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LDBC SNB Datagen: Under the hood

Arnau Prat

9th LBDC TUC meeting

9/10 February Walldorf (Germany)

Why a synthetic graph generator?

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- Real graphs are sometimes difficult to obtain
  - Not practical to distribute TeraBytes of data
  - Privacy concerns
- Real data do not always have the desired characteristics
  - Many dimensions to be tested (size, distributions, structural characteristics, etc.) as they can affect the performance of the tested systems
  - Difficult to obtain real data for all the desired dimension combinations

Wish list of a synthetic data generator

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- Scalable
    - From GigaBytes to TeraBytes of data
- Realistic
    - Distributions: attributes, degrees, etc.
    - Correlations: attributes, edges, etc.
    - Structural characteristics: clustering coefficient, largest connected component, diameter, etc.
- Flexible
    - Allow choosing the characteristics of the generated data
    - Support different output formats

LDBC SNB DATAGEN

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- DATAGEN is a fork of S3G2[1]
- Started development during LDBC European Project as the data generator for the LDBC Social Network Benchmark Workload
- Available at: https://github.com/ldbc/ldbc_snb_datagen

[1] Pham, Minh-Duc, Peter Boncz, and Orri Erling. "S3g2: A scalable structure-correlated social graph generator." Selected Topics in Performance Evaluation and Benchmarking. Springer Berlin Heidelberg, 2013. 156-172.

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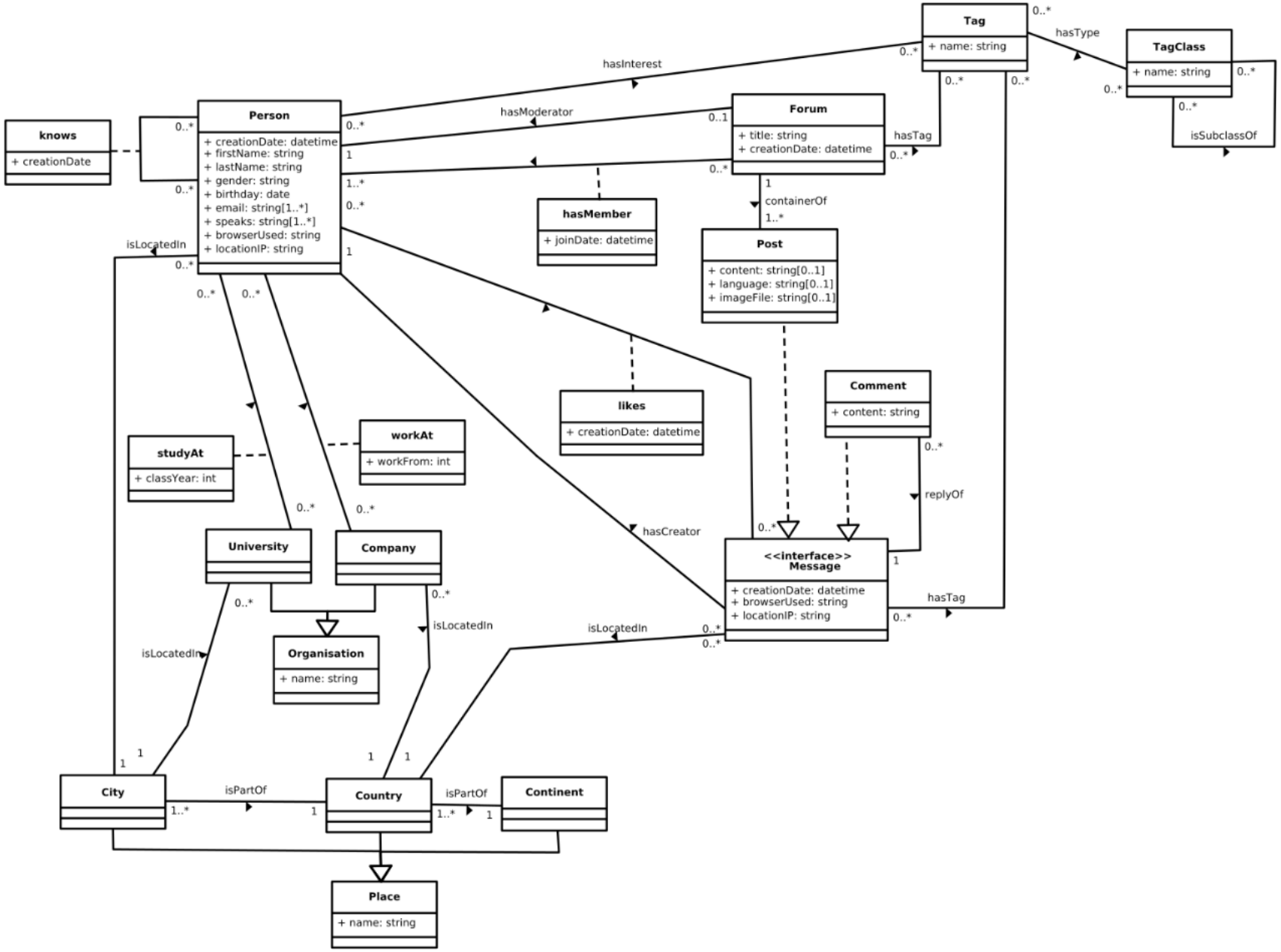
- Generates a Social Network graph
  - Uses dictionaries extracted from Dbpedia to populate the dataset with realistic attributes
    - e.g. Person names, countries, companies, tags (interests)
  - Correlated attributes
    - e.g. Person names with countries, correlations between tags, etc.
  - Correlated Friendship subgraph
    - i.e. Edges between persons sharing interests and universities are more likely
  - Realistic distributions
    - Facebook-like degree distribution, attribute distributions etc.
  - Event-based user activity generation
    - Mimick spikes of activity around specific events



