Fitzhugh-Nagumo Work-Precision Diagrams

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0.1 Fitzhugh-Nagumo

The purpose of this is to see how the errors scale on a standard nonlinear problem.

```
using DifferentialEquations, ParameterizedFunctions, ODE, ODEInterfaceDiffEq, LSODA
```

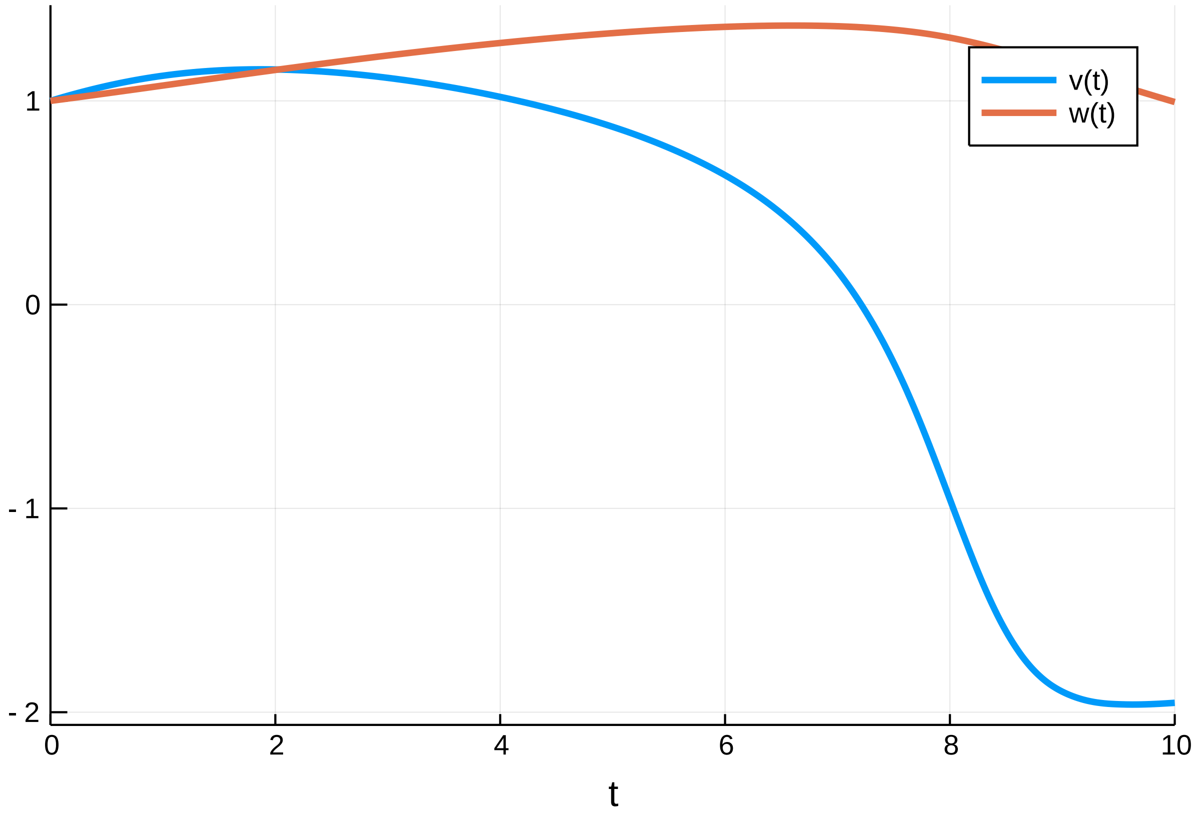
```
Error: ArgumentError: Package ODE not found in current path:
- Run `import Pkg; Pkg.add("ODE")` to install the ODE package.
```

```
f = @ode_def FitzhughNagumo begin
  dv = v - v^3/3 -w + l
  dw = τinv*(v +  a - b*w)
end a b τinv l

p = [0.7,0.8,1/12.5,0.5]
prob = ODEProblem(f,[1.0;1.0],(0.0,10.0),p)

abstols = 1.0 ./ 10.0 .^ (6:13)
reltols = 1.0 ./ 10.0 .^ (3:10);
sol = solve(prob,Vern7(),abstol=1/10^14,reltol=1/10^14)
test_sol = TestSolution(sol)
```

```
Error: UndefVarError: TestSolution not defined
```

```
using Plots; gr()
```

```
sol = solve(prob)
plot(sol)
```



0.2 Low Order

```
setups = [Dict(:alg=>DP5())
          #Dict(:alg=>ode45()) #fails
          Dict(:alg=>dopri5())
          Dict(:alg=>BS5())
          Dict(:alg=>Tsit5())
          Dict(:alg=>Vern6())
]
```

```
Error: UndefVarError: dopri5 not defined
```

```
wp =
    WorkPrecisionSet(prob,abstols,reltols,setups;appxsol=test_sol,save_everystep=false,numruns=1000,ma
```

```
Error: UndefVarError: test_sol not defined
```

```
plot(wp)
```

```
Error: UndefVarError: wp not defined
```

0.2.1 Interpolation

```
setups = [Dict(:alg=>DP5())
          #Dict(:alg=>ode45()) # fails
          Dict(:alg=>BS5())
          Dict(:alg=>Tsit5())
          Dict(:alg=>Vern6())
]
wp =
    WorkPrecisionSet(prob,abstols,reltols,setups;appxsol=test_sol,numruns=1000,maxiters=10000,error_es
```

```
Error: UndefVarError: test_sol not defined
```

```
plot(wp)
```

```
Error: UndefVarError: wp not defined
```

0.3 Higher Order

```
setups = [Dict(:alg=>DP8())
          #Dict(:alg=>ode78()) # fails
          Dict(:alg=>Vern7())
          Dict(:alg=>Vern8())
          Dict(:alg=>dop853())
          Dict(:alg=>Vern6())
]
```

```
Error: UndefVarError: dop853 not defined
```

```
wp =
    WorkPrecisionSet(prob,abstols,reltols,setups;appxsol=test_sol,save_everystep=false,numruns=1000,ma
```

```
Error: UndefVarError: test_sol not defined
```

```
plot(wp)
```

```
Error: UndefVarError: wp not defined
```

```
setups = [Dict(:alg=>DP8())
          Dict(:alg=>Vern7())
          Dict(:alg=>CVODE_Adams())
          Dict(:alg=>ARKODE(Sundials.Explicit(),order=6))
          Dict(:alg=>lsoda())
          Dict(:alg=>odex())
          Dict(:alg=>ddeabm())
]
```

```
Error: UndefVarError: CVODE_Adams not defined
```

```
wp =
    WorkPrecisionSet(prob,abstols,reltols,setups;appxsol=test_sol,save_everystep=false,numruns=1000,ma
```

```
Error: UndefVarError: test_sol not defined
```

```
plot(wp)
```

```
Error: UndefVarError: wp not defined
```

0.3.1 Interpolation

```
setups = [Dict(:alg=>DP8())
          #Dict(:alg=>ode78()) # fails
          Dict(:alg=>Vern7())
          Dict(:alg=>Vern8())
          Dict(:alg=>Vern6())
]
wp =
    WorkPrecisionSet(prob,abstols,reltols,setups;appxsol=test_sol,numruns=1000,maxiters=1000,error_est
```

```
Error: UndefVarError: test_sol not defined
```

```
plot(wp)
```

```
Error: UndefVarError: wp not defined
```

0.4 Conclusion

As expected, the algorithms are all pretty matched on time for this problem. However, you can clearly see the OrdinaryDiffEq.jl algorithms solving to a much higher accuracy and still faster, especially when the interpolations are involved.