1. Basic Functionalities

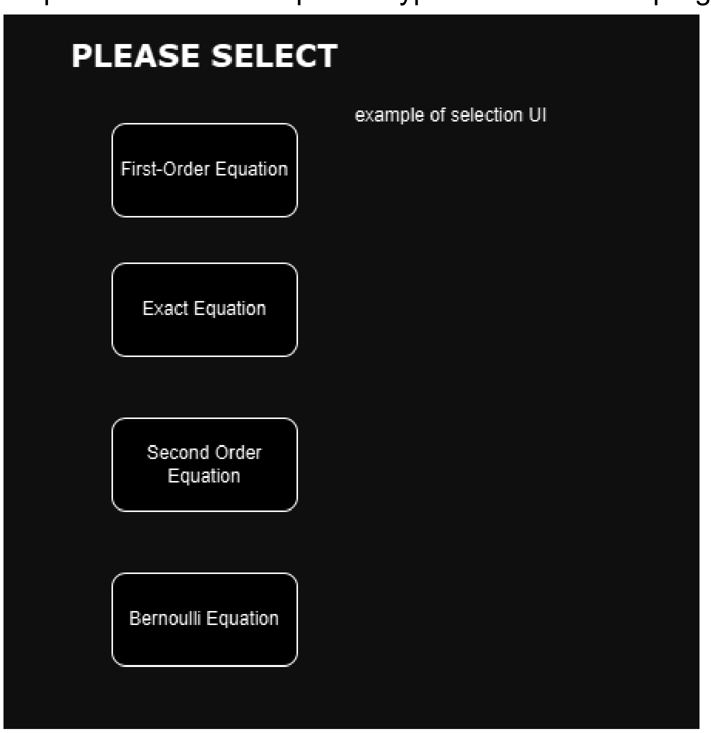
Below is a list of core functionalities needed for our differential equation solving and graphing application:

- Differential Equation Category
  - Input: User selects which type of differential equation
  - Process: The category chosen will change what the user can input
  - Output: Text boxes for the different components will appear
- Differential Equation
  - Input: User inputs the differential equation
  - Different processes and outputs stem from this input
- Graphing (Process 1)
  - Process: The differential equation is graphed
  - Output: The graph is displayed for the user
- Solving (Process 2)
  - Process: A solution to the differential equation is found
  - Output: The solution is displayed to the user
- Solution Process
  - Process: Steps are stored by the system as strings which outline how the differential equation is solved
  - Output: The steps are displayed to the user

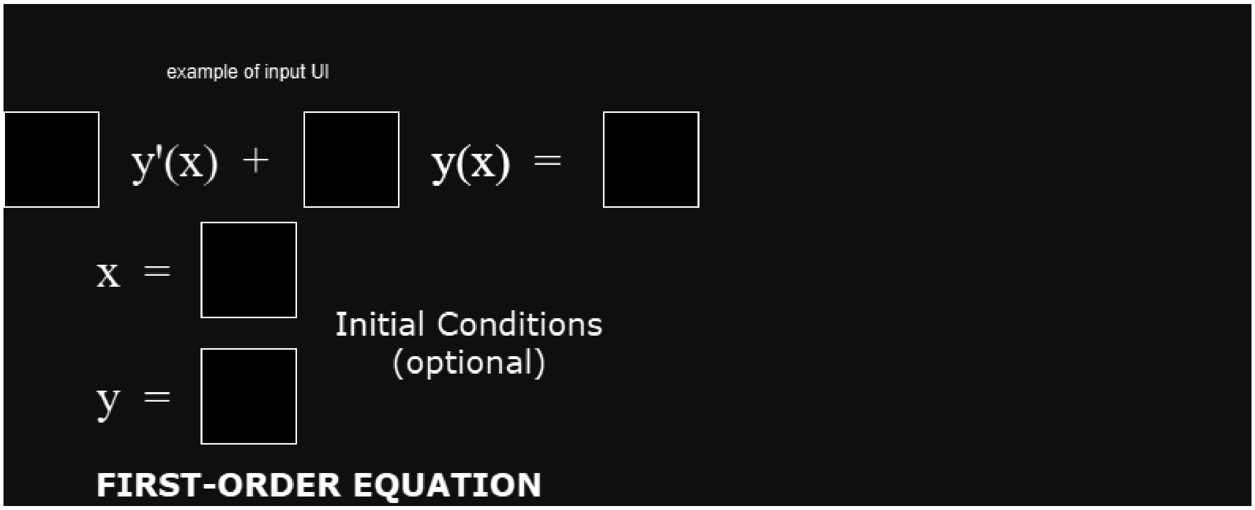
2. System Overview

Below example functionalities of our application:

