DiffSol

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What is DiffSol?

- Rust library for solving ODEs or semi-explicit DAEs.

$$M(t)\frac{dy}{dt} = f(t, y, p)$$

- Design goals:
  - High performance for large systems of equations
  - Easy to use and wrap in higher level languages.

Features

- Two solvers: Variable order **BDF** (e.g. `ode15s`), **SDIRK** (e.g. `ode23s`)
- Adaptive step size control
- Dense output
- Event handling
- Sensitivity analysis (forward only)
- Sparse and Dense Jacobians

Motivation

1. Difficult to use high performance solvers from **Python or Javascript**
2. **Rust** is a great systems language, but, lacks many native libraries for scientific computing.
   - Linear algebra improving (e.g. `nalgebra`, `faer`).
   - ODE solvers are still in infancy.

Installation & Docs

- DiffSol is available on crates.io.
- The source code is available on github
- API documentation is available on docs.rs
- User guide and examples are available in the DiffSol book

Usage

See logistic growth example here

DiffSL

- Using solvers from **higher level languages** (Python, Julia, R) tricky.
  - Difficult to pass in user defined functions
- DiffSol solves this problem by using a Domain Specific Language (DSL) called **DiffSL**
  - JIT compiled using LLVM at runtime.
  - See the DiffSL book

DiffSL example

See logistic growth DiffSL example here

Future work

- Adjoint sensitivity analysis
- Python bindings using PyO3 written by Alex Allmont
- Javascript bindings using wasm
- More solvers (e.g. Rosenbrock methods, explicit Runge-Kutta methods, stochastic solvers)