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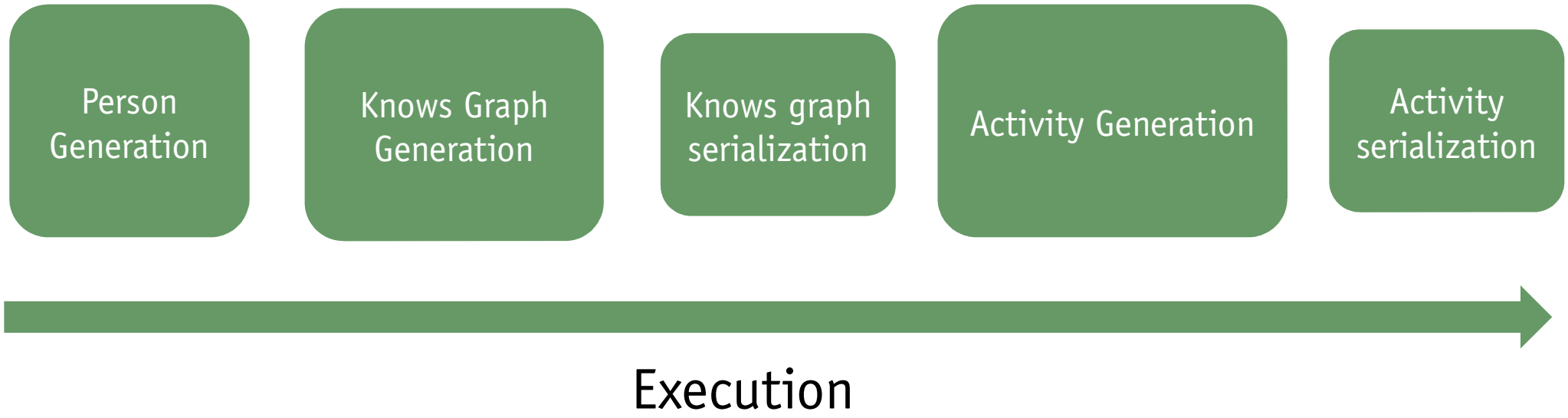
- Built on top of Hadoop
    - Able to generate Terabytes of data with a small commodity cluster
    - Billion edge graphs in few hours