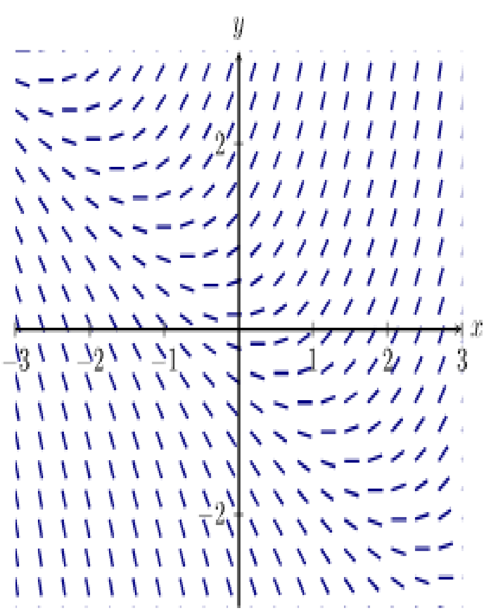
Step 1: User selects equation type in order for the program to know what methods to use

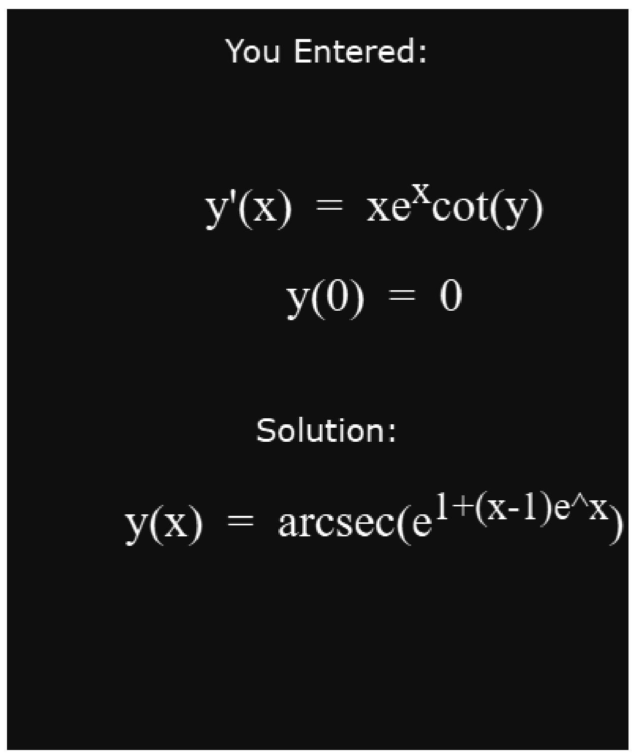


Step 2: The user inputs their equation according to the type they selected, optionally inputting initial conditions for an exact solution.



Step 3: Solution is displayed (Example solution and example slope field are not the same function) - slope field displayed for general solution, single function for initial condition inputs. General solution or exact solution will be printed as necessary to accompany





Step 4: Solution Process Displayed (example drawn on paper):

	$y'(x) = xe^x \cot y \quad ; \quad y(0)=0$	
	$\frac{dy}{dx} = xe^x \cot y$	convert to Leibniz notation
	$\tan(y)\,dy = xe^x\,dx$	separate variables
	$\int_0^y \tan(y)\,dy = \int_0^x xe^x\,dx$	integrate
evaluate	$\ln\sec(y)\Big\|_0^y = xe^x\Big\|_0^x - \int_0^x e^x\,dx$	integrat by part
simplify	$\ln\sec(y) - \ln\sec(0) = xe^x - e^x + e^0$	evaluate
Simplify	$\ln\sec(y) - \ln(1) = xe^x - e^x + 1$	simplify
simplify	$\ln\sec(y) - 0 = xe^x - e^x + 1$	simplify
	$e^{\ln\sec(y)} = e^{(x-1)e^x+1}$	isolate y
	$\sec(y) = e^{(x-1)e^x+1}$	Isolate y
	$y = \text{arcsec}\left(e^{(x-1)e^x+1}\right)$	Solve for y

Flow Chart of processes: