Introduction

Various 3D semantic attributes can be encoded as per-point probe functions on 3D geometries.

Deep Functional Dictionary Learning Framework

Our neural network takes shape-function pairs \((x, f)\) as inputs in training, and outputs a functional dictionary \(A(x, \theta)\) for each shape. Loss function \(L(A(x, \theta), f)\) is designed to minimize (1) the projection error from \(f\) to the vector space \(A(x, \theta)\), and (2) the number of atoms in the functional dictionary.

\[
L(A(x, \theta), f) = \|F(A(x, \theta), x, f) - f\|_2^2 + \frac{\lambda}{\text{atoms}} \sum_i \|A(x, \theta)_i\|_2^2
\]

where \(F\) is a linear combination weights, and \(A(x, \theta)_i\) are a set of constraints on both \(A(x, \theta)\) and a determined in each application. Since the nested minimization \(F(A(x, \theta), x, f)\) is generally not solved analytically due to \(C(A(x, \theta), x)\), we use an alternating minimization scheme:

\[
\text{function Single-Step Gradient Iteration}(C, x, f, \theta) \quad \text{Compute: } A^t = A(x, \theta)
\]

Weakly-supervised Keypoint Correspondence Estimation

\[
C_{xy}(A(x, \theta), x) = \begin{cases} 1 & \text{if } (x, y) \in \mathcal{C}\left(A(x, \theta), x\right) \text{ for all } y \\
0 & \text{otherwise}
\end{cases}
\]

ShapeNet Keypoint Correspondences

The percentage of correct keypoints (PCK) is measured both when finding correspondences between ground-truth and predicted keypoints in each shape (red line) and finding between ground-truth labels and atom indices for all shapes (green line).

References


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