Deep Reinforcement Learning and PINNs for Rotating Detonation Engines

FYS9429: Project Proposals

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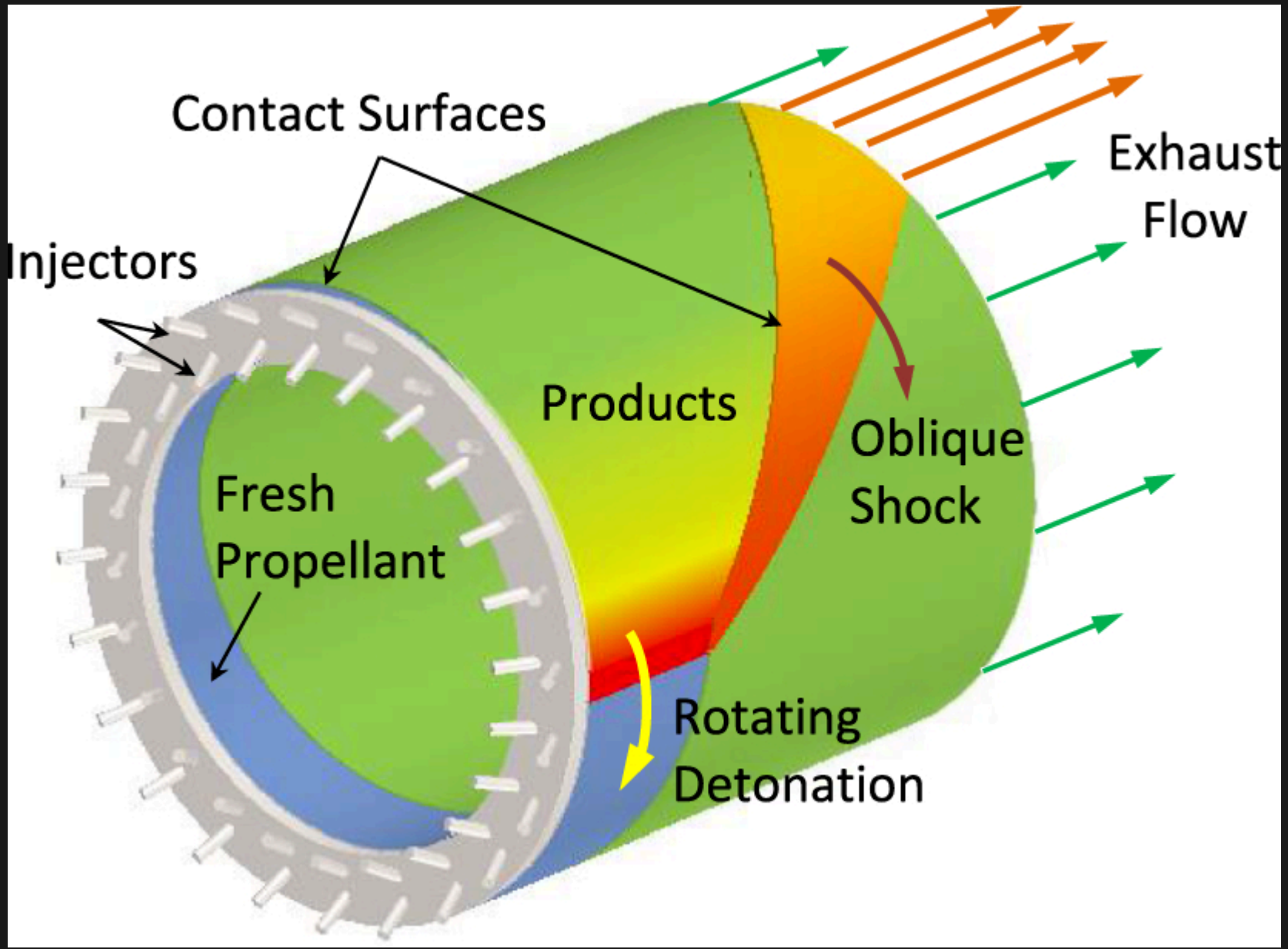
Rotating Detonation Engines (RDEs)

NASA’s 3D-printed Rotating Detonation Rocket Engine Test


Contact Surfaces
Exhaust
Flow
Injectors
Products
Oblique
Shock
Fresh
Propellant
Rotating
Detonation