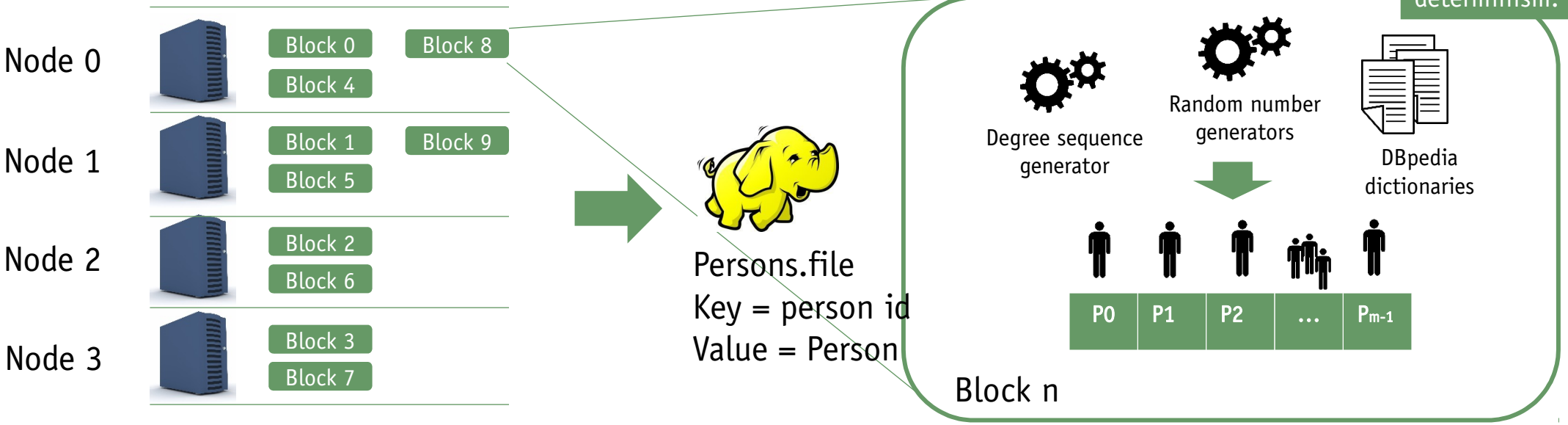
- Deterministic

Data Generation Process



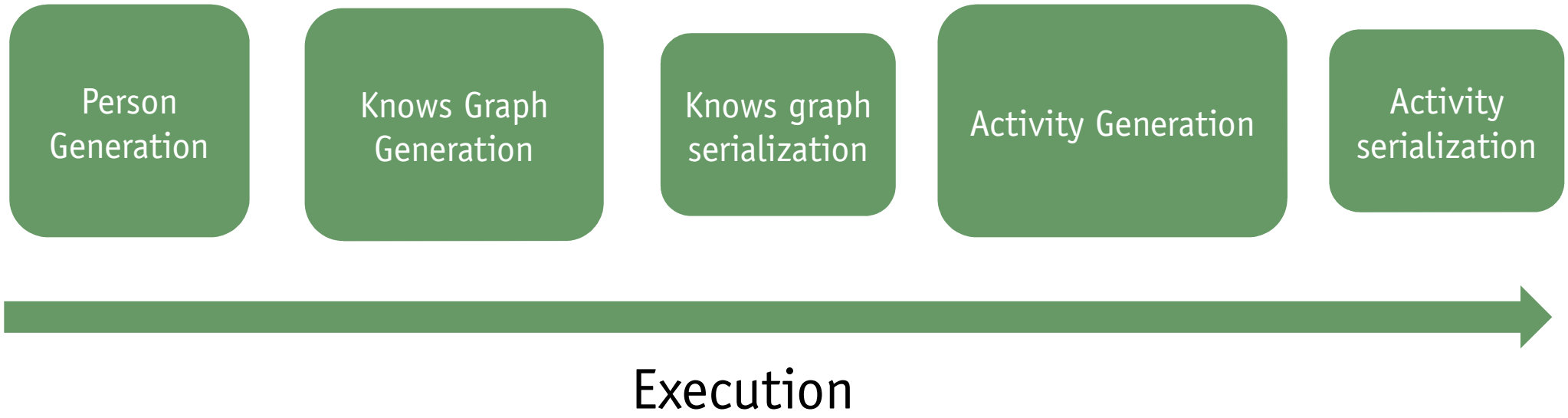
Person Generation

- A 4-machine cluster
- 100,000 Person network
- Block size m= 10,000 -> 10 blocks in total

