Apache GraphAr: An Open-Source Standard File Format for Graph Data Storage and Retrieval

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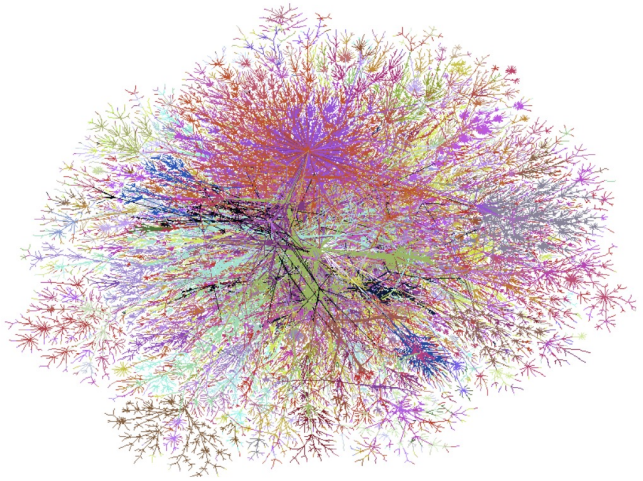
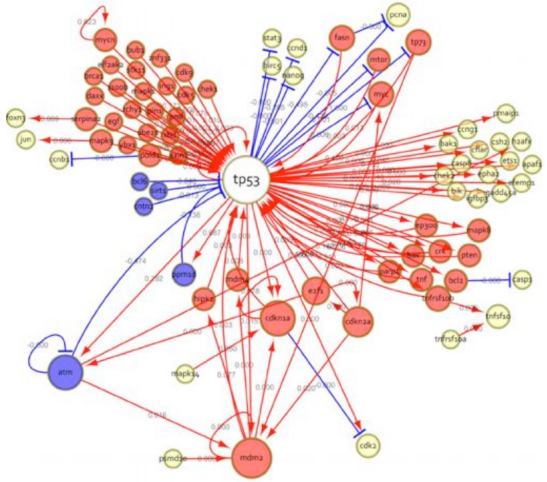
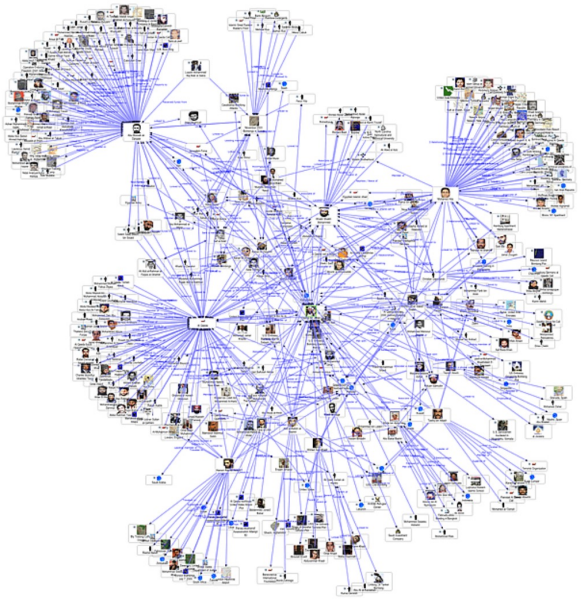
Graph Data is Everywhere



