THE UNIVERSITY OF CHICAGO

Department of Statistics

STATISTICS COLLOQUIUM

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Integral Geometry for Modeling Shapes

MONDAY, April 29, 2019 at 4:30 PM
Eckhart 133, 5734 S. University Avenue
Refreshments before the seminar at 4:00 PM in Jones 111

ABSTRACT

A challenge in data science is modeling 3-dimensional shapes such as a brain tumor or a bone. Three statistical questions we consider include: (1) computing the similarity between 3-dimensional shapes; (2) using the 3-dimensional shape as a covariate in regression problems; and (3) sub-image selection or what parts of the shape is associated to variation in a phenotype or trait. We would like to do all these without using landmarks or assuming the shapes are diffeomorphic. We use a shape representation based on integral geometry to perform the above tasks. The representation is based on a transformation of shapes into representations that allow for analysis using standard statistical tools. The transformations are based on Euler integration. By using a variation of Schapira's inversion theorem, we show that these transforms are injective on the space of shapes — each shape has a unique transform. The main theoretical result provides the first (to our knowledge) finite bound required to specify or differentiate any shape in a moduli space of shapes (characterized by bounds on critical points and curvature). For task (1) we present results comparing the similarity of heel bones in extinct and extant primates. For task (2) we present results on regressing disease free survival from the shape of glioblastomas. For task (3) we present results on what parts of the molar from several monkeys are variable with respect to dietary variation, for example insectivore versus frugivore. We close with the observation that our approach is one example of a fiber bundle framework for modeling shapes.

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