Hybrid: A Large-Scale In-memory Image Analytics Engine

Michael Gubanov
Department of Computer Science,
University of Texas at San Antonio
mikhail.gubanov@utsa.edu

ABSTRACT

Analytical image/video processing tasks such as scene/face/activity recognition are historically performed externally of most relational database management systems. Relational engines are optimized for relational data and therefore, have weaker support for non-relational data such as images or video. We have been working on `Hybrid`, a high-velocity in-memory analytics engine, which supports the advanced access capabilities for both image/video contents and structured data via SQL or JSON. This allows the user to query both relational (rows and columns of a table) and video/image contents (objects, activities, scene attributes) in a single SQL or *`Hybrid`* SQL/JSON statement [Gubanov and Pyayt, 2013, Gubanov and Shapiro, 2012]. Analytical tasks may then be performed on both types of data, without the expensive ETL (extract-transform-load) process. An example of the `Hybrid` query to a relational and image data source (queried in JSON) is illustrated below. The user manually specifies an `SQL:` prefix in the query portion which accesses the relational data and `JSON:` prefix in the part querying image data. A query then fuses [Gubanov et al., 2009, Gubanov et al., 2014] information from images (cast to JSON) and Web tables (relational), before outputting the best deal for a popular Broadway show [Gubanov and Stonebraker, 2014, Abedjan et al., 2014].

```
SELECT MIN(S.Price) AS Price, S.Show, S.Theater,
       S.ShowTime
FROM Shows AS S
WHERE S.Show IN
  (SELECT FlyersImage.TITLE
  FROM
  CAST(FlyersImage,
       JSON:
       db.find({
         "FlyersImage.screenwriter":"Roald␣Dahl",
          FlyersImage.date > "Sunday,␣27␣November"
          })
    }))
GROUP BY S.Show, S.Theater, S.ShowTime
ORDER BY Price ASC
```

To accomplish this, it would first find all shows by Roald Dahlm mentioned in the show flyers (pre-processed by OCR software and stored in a JSON database `WebImage`), after Sunday, November 27. Next, it fuses it with relational table `Shows` having prices, theater addresses, and show times to find the best deal. For homogeneous queries in one language, the language can be detected automatically by the `Query Processor` using a machine learning classifier [Speed, 2010, Lin and Lin, 2003, Mitchell, 1997] trained to detect the query language.

In addition to the ability store extracted image metadata in JSON, like in the query above, `Hybrid` represents and stores images and videos as matrices in a relational table column and supports a subset of linear algebra operators to perform more complex analytics on them. This approach differs from the classical, relational storage techniques which store images/videos as BLOBS with limited access through SQL. Because they are stored as unstructured binary objects, the meaningful use of BLOB data requires the user to develop an external, user-defined function (e.g. in C++). `Hybrid` provides access to both video/image and structured data from the same SQL statement, which enables *`Hybrid` analytics*, analytics on both relational and image data. Our current prototype performs OCR, interactive activity, and pattern recognition in SQL using both large-scale matrix and relational data.

1. REFERENCES

[Abedjan et al., 2014] Abedjan, Z., Morcos, J., Gubanov, M., Ilyas, I. F., Stonebraker, M., Papotti, P., and Ouzzani, M. (2014). Dataxformer: Leveraging the web for semantic transformations. In *CIDR*.

[Gubanov and Pyayt, 2013] Gubanov, M. and Pyayt, A. (2013). Readfast: High-relevance search-engine for big text. In *ACM CIKM*.

[Gubanov and Shapiro, 2012] Gubanov, M. and Shapiro, L. (2012). Using unified famous objects (ufo) to automate alzheimer's disease diagnostics. In *BIBM*.

[Gubanov and Stonebraker, 2014] Gubanov, M. and Stonebraker, M. (2014). Large-scale semantic profile extraction. In *EDBT*.

[Gubanov et al., 2014] Gubanov, M., Stonebraker, M., and Bruckner, D. (2014). Text and structured data fusion in data tamer at scale. In *ICDE*.

[Gubanov et al., 2009] Gubanov, M. N., Popa, L., Ho, H., Pirahesh, H., Chang, J.-Y., and Chen, S.-C. (2009). Ibm ufo repository: Object-oriented data integration. *VLDB*.

[Lin and Lin, 2003] Lin, H.-T. and Lin, C.-J. (2003). A study on sigmoid kernels for svm and the training of non-psd kernels by smo-type methods. Technical report, Department of Computer Science, National Taiwan University, Taipei, Taiwan.

[Mitchell, 1997] Mitchell, T. M. (1997). *Machine Learning*. McGraw-Hill, Inc., New York, NY, USA, 1 edition.

[Speed, 2010] Speed, T. (2010). Statistical models: Theory and practice. *International Statistical Review*, 78(3):457–458.