

SUPPLEMENTAL MATERIAL

Here we describe the setup of our experiments.

For all experiments, we use the SIREN network with the ADAM optimizer and no scheduler.

Taylor-Green

Experiment.

Domain.

$$x \in [0, 2\pi], y \in [0, 2\pi]$$

Initial Velocity.

$$u(x, y) = (\sin(x) \cos(y), -\cos(x) \sin(y))$$

Parameters.

- learning rate: 10^{-5}
- layer size: 6
- number of layers: 64
- timestep (Δt): 0.001
- max iterations: 10000
- batch size: 64^2
- cutoff function ε : 0.01
- screening weight: 350

Comparison experiment. All previous methods INSR [Chen et al. 2023b], PINN [Raissi et al. 2019], and piDeepONet [Wang et al. 2021] are run using the same parameters.

Domain.

$$x \in [0, 2\pi], y \in [0, 2\pi]$$

Initial Velocity.

$$u(x, y) = (\sin(x) \cos(y), -\cos(x) \sin(y))$$

Parameters.

- layer size: 3
- number of layers: 256
- timestep (Δt): 0.001
- max iterations: 20000
- cutoff function ε : 0.01
- screening weight: 350

Von Kármán vortex street

Domain.

$$x \in [-1.1, 1.9], y \in [-0.6, 0.6]$$

Initial Velocity.

$$u(x, y) = (0.5, 0.0)$$

Obstacle. Circular obstacle with radius 0.04 and center (-0.8, 0.0)

Parameters.

- learning rate: 10^{-5}
- layer size: 2
- number of layers: 128
- timestep (Δt): 0.05
- max iterations: 10000

- batch size: 128^2
- cutoff function ε : 0.015
- screening weight: 350

Smoke

Rising smoke plume.

Domain.

$$x \in [-1.0, 1.0], y \in [-1.0, 1.0], z \in [-1.0, 1.0]$$

Initial Velocity. Randomly supplied values within a range

$$(x, y, z) \in ((-0.1, 0.1), (-0.1, 0.1), (0.1, 0.3))$$

Parameters.

- learning rate: 10^{-5}
- layer size: 5
- number of layers: 64
- timestep (Δt): 0.05
- max iterations: 10000
- batch size: 128^3
- cutoff function ε : 0.01
- screening weight: 350

Smoke plume with obstacle.

Domain.

$$x \in [-1.0, 1.0], y \in [-1.0, 1.0], z \in [-1.0, 1.0]$$

Initial Velocity.

$$u(x, y, z) = (0.0, 0.0, 1.0)$$

Obstacle. Spherical obstacle with radius 0.1 and center (0.0, 0.0, -0.3)

Parameters.

- learning rate: 10^{-5}
- layer size: 5
- number of layers: 64
- timestep (Δt): 0.05
- max iterations: 10000
- batch size: 128^3
- cutoff function ε : 0.01
- screening weight: 350

Smoke ring.

Domain.

$$x \in [-1.0, 1.0], y \in [-1.0, 1.0], z \in [-1.0, 1.0]$$

Initial Velocity.

$$\theta = \operatorname{acos} \left(\frac{x - 0.2}{\sqrt{(x - 0.2)^2 + (y - 2)^2}} \right)$$

$$u_1(x, y, z) = (0, 0, 0.2(1 + 0.01 \cos(8 \cos(\theta))))$$

$$u_2(x, y, z) = (0, 0, -0.2(1 + 0.01 \cos(8 \cos(\theta))))$$

u_1 and u_2 are defined only within spheres. First smoke sphere has center $(0.0, 0.0, -0.21)$ with radius 0.2. The second smoke sphere has center $(0.0, 0.0, 0.21)$ with radius 0.2.

Parameters.

- learning rate: 10^{-5}
- layer size: 5
- number of layers: 64
- timestep (Δt): 0.05
- max iterations: 10000
- batch size: 128^3
- cutoff function ε : 0.01
- screening weight: 350