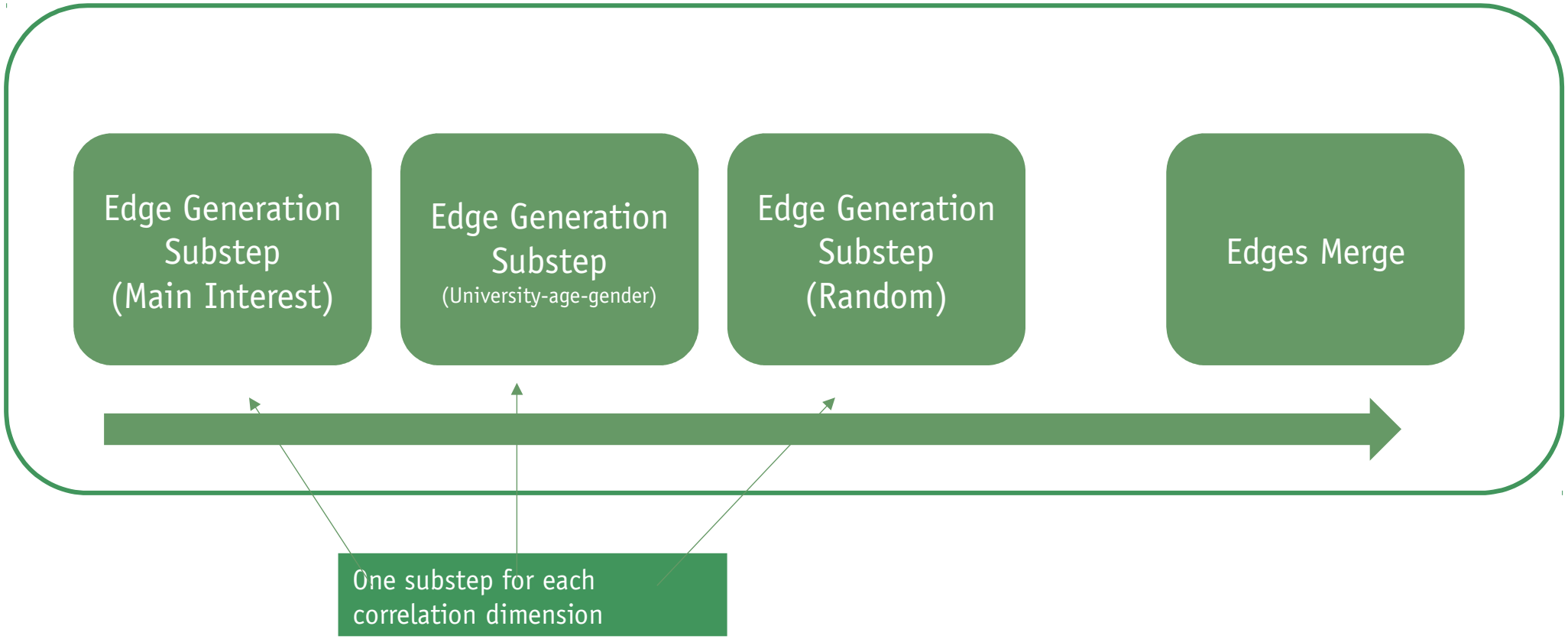


Each block has its own independent state, which depends only on the block id. This guarantees determinism.

