

The Implicit/Backward Euler Method

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A notebook to experiment with the implicit or backward Euler method.

Defining The Backward Euler Method

The following definition allows us to use the Backward Euler method within Mathematica's NDSolve command.

```
In[13]:= BackwardEuler = {"FixedStep", Method → {"ImplicitRungeKutta",  
  "Coefficients" → "ImplicitRungeKuttaRadauIIACoefficients",  
  "DifferenceOrder" → 1, "ImplicitSolver" → {"FixedPoint",  
  AccuracyGoal → MachinePrecision, PrecisionGoal → MachinePrecision,  
  "IterationSafetyFactor" → 1}}};
```

A Test Case

Here is an ODE on which to experiment

```
In[14]:= de = u'[t] == -u[t] + t
```

Let's define the solution as "backeuler"

```
In[17]:= backeuler =  
  NDSolve[{de, u[0] == 1}, u, {t, 0, 5}, StartingStepSize → 0.1, Method → BackwardEuler]
```

Examine the solution value at t = 5.

```
In[18]:= u[5] /. backeuler
```

Plot the solution

```
In[19]:= Plot[Evaluate[u[t] /. backeuler], {t, 0, 5}, PlotRange → All]
```