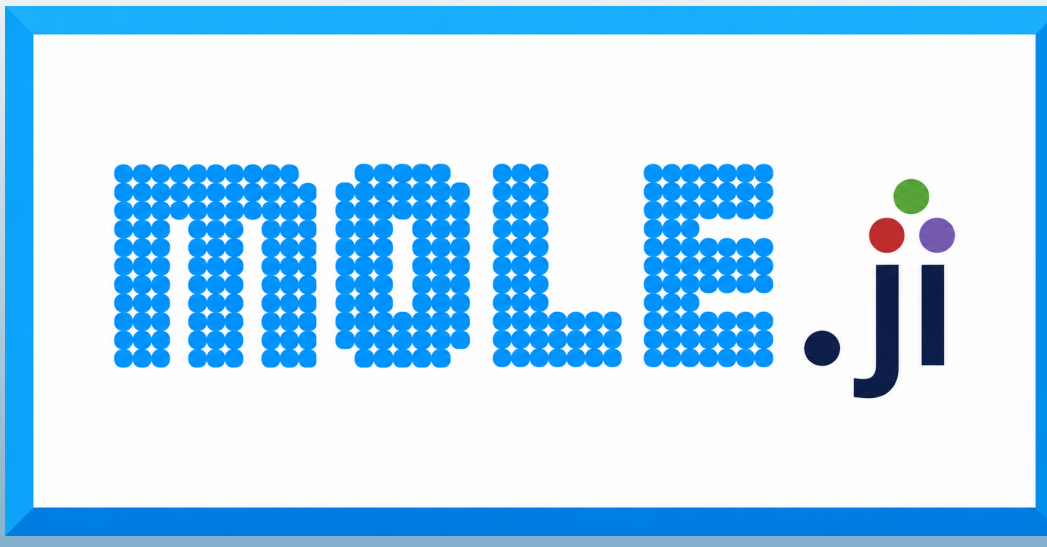




MIMETIC OPERATORS LIBRARY ENHANCED IN JULIA: MOLE.JL

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Abstract

The Mimetic Operators Library Enhanced (MOLE) is an open-source software library [1] that implements mimetic difference operators and associated tools for robust, accurate, and physically consistent numerical solutions of PDEs. Originally developed in MATLAB/Octave and C++, we present here its Julia implementation: MOLE.jl. MOLE.jl offers ease-of-use via idiomatic and user-extensible Julia APIs, integration with the Julia ecosystem tooling, modularity, and composability of differential operators.

Motivation and background

Mimetic discretization methods provide compatible numerical approximations for partial differential equations (PDEs) that mimic desired properties of the model, e.g., conservation laws, symmetry and positivity of solutions, duality and self-adjointness of differential operators, and exact mathematical identities of the vector and tensor calculus by construction.

MOLE.jl provides ease of use with a modular interface for composable Corbino and Castillo [2] mimetic operators.

MOLE.jl architecture

- Composable operators, modular boundary-condition framework
- Compatible with the Julia scientific ecosystem

```
L = lap(k, m, dx, n, dy)
D = div(k, m, dx, n, dy)
G = grad(k, m, dx, n, dy)
Icf = interpol(Val(:centers_to_faces), k, m, n)
Ifc = interpol(Val(:faces_to_centers), k, m, n)
```

Current support

- Operators (1D/2D): gradient, divergence, Laplacian, and interpolators
- Boundary Conditions (1D/2D): Dirichlet, Neumann, and Robin
- Tests: Code coverage 85%
- Examples: elliptic 1D/2D, parabolic 1D/2D, 1D hyperbolic, 2D Navier-Stokes
-] add MOLE