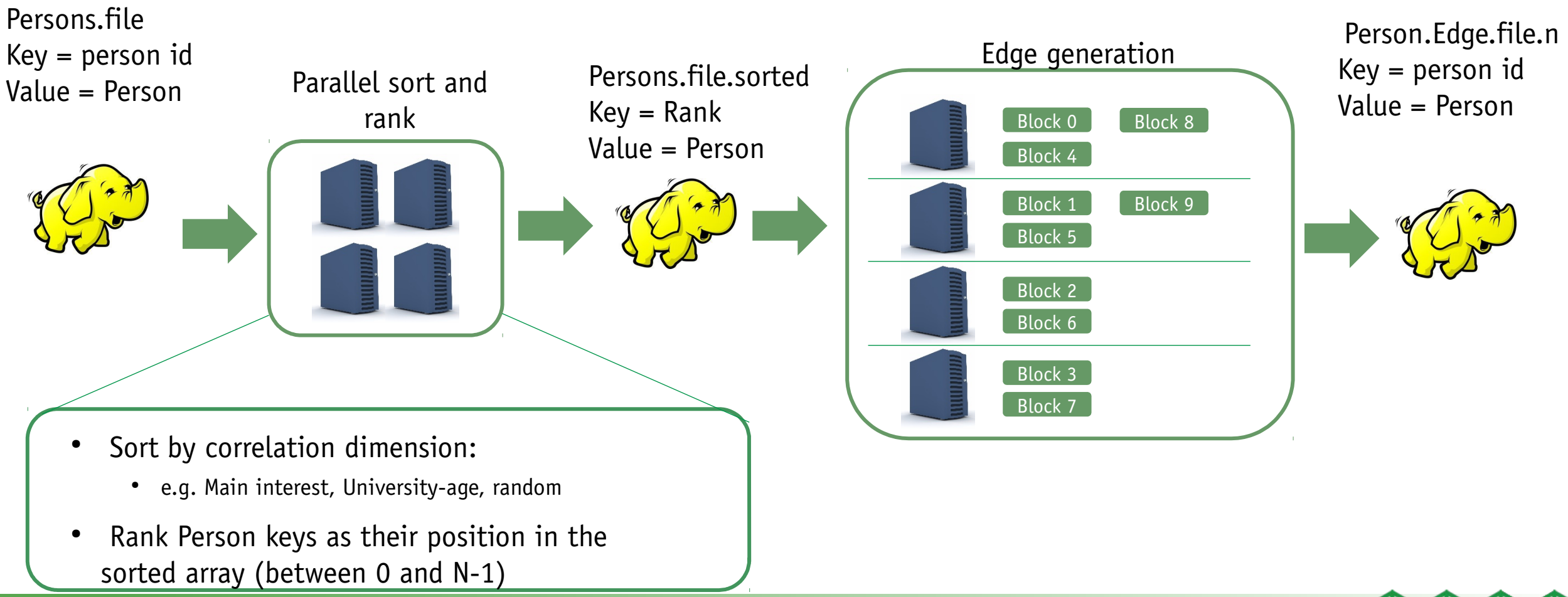
Data Generation Process



Knows Graph Generation



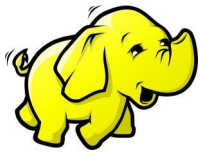
Edge Generation Substep



- Sort by correlation dimension:
  - e.g. Main interest, University-age, random
- Rank Person keys as their position in the sorted array (between 0 and N-1)

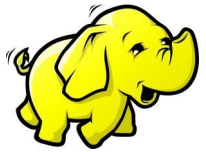
Edge Generation Substep

Persons.file
Key = person id
Value = Person

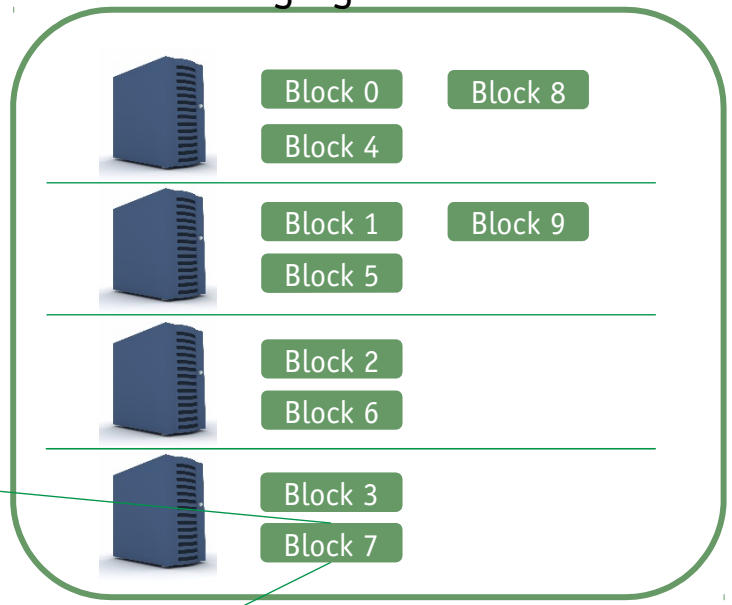


Parallel sort and rank

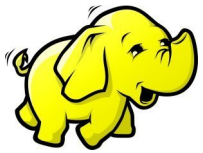
Persons.file.sorted
Key = Rank
Value = Person

