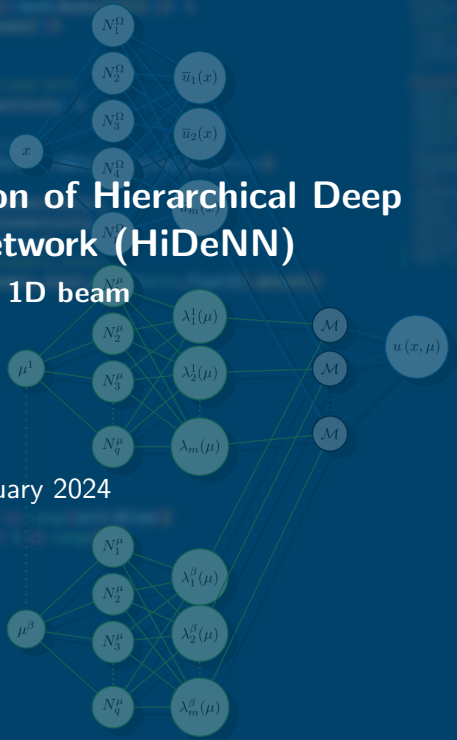
Parametric implementation of Hierarchical Deep Learning Neural Network (HiDeNN)

1 parameter, 1D beam

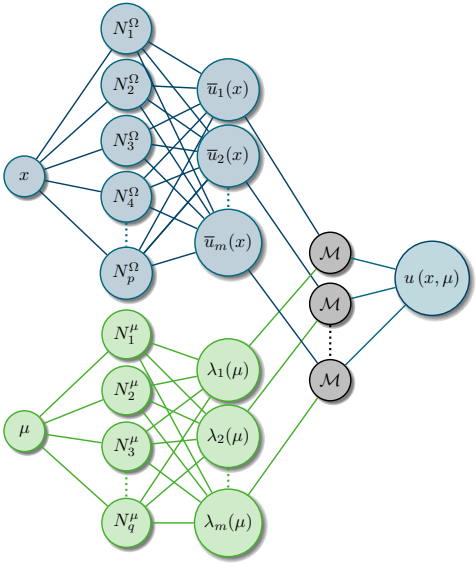


29th of February 2024

ÉCOLE POLYTECHNIQUE

IP PARIS

- Tensor decomposition
  - $\boldsymbol{u}(\boldsymbol{x}, \boldsymbol{\mu}) = \sum_{i=1}^{m} \overline{\boldsymbol{u}}_i(\boldsymbol{x})\ \lambda_i(\boldsymbol{\mu})$
- Illustration with $m = 2$
- We already have the computation of $u_1(x)$
- $(p + q) \times m$ unknowns
- Achieve update by Freezing the $\{u_i\}_{i \in [\![1,m]\!]}$



- For a new patient, project $\mu(x)$ onto a basis $\left\{f^k(x)\right\}_{k\in[\![1,\beta]\!]}$
  - $\mu(x) = \sum_{k=1}^{\beta} \mu^k f^k(x)$
  - $\left\{u^k\right\}_{k\in[\![1,\beta]\!]}$ input parameters for the NN
- $\boldsymbol{u}(\boldsymbol{x}, \boldsymbol{\mu^1}, \cdots, \boldsymbol{\mu^\beta}) = \sum_{i=1}^{m} \overline{\boldsymbol{u}}_i(\boldsymbol{x}) \prod_{j=1}^{\beta} \lambda_i^j(\boldsymbol{\mu^j})$
- Retrieve $\mu(x)$ for computing the loss
  - $\mathcal{L} = g\left(\boldsymbol{u}\left(\left(\boldsymbol{x}, \left\{u^k\right\}\right), \boldsymbol{x}, \mu(x)\right)\right)$