Chair of Computational Modeling and Simulation
TUM School of Engineering and Design
Technical University of Munich

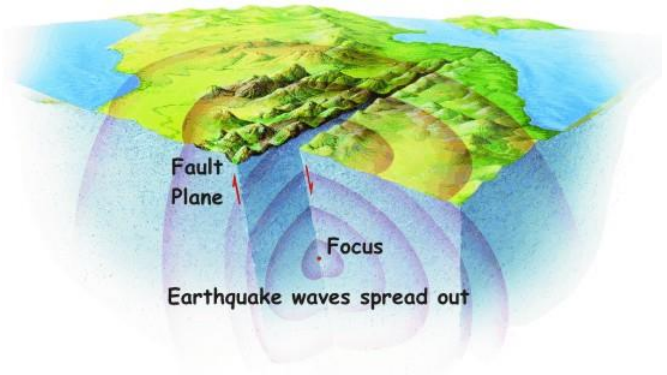
Physics informed Neural networks for solving the wave equation

Project Characteristics

Modeling:
Mathematics:
Programming:
Science:

Task

- The wave equation is a fundamental partial differential equation (PDE) used to model phenomena such as
  - Seismic wave propagation
  - Acoustic waves
  - Vibrations in structures
- Traditional numerical methods like finite difference or finite element methods can become computationally expensive for simulations with high degrees of freedom or complex geometries



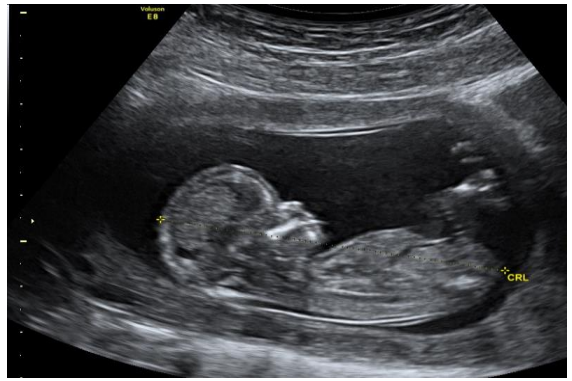


Fig: Application of waves in (a) Seismic wave propagation[1] (b) Ultrasound[2]

[1] Singh, Ritik. ‘Powerful Earthquake Strikes Vanuatu, Tremors Felt Across the Islands"’. *Plutus IAS*, 26 Dec. 2024, https://plutusias.com/powerful-earthquake-strikes-vanuatu-tremors-felt-across-the-islands/.
[2] Auburn, Mt. *What to Expect During Your Ultrasound - Mt. Auburn OB/Gyn*. 3 Aug. 2018, https://mtauburnobgyn.com/2018/08/what-to-expect-during-your-ultrasound/

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- PINNs[1] integrate physics-based constraints into the training of neural networks by embedding partial differential equations (PDEs).

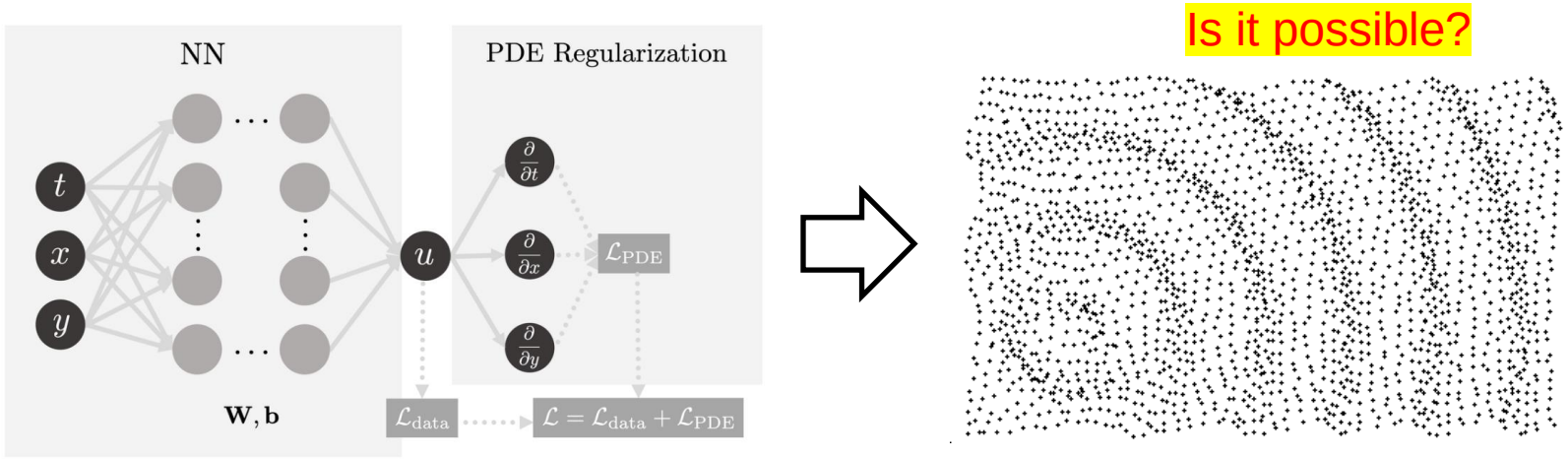

Fig: Using PINNS to solve for the wave equation[2]

[1] Raissi, M., Perdikaris, P., & Karniadakis, G. E. (2019). Physics-informed neural networks: A deep learning framework for solving forward and inverse problems involving nonlinear partial differential equations. *Journal of Computational Physics*, *378*, 686–707. https://doi.org/10.1016/J.JCP.2018.10.045
[2] *Physics Informed Neural Networks (PINNs)*. https://www.linkedin.com/pulse/physics-informed-neural-networks-pinns-fast-code-ohrjc. Accessed 27 Jan. 2025.