5 + 3”) and updates to the result (e.g., “8”) upon pressing equals or Enter.
* **Input Flexibility**: Users can interact via:
  + Mouse clicks on buttons for digits, operators, equals, or clear.
  + Keyboard inputs for digits, operators, Enter (equals), ‘C’ (clear), and Backspace (corrections).
* **Error Handling**: Errors like division by zero or invalid inputs trigger messagebox alerts, preventing application crashes.
* **Example Operation**:
  + Input Sequence: Type “5”, press “+”, type “3”, press Enter.
  + Output: Display shows “5 + 3” during input, then “8” after Enter.
  + 
* **Error Case**:
  + Input Sequence: Type “5”, press “/”, type “0”, press Enter.
  + Output: Messagebox displays “Cannot divide by zero!”.
  + 

The application was tested on Python 3.9, confirming reliable performance across multiple input scenarios.

**VI. Conclusion**

The Simple Calculator project successfully fulfills the MITS Internship requirements by delivering a robust, user-friendly desktop application for basic arithmetic operations. The use of Tkinter enabled a responsive GUI, while the integration of keyboard and mouse inputs enhanced accessibility. The real-time expression display and error handling features demonstrate attention to user experience and software reliability. The project reinforced skills in Python programming, GUI development, and event-driven design, aligning with the internship’s objectives. The code’s portability and clear documentation make it suitable for educational purposes and future enhancements.

**VII. Future Work**

The Simple Calculator can be extended to increase its functionality and appeal:

* **Advanced Functions**: Incorporate square roots, exponents, or trigonometric operations for a scientific calculator mode.
* **Calculation History**: Add a panel to display past calculations, improving usability for complex workflows.
* **Enhanced Styling**: Use Tkinter’s ttk widgets or external libraries like ttkbootstrap for modern themes and visual appeal.
* **Expression Parsing**: Support complex expressions (e.g., “5 + 3 \* 2”) using a safe parser to handle operator precedence.
* **Cross-Platform Distribution**: Package the application as an executable using PyInstaller for broader accessibility.
* **Accessibility Features**: Implement support for screen readers or high-contrast modes to accommodate diverse users.

**References**

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