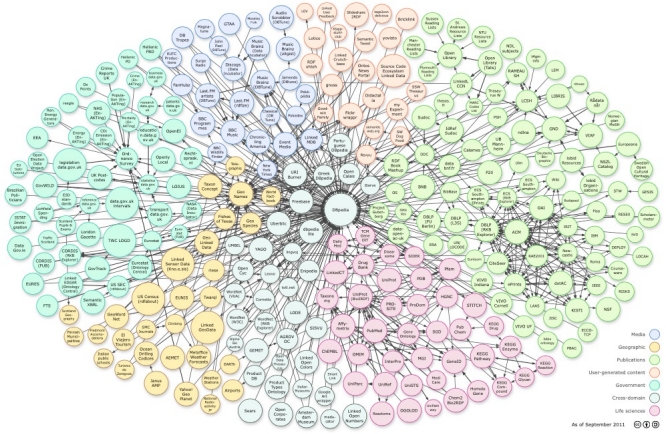
Web



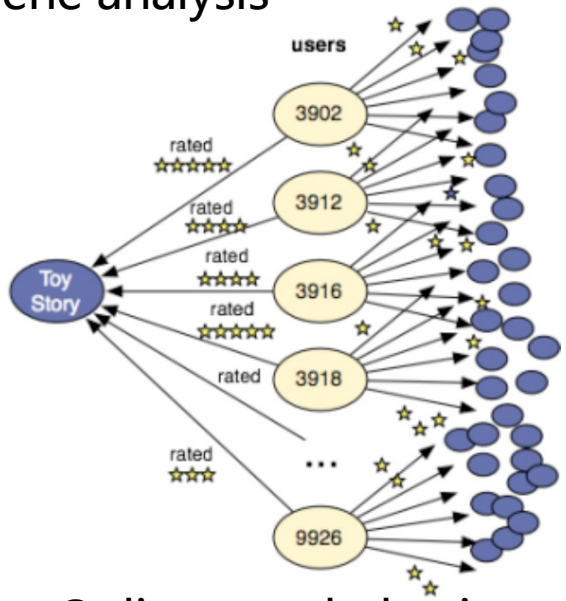
Gene analysis



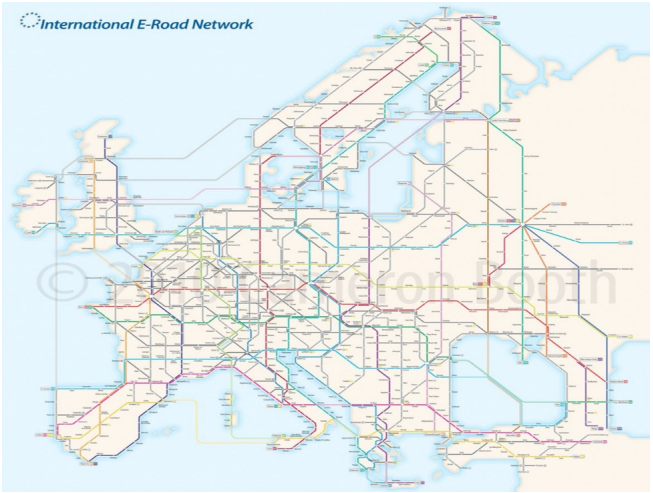
Social network



Knowledge base

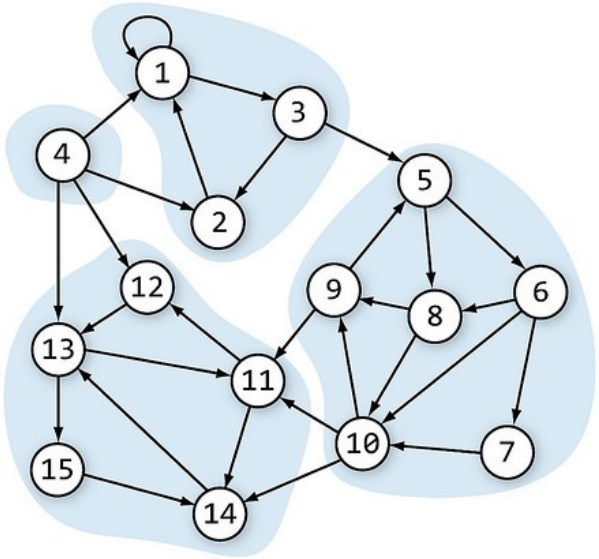


Online user behavior

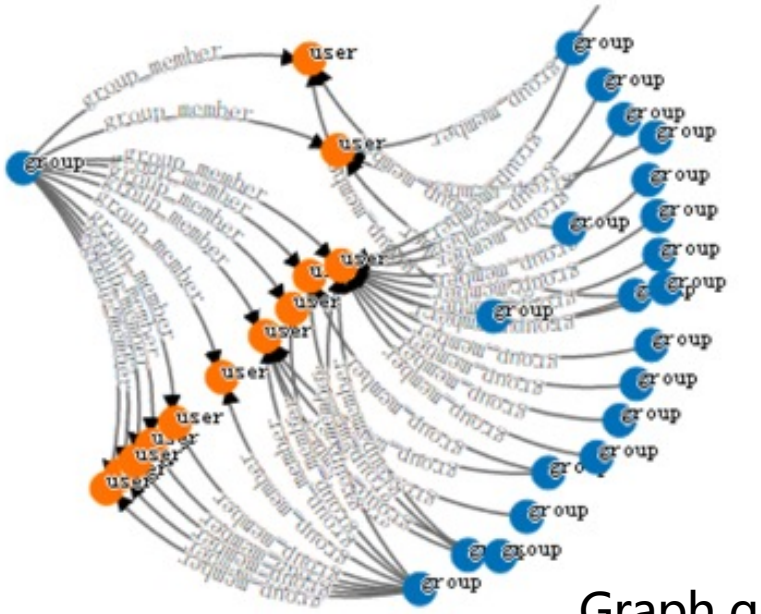


Traffic graph

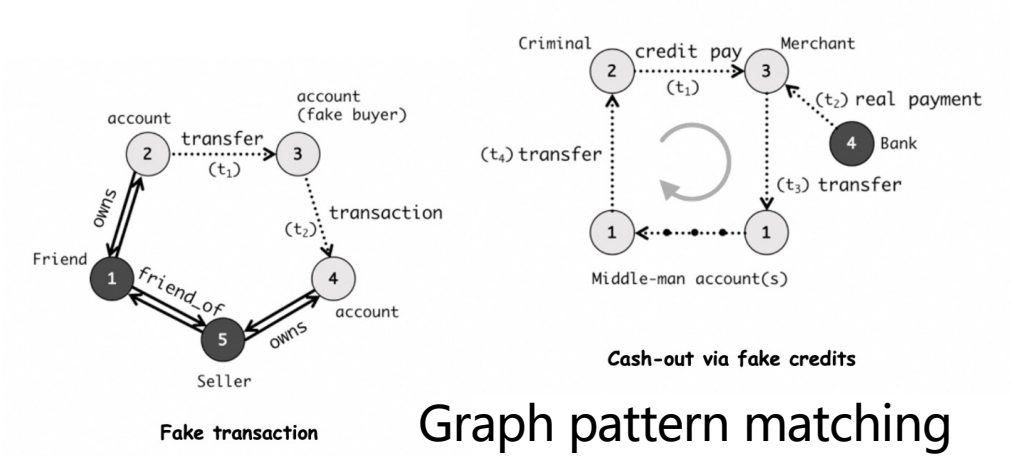
Diverse Graph Computing Workloads



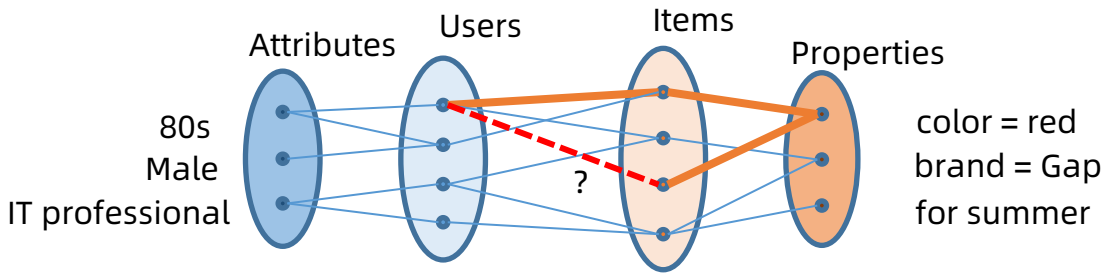
Iterative graph analytics, e.g., PageRank, LPA…



Graph querying/traversal



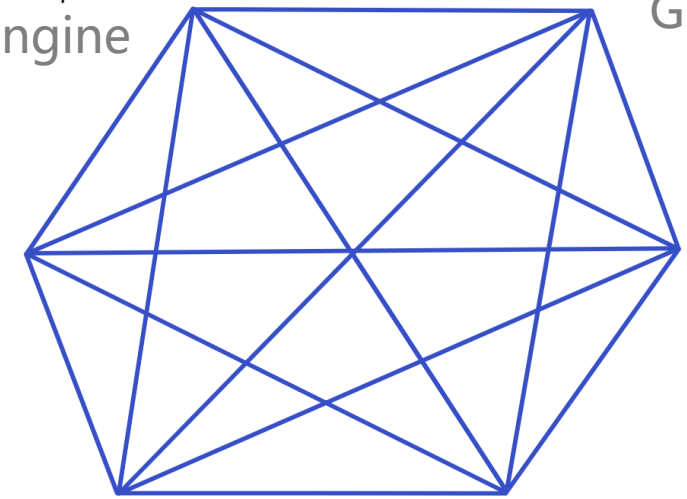
Graph pattern matching



Graph learning

Various Graph Systems

- Graph DBs, GNN Frameworks, Graph Engines, KBs….
- **How do they share graph data?**