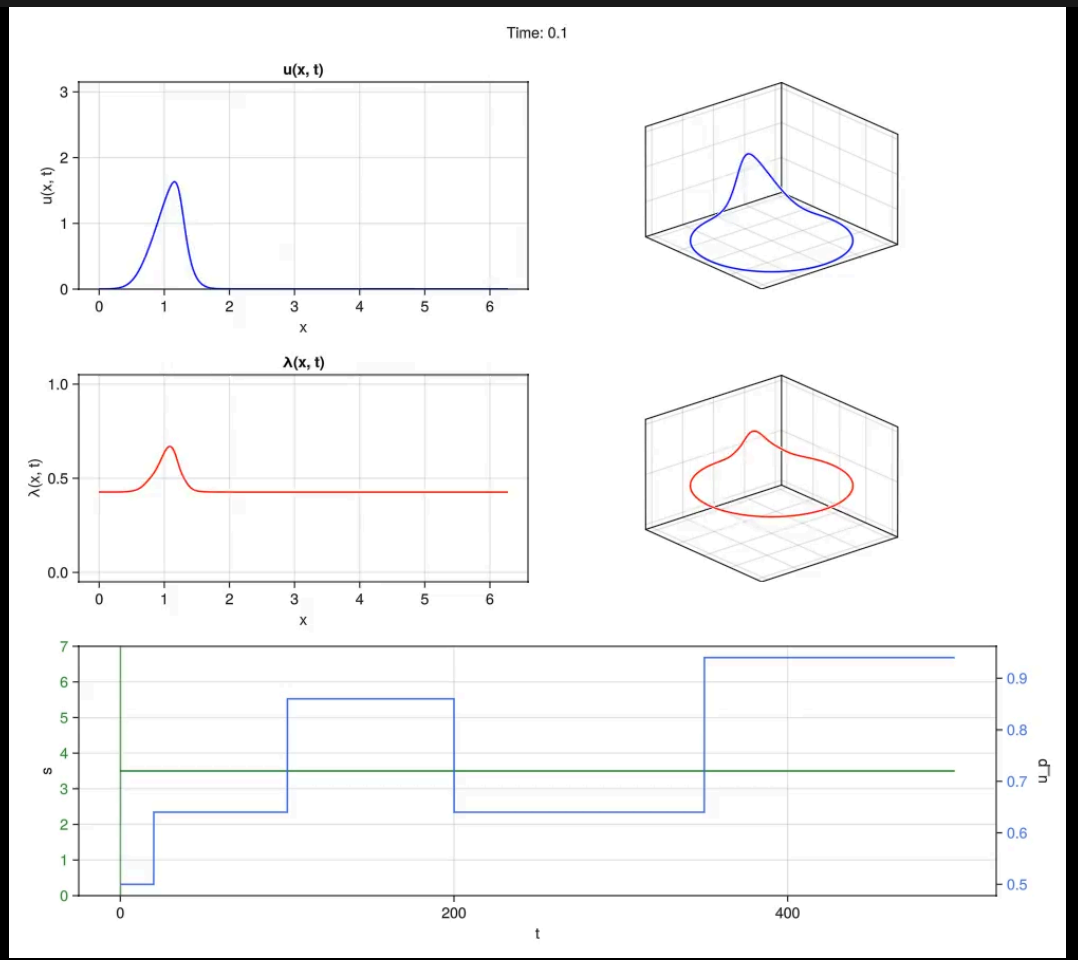
Model equations

$$u_t + uu_x = (1-\lambda)\omega(u)q_0 + \nu_1 u_{xx} + \epsilon\xi(u,u_0)$$
$$\lambda_t = (1-\lambda)\omega(u) - \beta(u,u_p,s)\lambda + \nu_2\lambda_{xx},$$

where

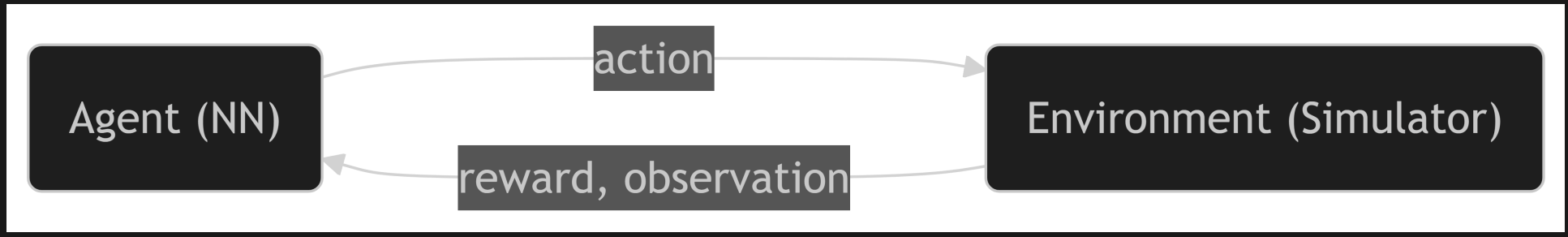
$\omega(u) = e^{\frac{u-u_c}{\alpha}}$, $\xi(u,u_0) = (u_0-u)u^n$ and
$\beta(u,u_p,s) = \frac{su_p}{1+e^{k(u-u_p)}}$

