

Image retrieval and human shape perception

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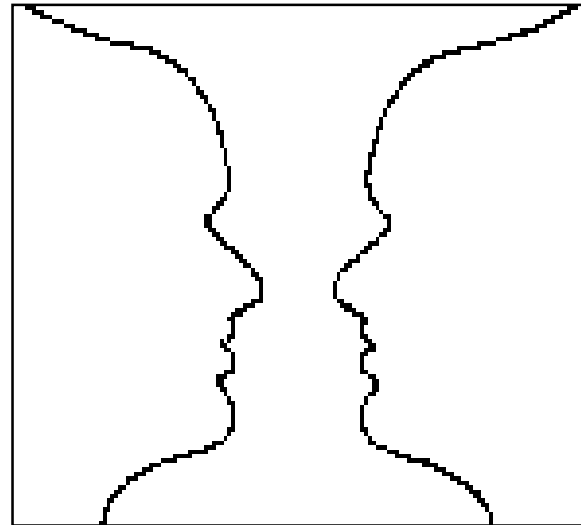
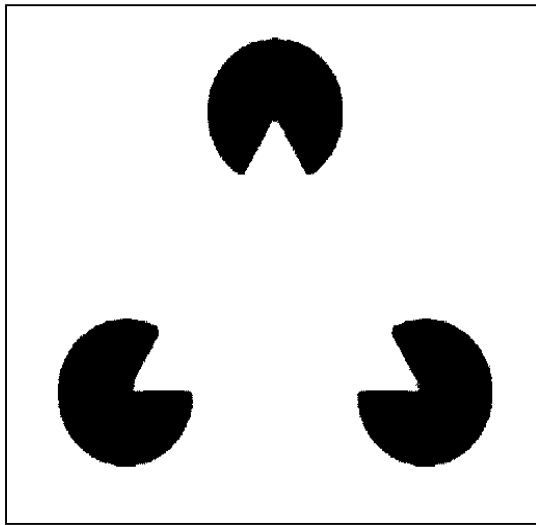
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Shape matching

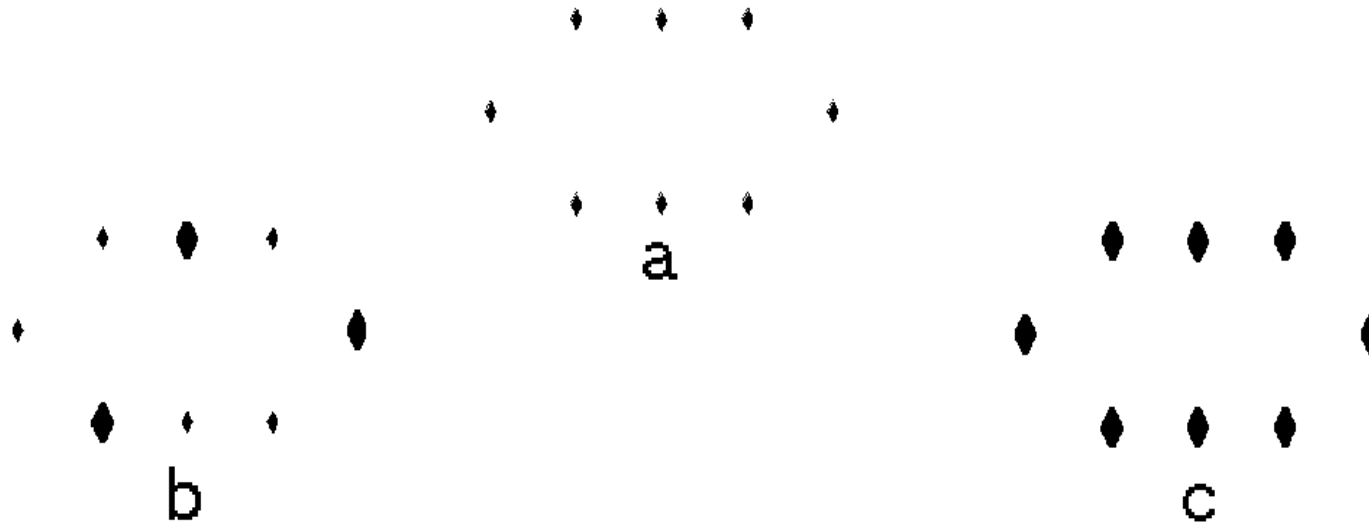
- Difficult problem area with important applications, e.g:
 - industrial inspection, face and fingerprint matching, trademark registration
- Many techniques proposed in literature, e.g.
 - Fourier descriptors, moment invariants, elastic deformation of templates
- Techniques still not effective enough for critical applications such as trademark registration. Possible reasons:
 - Extracted features don't accurately capture human similarity judgements
 - Computers don't segment images in same way as humans