APACHE GIRAPH

Spark GraphX
Computing Engine

TuGraph™
Graph Database

TigerGraph

GraphScope
Graph Computing Engine

neo4j
Graph Database

Amazon Neptune

Azure Cosmos DB
Graph Database

PyG
GNN Framework

JanusGraph

ArangoDB

What is GraphAr

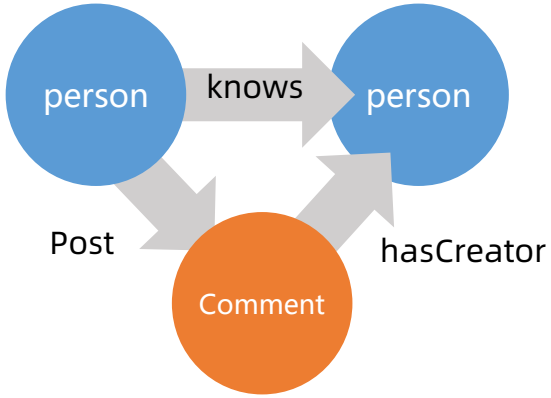
- Short for **Graph Ar**chive
- An open source, standard data file format for graph data storage & retrieval.
- Designed for
  - Serving as a standardized file format for importing, exporting and archiving of the graph data which can be used by diverse existing systems, reducing the overhead when various systems co-work.
  - As a direct data source for (out-of-core) graph processing applications.

