Classification of Aneurysm Morphology

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Background

- A cerebral aneurysm is an abnormal enlargement of any artery located at or near bifurcations of the arteries in the Circle of Willis.
- Identifying individuals at risk is still challenging.
- 3D Shape Contexts are a natural extension of 2D shape contexts, which are semi-local descriptions of object shape centered at points on the surface of the object.
- Though 3D shape context is less efficient than the other currently used methods, but it is simple to achieve and invariant under scaling and translation, while the currently used graph-based descriptors are more complex and difficult to be constructed and derived.

Methods

- **Step 1** Read the .stl file and transform it into the form we need. Mainly extract the location information.
- **Step 2** Since the data points are too many, we need to do sampling to gain the sample which is appropriate for the process.
- **Step 3** Create a spherical coordinate for each data point in the 3D graph and calculate the coordinates for each other point to compute the bins (3D shape context).
- **Step 4** As shape contexts are distributions represented as histograms, we need to use the "shape context cost" of matching the two points.
- **Step 5** We choose to use the Hungarian method to find the matching that minimizes total cost.
- **Step 6** Given the set of correspondences between a finite set of points on the two shapes, we should do a transformation to map any point from one shape to the other.
- **Step 7** A shape distance between two 3D shapes P and Q need to be computed.
- **Step 8** We need to set a threshold to find out whether the two 3D shapes match or not.

Results

- The data we have includes 10 .stl files, of which 5 files are growing aneurysm while the other 5 files are stable aneurysm.
- By applying the method we designed to the data we have, we could calculate the total cost for every two of ten files, and the results are in the table listed below.
- More precisely, if the threshold is set as 60000, for growing aneurysm cases, 74.3% (26/35) of them are correctly classified. And as for the 5 test files of stable aneurysm, 65.7% (23/35) of them are correctly. The total accuracy is 71.1% (32/45).

	BI8022	MM8894	RS4668	VR1339	WC610	FE1546	LR1592	LR4789	TK928	XJ3252
BI8022		46707	54855	52060	59034	63017	65733	75497	36062	88859
MM8894			95314	56731	76777	42852	25065	28242	63571	49489
RS4668				75419	41376	108471	86477	97571	81052	60228
VR1339					73389	49844	64332	51040	67897	50466
WC610						80420	74236	75075	61712	69266
FE1546							49272	52095	47560	67064
LR1592								30826	54494	42690
LR4789									52081	57335
TK928										48082
XJ3252										

Table 1. The total costs for every two of ten files. The cells in purple represent stable cases, the cells in blue represent growing cases and the cells in gray are none. When threshold is set as 60000, we add black borders to all the cells that represent the correct predictions.

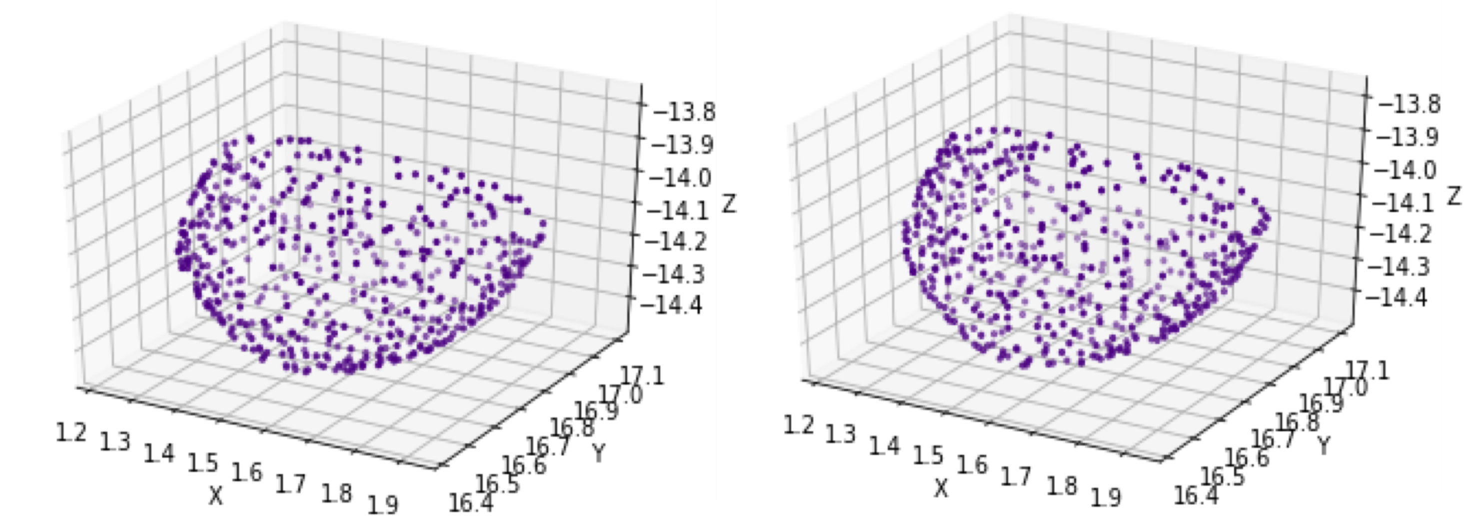

Figure 1. Bi8022 with 500 random sample points when we compare it with itself. Two images are not totally identical since the points are sampled by random.

Conclusion

- This method with 3D shape context could be a relatively reliable method for classification of aneurysm morphology, while it should be improved in many aspects.
- The classification results are rather poor for certain cases, like MM8894, VR1339, showing the unsatisfying application range and error-tolerant for different shapes.
- 500 is not enough for the amount of the sample points. With more sample points, like 2000, the better classification performance we can get, which surely leads to more time expense.
- We need more labelled samples as the input training dataset. Sufficient trainset can provider us with more accurate predictions.
- Other well-performed descriptors should be taken into consideration, like shape distributions.

References

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