Human shape perception



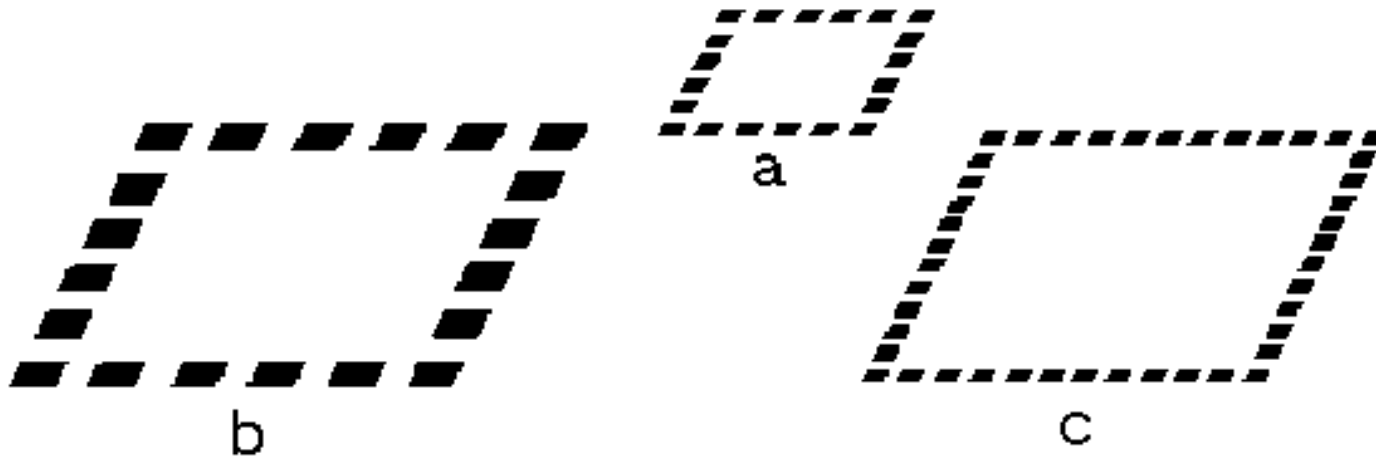
- Subject of study by psychologists for nearly a century
- Many theories proposed, including Gestalt principles
- Empirical studies of shape and image similarity scarce, but very revealing

Evidence for Gestalt grouping



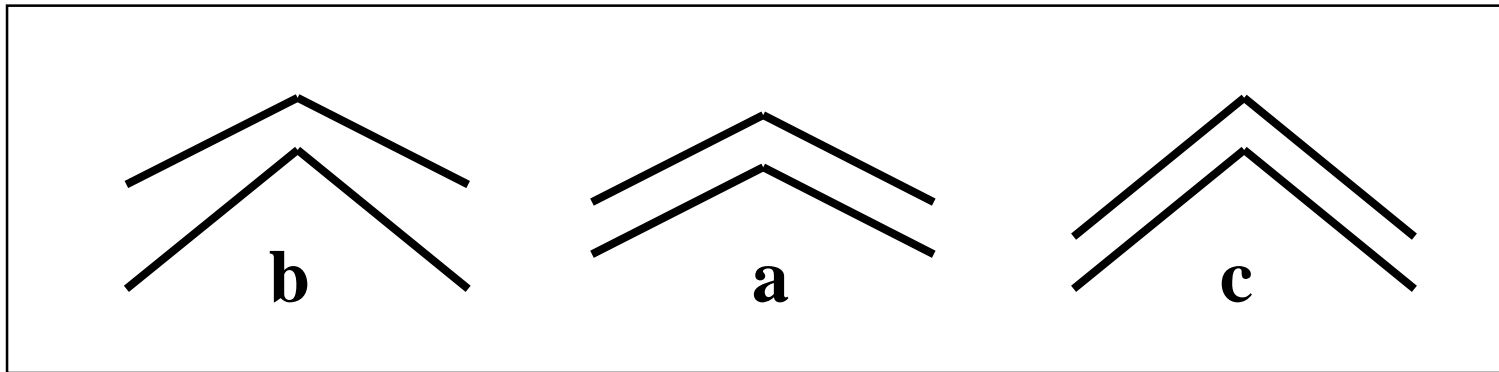
- Observers all judge (c) more similar than (b) to reference image (a), despite more constituents changing in size
- Conclusion: grouping of three elements perceived as important aspect of image (b)'s overall shape

Problems with scale invariance



- Image (c) judged more similar than (b) to reference image (a) - though (b) is direct enlargement of (a)!
- Phenomenon can be explained by distinguishing between *form* (overall image shape) and *material* (shape and size of individual components)

Singularity (Pragnanz)



- Most observers rate (a) as more similar to (c) than (b).
- Explanation: certain aspects of image have disproportionate effect on similarity judgements, e.g:
 - straight lines *vs* curves
 - equal *vs* unequal length segments
 - parallel *vs* non-parallel lines
 - right angles *vs* other angles

Implications for shape retrieval

- Human similarity judgements depend on way image is perceived rather than objective physical properties
- Gestalt principles appear to be useful in building up model of perceived image
- Need to be able to distinguish between *form* and *material* in perceived image
- Shape measures need to take account of *singularity* principle (disproportionate influence of elements such as right-angles and parallel lines)

Application of principles

- Shape retrieval research at UNN aims to follow these principles:
 - ARTISAN trademark retrieval project developed system incorporating findings from human visual perception studies – partially successful in solving problem
 - SPIRIT project investigated way in which humans naturally segment trademark images, showing extent of (and partly explaining) variability between different individuals
 - Planned collaborative PROFI project (led by Utrecht University) aims to construct and test multiple-view image model based on these results
- Much more remains to be done!