Key Features

- **Apache incubating**, open-source and vendor neutral
- The file format supports the property graphs and different representations for the graph topology (COO, CSR and CSC).
- It is compatible with existing widely-used file formats including ORC, Parquet (and less ideally CSV).
- Apache Spark can be utilized to generate, load and transform GraphAr files.
- It is convenient for use in a variety of single-machine/distributed graph processing systems, databases, and other downstream computing tasks.
- It enables users to conveniently perform operations without modifying the payload files, such as appending new vertices, adding new properties, or constructing a new graph with a set of selected vertices and edges.

Design of GraphAr: A Running Example

- A property graph and its vertices



internal vid	id	firstName	lastName	gender
0	933	Mahinda	Perera	male
1	6597069767117	Eli	Peretz	female
2	10995116278700	Joseph	Anderson	female
...	...	...	...	...
903	32985348834100	Bruno	Oliveira	male

Logical Table of Vertices

internal vid	id
0	933
1	6597069767117
...	...
499	13194139534267

./vertex/person/id/chunk0

internal vid	firstName	lastName	gender
0	Mahinda	Perera	male
1	Eli	Peretz	female
...	...	...	...
499	Asha-Rose	Chung	male

./vertex/person/firstName_lastName_gender/chunk0

internal vid	id
500	15393162788965
501	15393162789614
...	...
903	32985348834100

./vertex/person/id/chunk1

internal vid	firstName	lastName	gender
500	Hans	Becker	male
501	Adi	Cohen	female
...	...	...	...
903	Bruno	Oliveira	male

