Signals
and
Machine Learning

Summary

Signal Representation

Main Topics

- Signals and Media
  - Types of Signals / Nature of Signals
- Signal Representation
  - Representations / Schemes / Domains
- Sampling and Reconstruction
  - Regular and Irregular Sampling / Reconstruction Methods / Aliasing

Neural Networks for Signals

Main Topics

- Neural Network Architectures
  - Data NN / Coordinate NN
- Signal Specification
  - Input Dimension / High and Low Dimension
- Neural Nets in Spectral Domain
  - Neural Tangent Kernel / Fourier Feature Mapping
- Compressive Sensing
  - Sampling Sparse Signals / Sensing and Reconstruction

Geometric Deep Learning

Summary

High-Dimensional Learning

Main Topics

- Statistical Learning
  - Data Distribution / Approximation Model / Error Metric
  - ML Algorithm / Empirical Risk Minimization
  - Decomposition of Error (Approximation / Statistical / Optimization)

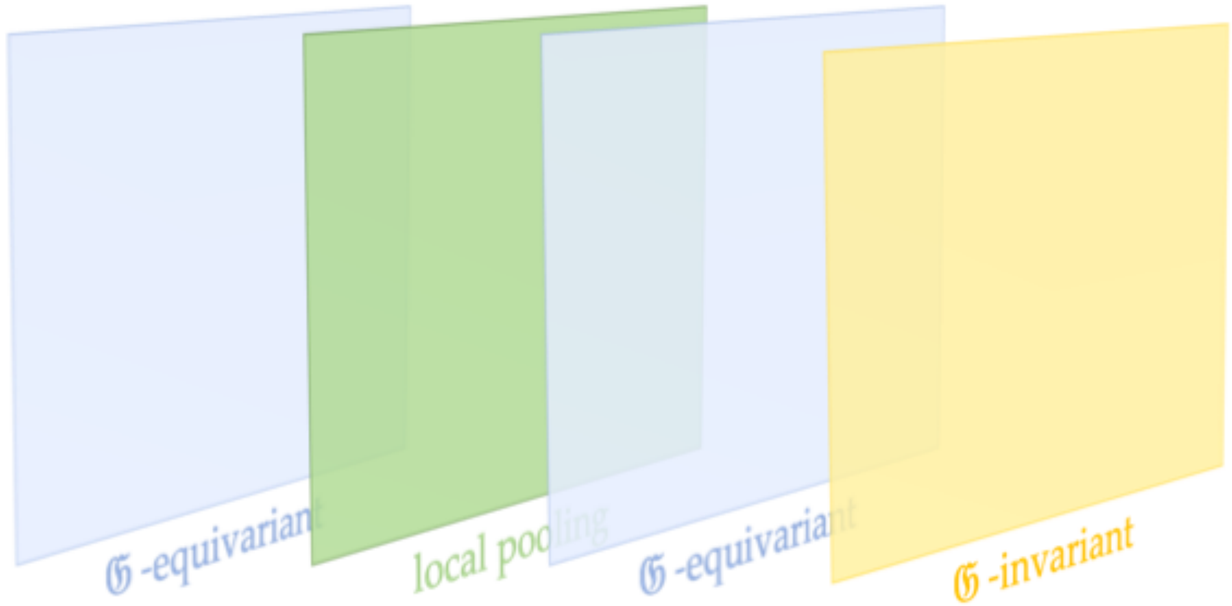
- The Curse of Dimensionality
  - Universal Approximation Theorem (Dimension Dependent)
  - Classic Regularity Fails in High Dimensions

- Addressing the Curse
  - Geometric Function Spaces (Low Dimensional Structure)
  - Novel Notions of Regularity

Geometric Deep Learning Theory

Basic Concepts

- Symmetry Prior
- *Invariant Functions*
- *Equivariant Functions*
- *Scale Separation Prior*
- Geometric Blueprint



The 5 Gs

Main Topics

- Graphs (*Sets*) [GNNs, Deep Sets, Transformers]
  - Arbitrary Ordering / Permutation Invariance / Neighbors / Message Passing
- Grids (*Images / Sequences*) [CNNs, LSTMs]
  - Fixed Neighborhood / Linear Local Aggregation / Convolution / Shift-Equivariance
- Groups (*Homogeneous Spaces*) [Group CNNs]
  - Symmetry Groups / Matching Transformations
- Gauges & Geodesics (*Meshes*) [Intrinsic CNNs]
  - Manifolds / Riemannian Metric / Parallel Transport / Gauge -Equivariant