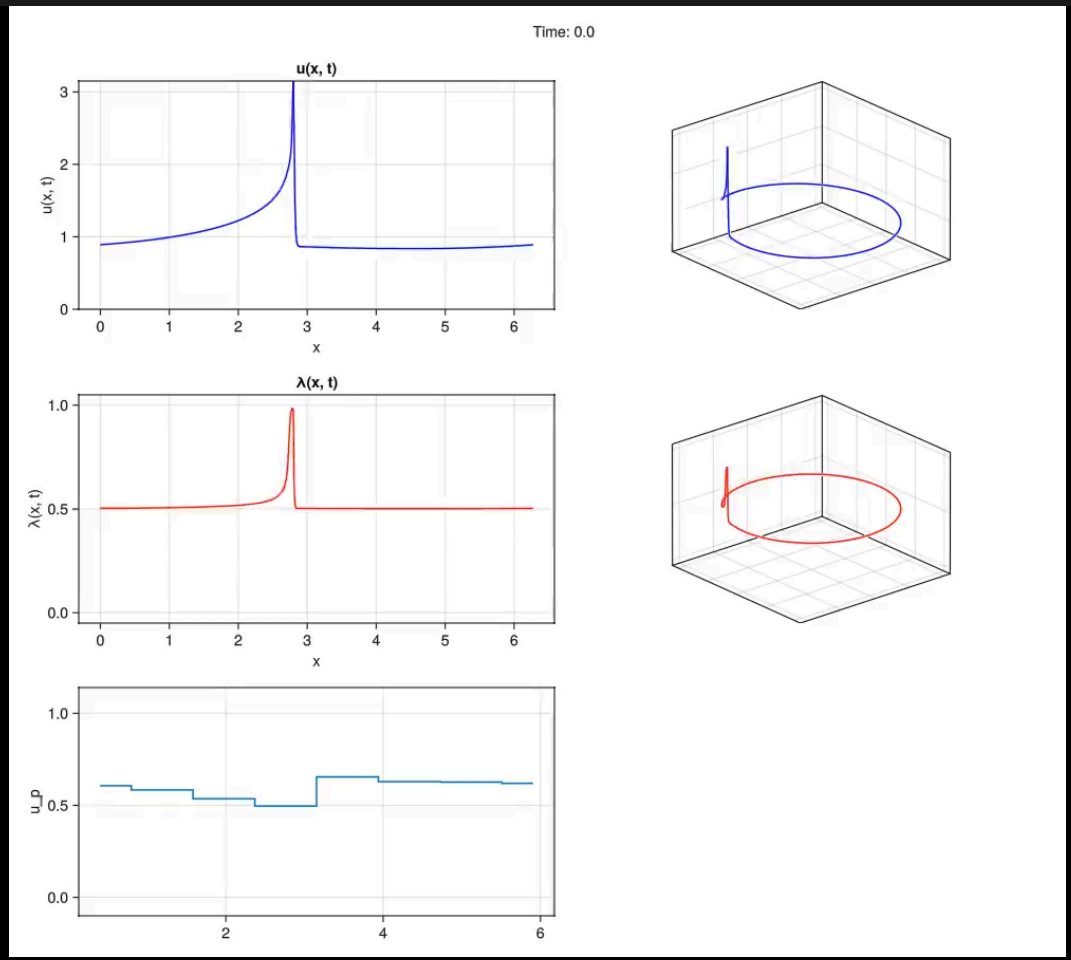
Dynamics



Deep Reinforcement Learning

- Train an agent to control the injection pressure




Time: 0.0
u(x, t)
u(x, t)
x
λ(x, t)
λ(x, t)
x
u_p

Project idea 1

- Implement DRL algorithm(s)

Goals:

- Understand DRL algorithms better
- Improve coding skills
- Potentially remove cross-language dependency

Project idea 2/3

- Use PINNs to solve the model equations
  - PDE and/or ODE

Goals:

- Reduce training time