Brain-Inspired Algorithms for Improving Similarity Search

BACKGROUND: The capability of searching, retrieving, and managing digital information is one of the foundations of modern technologies. To address these goals, computational algorithms such as locally-sensitivity hashing (LSH) are utilized to sort through any database to find results similar to a given search query input. Such searches are commonly used, for example, to make recommendations of songs, videos, news articles, or products that are similar to one a user is viewing. Similarity search, however, has been notoriously difficult to solve efficiently when searching through very large databases, or when items in the database (e.g., images, videos) are very high dimensional.

INVENTION: To address the limitations of LSH, investigators at Salk explored an area one wouldn't associate with high-power computing: olfactory neural circuits of fruit flies. The fruit fly uses a three-layer neural network to generate "hashes" for each odor it has encountered. The hashes generated are locality-sensitive, meaning that similar odors are assigned similar hashes, so that behaviors learned from one odor can be generalized to a very similar odor, or a noisy version of the odor. The algorithm used by the fruit fly to generates odor hashes, however, is very different than what is used by conventional LSH algorithms. Salk scientists discovered that the fruit fly's algorithm generates search results more rapidly, and those results are more accurate, than LSH, opening up many new avenues for similarity search in the future.

APPLICATIONS:

- Enables high-precision similarity searches based on a multitude of input formats.
- Manages and categorizes digital files and databases: documents, videos, images, songs, de-duplications problems, clustering, etc.

ADVANTAGES:

- Roughly, 50-100% more accurate search results compared to conventional LSH when benchmarked across several datasets (see Fig1 comparing performance on the SIFT, GLOVE, and MNIST datasets).
- Reduces computational power required to perform similarity searches by 4-5x, and reduced memory consumption by 2-4x.

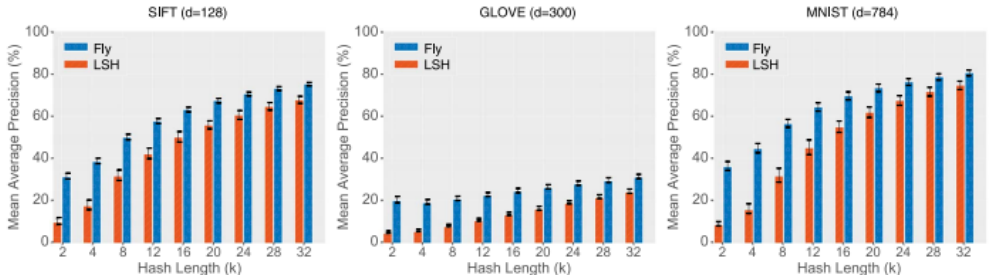

Fig1: hashing performance comparison between the fly and LSH on the SIFT, GLOVE, and MNIST datasets

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PATENT STATUS: Patent application filed

PUBLICATIONS:

A Neural Algorithm for a Fundamental Computing Problem. Science 10 Nov 2017: 793-796.
http://science.sciencemag.org/content/358/6364/793.full
https://www.salk.edu/news-release/fruit-fly-brains-inform-search-engines-future/

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