MODIFIED EULER METHOD

It is a numerical integration technique used in power system analysis to solve non-linear differential equations most notably the swing equation when assessing transient stability

Why It Is Used in Power Systems

- **Non-Linearity:** Power system dynamics during disturbances (like short-circuit faults or line switching) are governed by non-linear second-order differential equations describing generator rotor angle
- **Accuracy vs. Standard Euler:** The standard Euler method uses a single slope at the start of a time step, which leads to large truncation errors and numerical instability. The Modified Euler method improves accuracy by averaging the slope at the beginning and the predicted slope at the end of the interval.

How the Algorithm Works (Step-by-Step)

To solve a first-order (or converted first-order system of) differential equation like $\frac{dy}{dt} = f(t, y)$ with step size h:

1. **Convert Second-Order to First-Order:**
   The swing equation is a second-order differential equation. It is split into two coupled first-order differential equations:

$$\frac{d\delta}{dt} = \omega - \omega_s$$

$$\frac{d\omega}{dt} = \frac{1}{M}[P_m - P_e - D(\omega - \omega_s)]$$

2. **Predictor Step (Initial Estimate):**
   Calculate an initial prediction $y_1^{(0)}$ using the standard Euler formula with the derivative

3. **Evaluation (Slope at the End):**
   Evaluate the derivative function at the predicted end-point $(t_1, y_1^{(0)})$:

$$f_1 = f(t_1, y_1^{(0)})$$

4. **Corrector Step (Averaging Slopes):**
   Compute the refined value y_1 by taking the average of the initial slope $f(t_0, y_0)$

Advantages and Limitations

- **Advantages:**
  - Simpler to program and less computationally intensive per step than higher-order Runge-Kutta methods.
  - Provides a better trade-off between speed and accuracy than the basic Euler