./vertex/person/firstName_lastName_gender/chunk1

Physical Table of Vertices

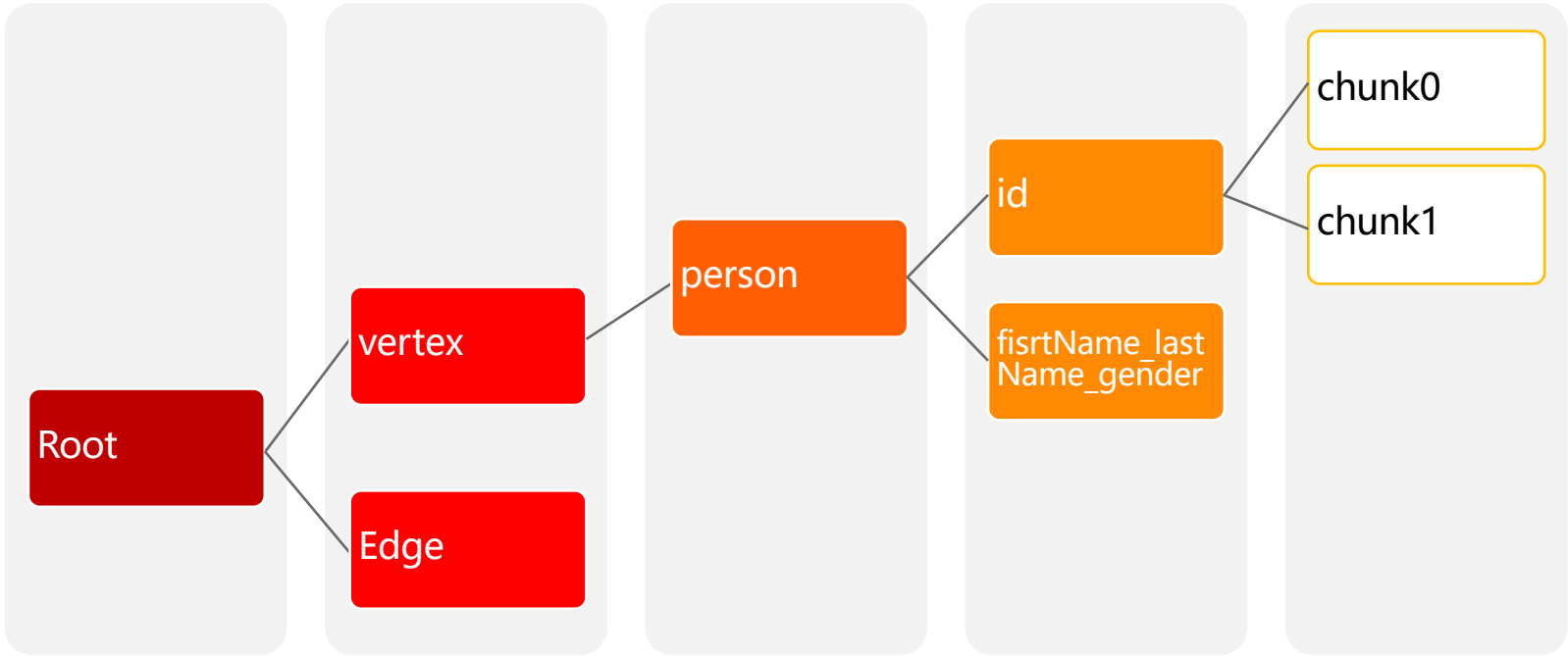
Chunk size = 500

Vertices in GraphAr: Metadata and Payload Files

Metadata person.vertex.yml

```yaml
label: person
chunk_size: 100
prefix: vertex/person/
property_groups:
  - properties:
      - name: id
        data_type: int64
        is_primary: true
    prefix: id/
    file_type: csv
  - properties:
      - name: firstName
        data_type: string
        is_primary: false
      - name: lastName
        data_type: string
        is_primary: false
      - name: gender
        data_type: string
        is_primary: false
    prefix: firstName_lastName_gender/
    file_type: csv
version: gar/v1
```

Payload files



Edges in GraphAr

Logical Table of Edges

internal vid	offset
0	0
1	3
...	...
901	6625
902	6626
903	6626
	6626

source	destination	creationDate
0	87	2010-07-30T15:19:53.298+0000
0	849	2010-10-27T02:33:06.288+0000
0	623	2012-04-12T13:56:58.931+0000
1	538	2011-03-25T14:49:23.134+0000
1	539	2011-06-16T11:28:39.623+0000
...	...	...
1	58	2011-06-10T17:47:19.432+0000
...	...	...
900	826	2012-08-21T00:02:08.530+0000
901	252	2012-08-13T10:11:20.606+0000

