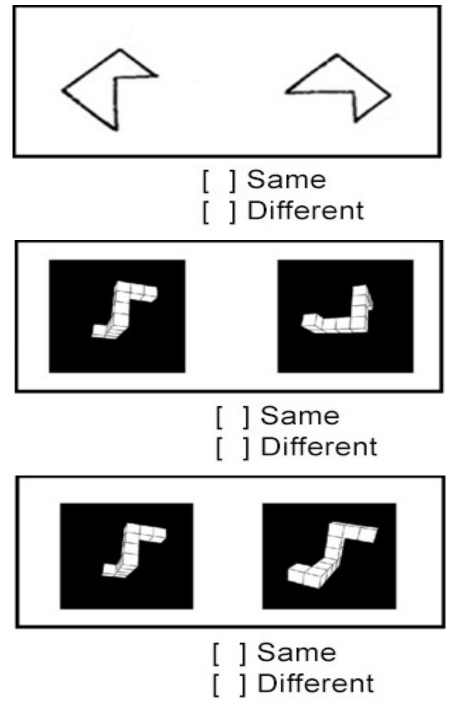
EECS 6323 - Winter 2021Course Project

You will investigate solutions to the *Same-Different* problem



See Shepard, Roger N., and Jacqueline Metzler. *"Mental rotation of three-dimensional objects." Science* 171.3972 (1971): 701-703.

This is a study on how humans solve such problems. Main conclusion is that they mentally rotate one object to align it with another. The time it takes for a correct answer depends on the angle of rotation. This result has been replicated man times.

However, these are quite limited studies since they were done either on paper or on a display monitor with a seated subject fixating at the centre of the screen.

This is a basic cognitive ability of humans and we do it for simple situations maybe several times a day (see Carroll, J. B. (1993). *Human cognitive abilities: A survey of factor-analytic studies*. Cambridge University Press.)

Here you will consider a more realistic version, suitable for embodiment on a robot, for example, that fills the role of an assistant in a manufacturing setting or in an elder care setting. (Examples: Can you bring me 2 matching cups from the cupboard? Can you bring me two red, 6-pin LEGO blocks from the parts bin? Can you find me a screwdriver just like this one?) .

The problem for you to solve is this.

1. Presented with two objects, what is the shortest sequence of actions that a robot needs to take in order to decide if the objects are the same or different? The set of actions to choose from are changes in the position and the pose of the robot (specifically, the optical axis of the robot's eye(s) with full 6 degrees of freedom - position and rotations). Illumination will be fixed by the system to the homogeneous setting. If you wish more of a challenge, then you can choose the point source lighting setting and try the task with different light source positions (extra points can be gained this way).

2. Your solution is constrained as follows:

- no learning except for low level features (with justification as to why classic ones do not suffice)
- all solutions must be active (each data acquisition is preceded by the hypothesis of what is expected to be observed)
- brute-force search solutions not acceptable (such as take the same set of views of each object and compare)
- test images to be provided via the use of https://polyhedral.eecs.yorku.ca/ (alternate site using York's VPN - http://230t.eecs.yorku.ca:8044/)

  The easiest way to create your set is to generate many single polyhedron images where for each you generate several different views. Say you generate 20 different objects, each with 5 different viewpoints (randomly chosen) for a total of 120 different images. Then randomly pick pairs of these. There are 7140 such pairs. Each object can be part of 10 different "same" pairs so there are 200 "same" pairs in total. All the rest are "different". You can of course use more objects and more views as you wish.

- a family of algorithms rather than a single one, intelligently deployed, is acceptable as long as they conform to all the above constraints

3. Individual work only

- I will create a set of 55 object pairs under the same conditions; you will run your code on it. The number of correct responses will form part of your grade (55 points).
- You are also expected to produce a short document describing your solution (in the form of an 6-8 page conference submission). This is worth 20 points towards your grade.
- Final grades due April 30 - so all course material must be submitted by April 16. No extensions.