Navier-Stokes Example

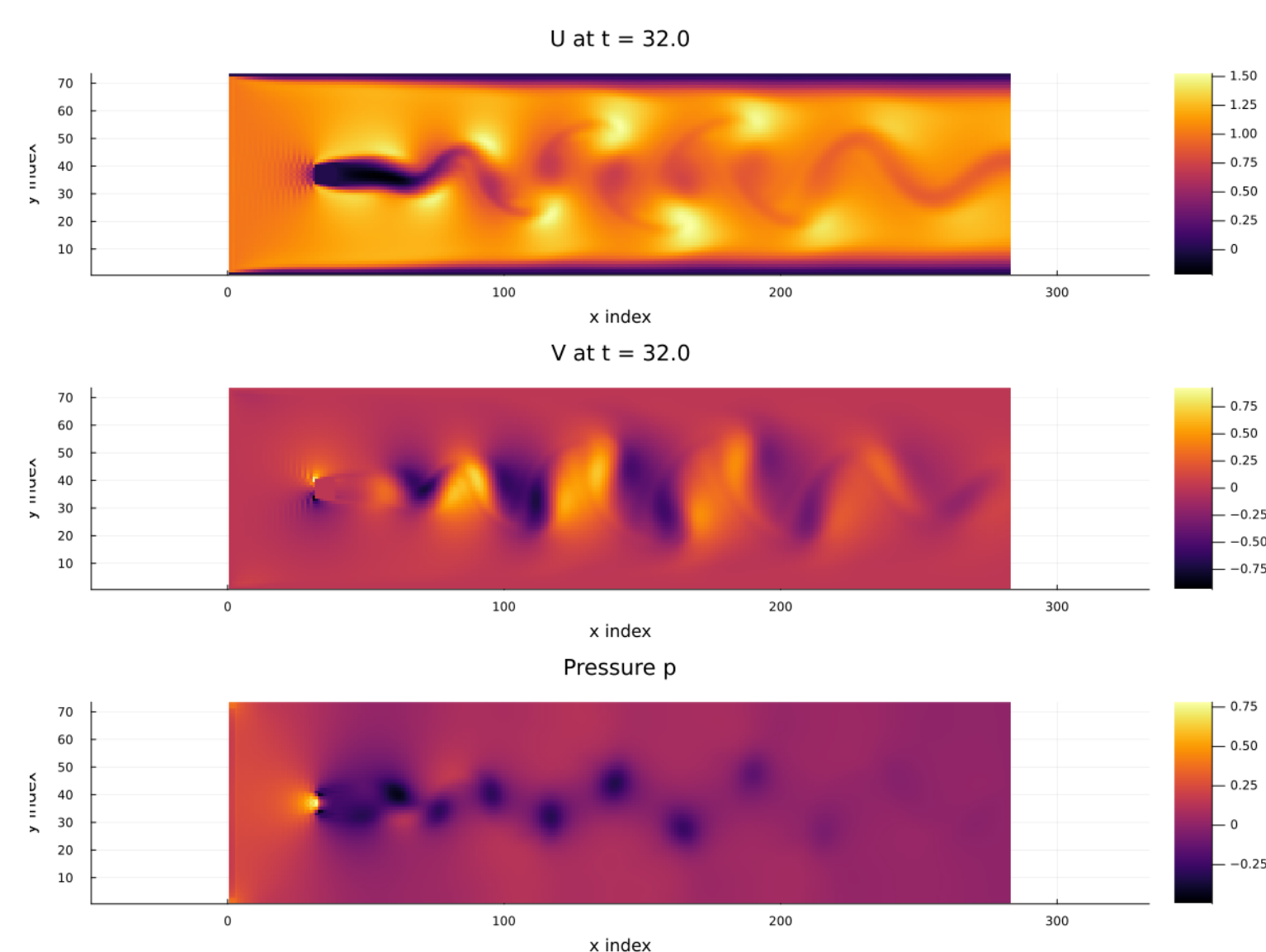


Fig. 1: 2D Navier-Stokes Example: Channel flow with a cylinder.

References

- [1] Johnny Corbino, Miguel Dumett, and Jose Castillo, *MOLE: Mimetic Operators Library Enhanced*, Journal of Open Source Software (2024), <https://doi.org/10.21105/joss.06288>
- [2] Johnny Corbino and Jose Castillo, *High-order mimetic finite-difference operators satisfying the extended Gauss divergence theorem*, Journal of Computational and Applied Mathematics (2020), <https://www.sciencedirect.com/science/article/pii/S0377042719303231>

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