Physical Table of Edges

edges of vertex chunk 0

internal vid	offset
0	0
1	3
...	...
499	3772
	3778

./edge/person_knows_person/ordered_by_source/offset/chunk0

source	destination
0	87
...	...
164	829

./edge/person_knows_person/ordered_by_source/adj_list/part0/chunk0

creationDate
2012-04-21T19:08:41.647+0000
...
2012-08-10T02:49:19.288+0000

./edge/person_knows_person/ordered_by_source/creationDate/part0/chunk0

source	destination
164	30
...	...
269	565

./edge/person_knows_person/ordered_by_source/adj_list/part0/chunk1

creationDate
2012-06-26T02:41:08.148+0000
...
2012-03-10T06:07:41.141+0000

./edge/person_knows_person/ordered_by_source/creationDate/part0/chunk1

source	destination
269	321
...	...
499	628

./edge/person_knows_person/ordered_by_source/adj_list/part0/chunk2

creationDate
2012-02-19T06:42:02.399+0000
...
2012-08-13T10:11:20.606+0000

./edge/person_knows_person/ordered_by_source/creationDate/part0/chunk2

edges of vertex chunk 1

internal vid	offset
500	0
501	1
...	...
903	2848
	2848

./edge/person_knows_person/ordered_by_source/offset/chunk1

source	destination
500	623
...	...
637	704

./edge/person_knows_person/ordered_by_source/adj_list/part1/chunk0

creationDate
2010-07-30T15:19:53.298+0000
...
2010-06-11T19:23:42.146+0000

./edge/person_knows_person/ordered_by_source/creationDate/part1/chunk0

source	destination
638	375
...	...
793	884

