

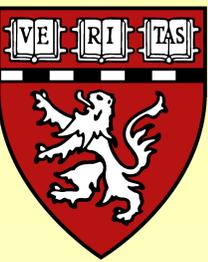


Finding Patterns in Glaucomatous Visual Field Loss

Components, Prototypes, and Archetypes

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Introduction



- numerous **classification schemes** for **glaucomatous VF loss** over past decades
- Keltner et al. (2003): OHTS; 2,509 VFs qualitatively inspected
→ 17 mutually exclusive categories

Purpose of this work:

- 1 generation of a **purely mathematical classification scheme** that is **agnostic to ophthalmological background**
- 2 **comparison** of these subtypes to **qualitative ophthalmological classification**
- 3 **quantitative decomposition** of any clinical VF into these subtypes

Methods

- 31,591 **Humphrey Visual Fields** (SS 24–2) of **glaucoma patients or suspects** from large clinical glaucoma practice
- 24,412 **reliable VFs** (Fixation Losses $\leq 33\%$, False Negatives $\leq 20\%$)
⇒ 13,231 remaining VFs
- *no repeated measurements* over same eye and patient
⇒ OS locations mirrored to match OD locations
- Total Deviation norms taken from *Peridata*
- comparison of *unsupervised statistical learning procedures*
⇒ no ophthalmological background knowledge

Finding Patterns by Statistical Learning Procedures

Prototypes: Example: Cluster Analysis (k-means)

- forming of homogeneous groups by a **similarity measure**
- **partitioning**

Components: Example: Independent Component Analysis

- **inherent features** according to certain constraint (e.g. independence)

Hybrid:
placing feature vectors on **convex hull** of the data

Archetypal Analysis

Results: 16 of 17 computational archetypes match Keltner, and we can additionally quantitatively decompose VFs

Keltner et al. (2003)

Classification of visual field abnormalities in the ocular hypertension treatment study. *Archives of Ophthalmology*, 121(5):643-650

- **ocular hypertension**: major risk factor
- 17 **qualitative categories**, based on
 - visually observing thousands of VFs
 - ophthalmological background knowledge

16 of 17 archetypes match Keltner. Additionally, we can quantitatively decompose any VF:

Decomposition

Illustrative VF: (42 year old POAG patient)

Nerve Fiber Abnormalities

Keltner terminology, category sum of weights, Keltner examples

Altitudinal (3.9%)
Arcuate (10.8%)

matching archetypes (TD and TD prob)

Nonnerve Fiber Abnormalities

Total loss (6.4%)
Central (4.1%)
Hemianopia (4.6%)
Widespread (0.6%)

clearly nerve fiber related!

Conclusion

- 1 learning components on convex hull quantifies ophthalmological categorization procedures
- 2 qualitative verbal definitions may miss relevant features (see "Total loss" category)
- 3 our statistical categorization allows quantitative decompositions of arbitrary VF measurements
↓
potential for progression analysis and structure-function relations