./edge/person_knows_person/ordered_by_source/adj_list/part1/chunk1

creationDate
2010-05-16T17:41:47.623+0000
...
2011-12-22T17:56:13.491+0000

./edge/person_knows_person/ordered_by_source/creationDate/part1/chunk1

source	destination
793	662
...	...
901	252

./edge/person_knows_person/ordered_by_source/adj_list/part1/chunk2

creationDate
2012-01-04T13:29:11.784+0000
...
2012-08-03T01:00:51.312+0000

./edge/person_knows_person/ordered_by_source/creationDate/part1/chunk2

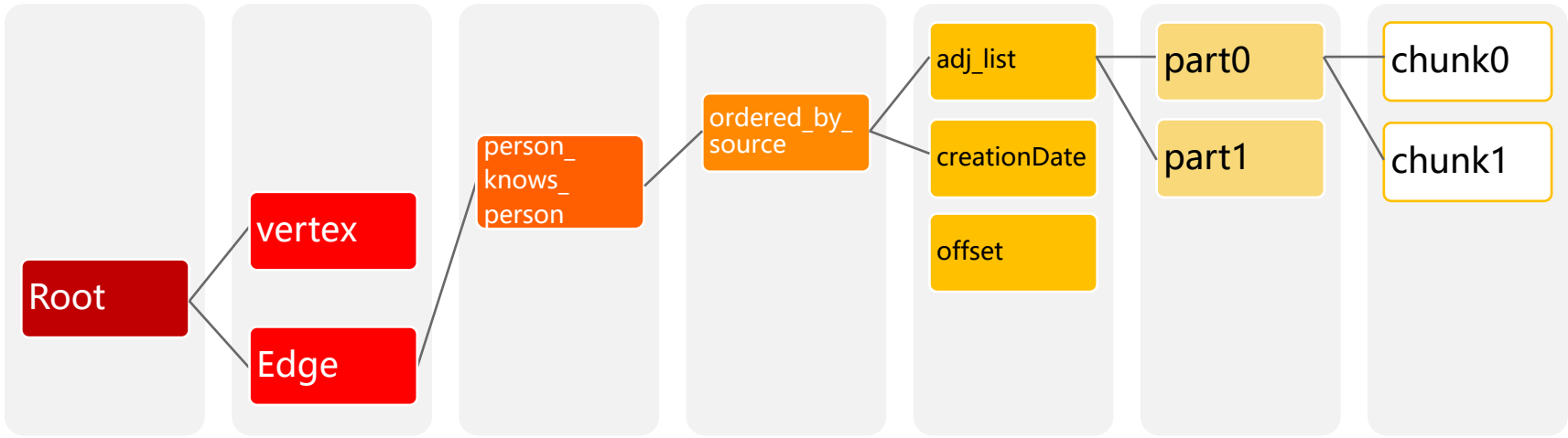
Edges in GraphAr: Metadata and Payload Files

Metadata

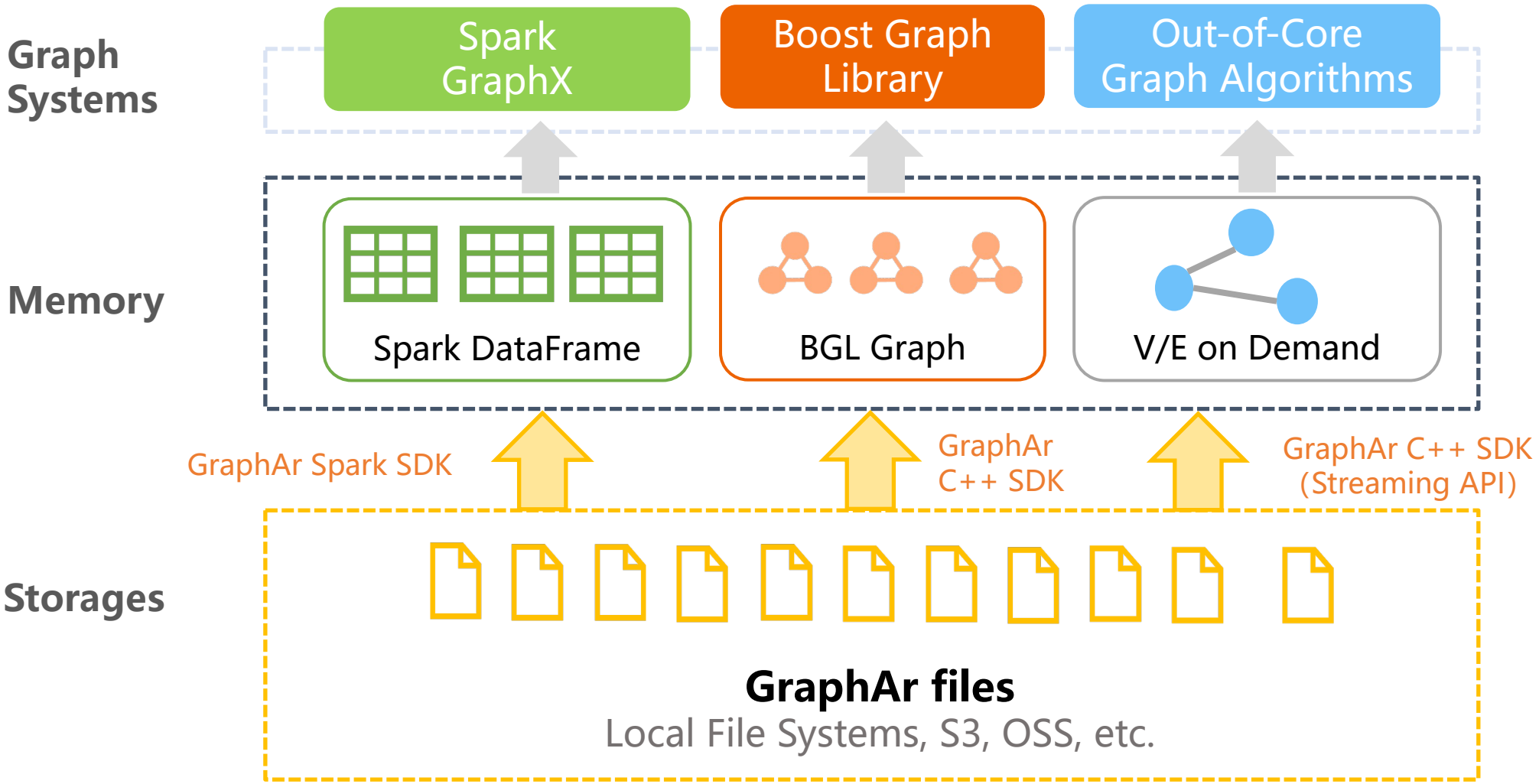
person_knoews_person.edge.yml

```yaml
src_label: person
edge_label: knows
dst_label: person
chunk_size: 1024
src_chunk_size: 100
dst_chunk_size: 100
directed: false
prefix: edge/person_knows_person/
adj_lists:
  - ordered: true
    aligned_by: src
    prefix: ordered_by_source/
    file_type: csv
    property_groups:
      - prefix: creationDate/
        file_type: csv
        properties:
          - name: creationDate
            data_type: string
            is_primary: false
  - ordered: true
    aligned_by: dst
    prefix: ordered_by_dest/
    file_type: csv
    property_groups:
      - prefix: creationDate/
        file_type: csv
        properties:
          - name: creationDate
            data_type: string
            is_primary: false
version: gar/v1
```

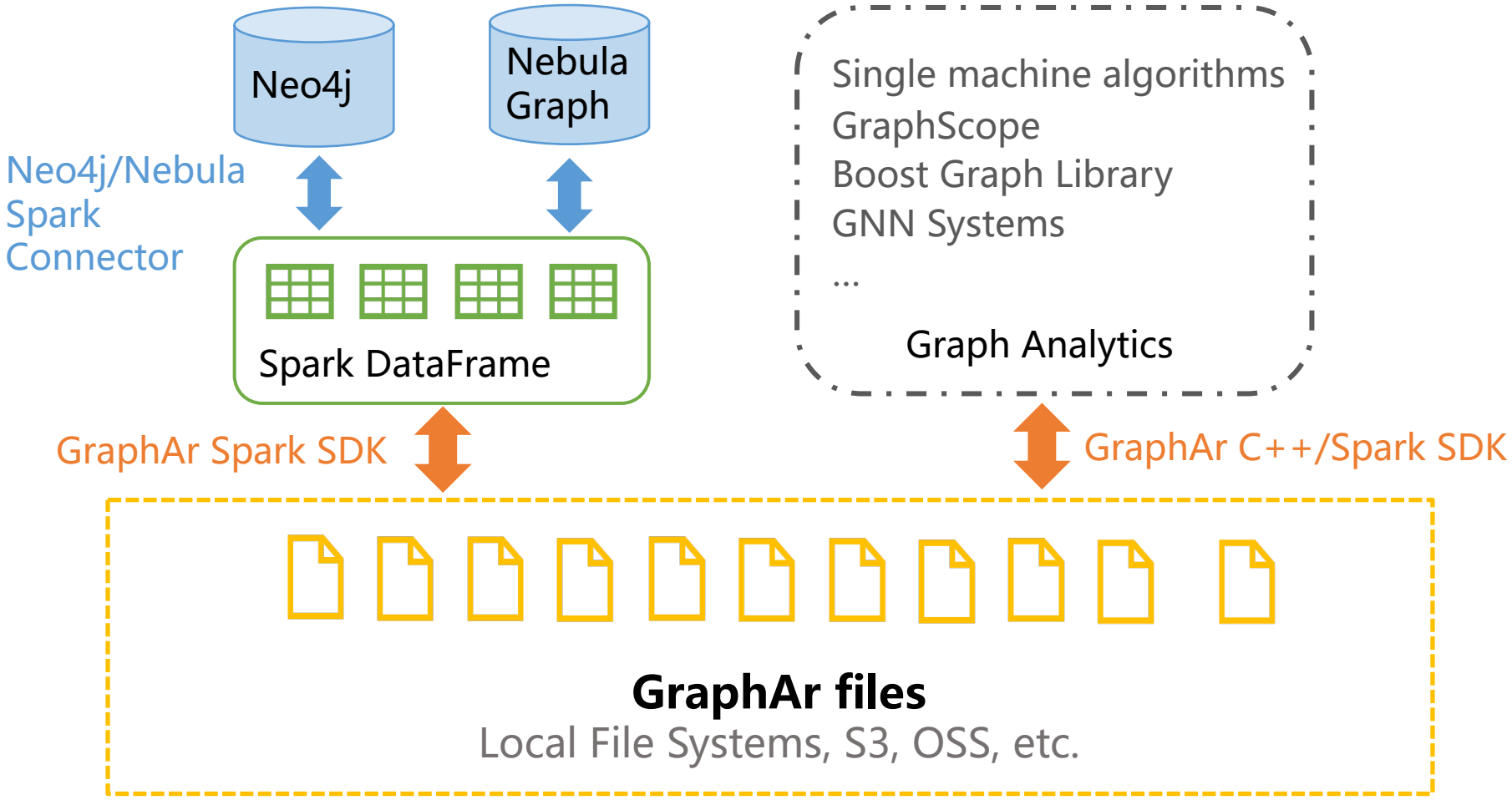
Payload files



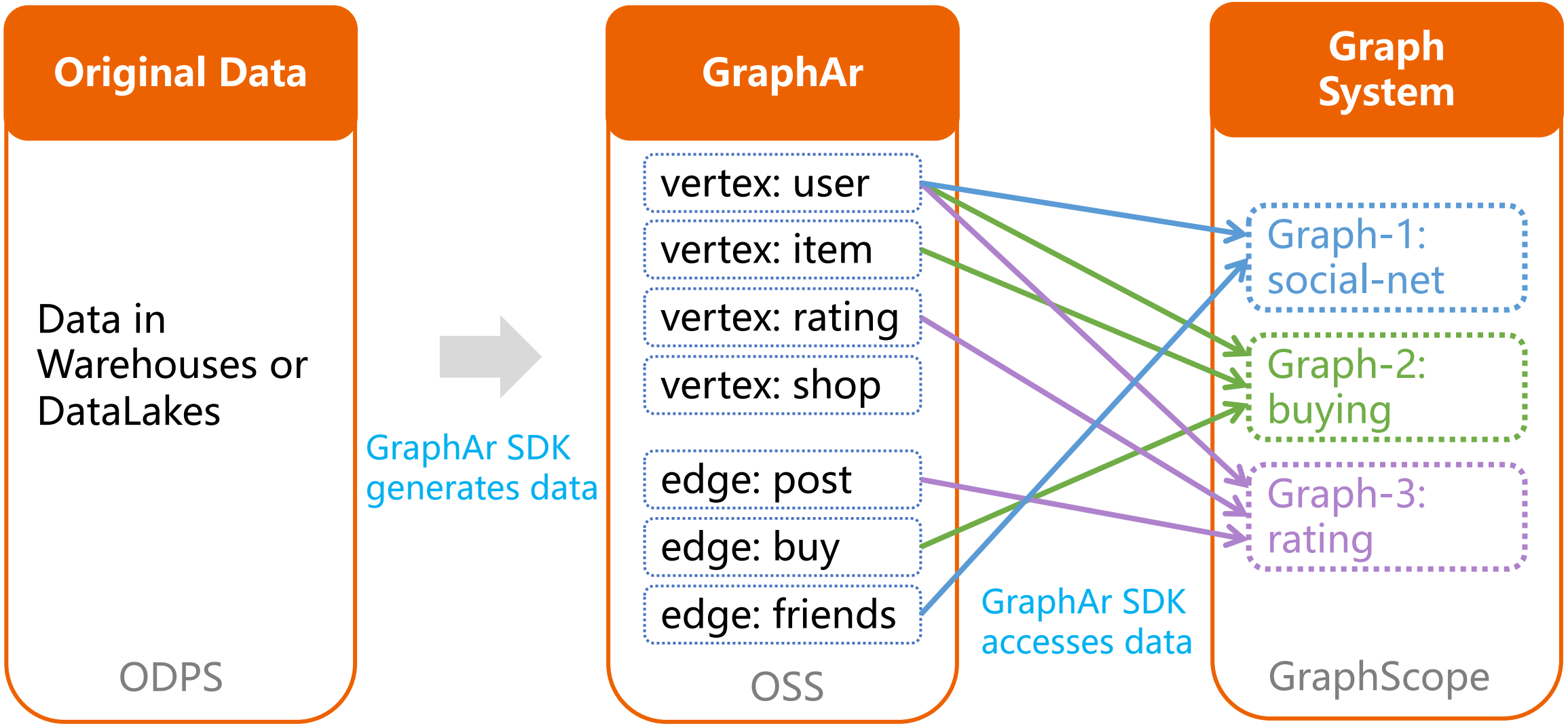
GraphAr in Action: As Graph Data Source



GraphAr in Action: As Archive of Graph DBs



GraphAr in Action: Graph Transformation



Future of GraphAr

- Support more file formats, more standard and user-defined data types.
- More graph features: RDF, time-series
- Encoding optimizations.
- Complete Spark suite to transform & create GraphAr files.
- Integrations with popular graph systems, such as Neo4j, Nebula, TuGraph, PyG …
- Explore the use of GraphAr for data lake of graphs.

Welcome to join forces with us!

Thank you!

Learn more at https://graphar.apache.org

Initiated and donated by GraphScope Team from Alibaba