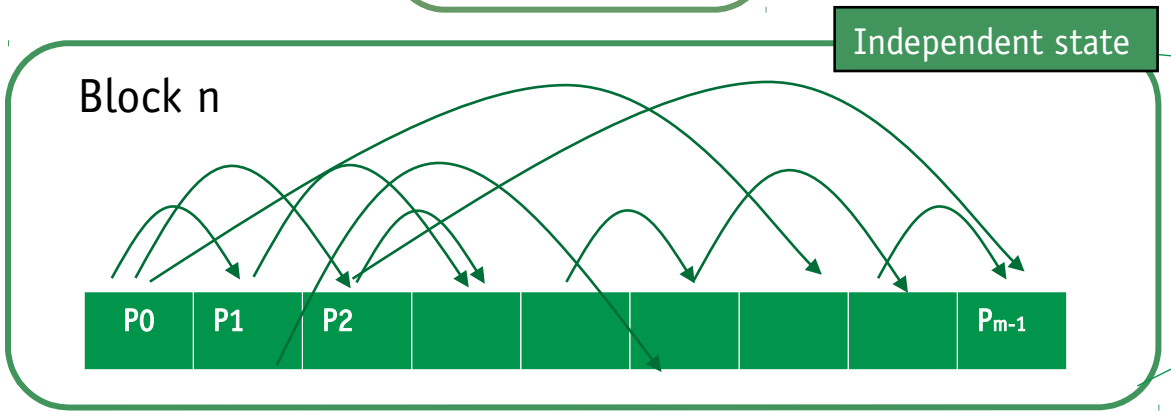


Edge generation



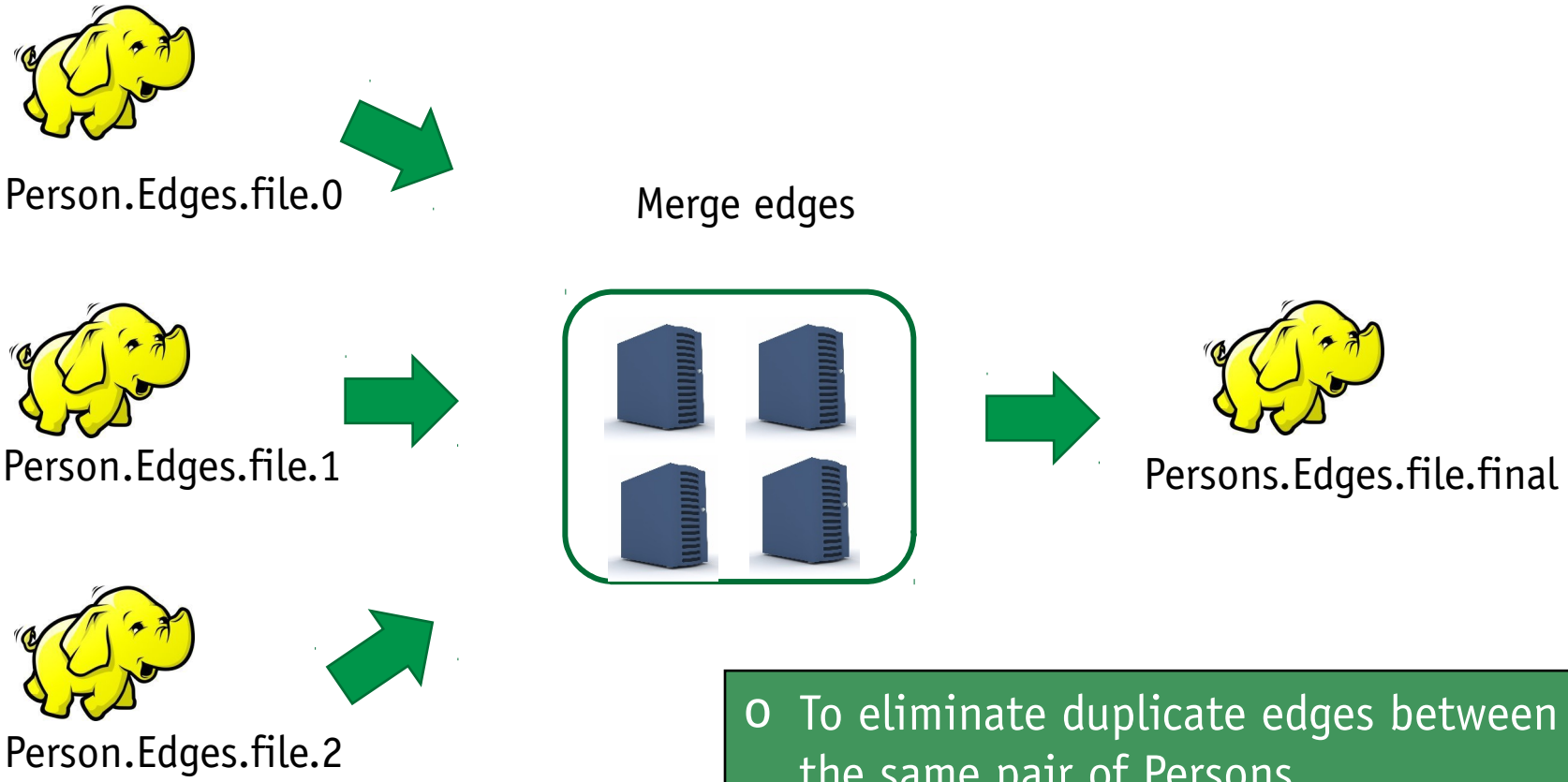
Person.Edge.file.n
Key = person id
Value = Person





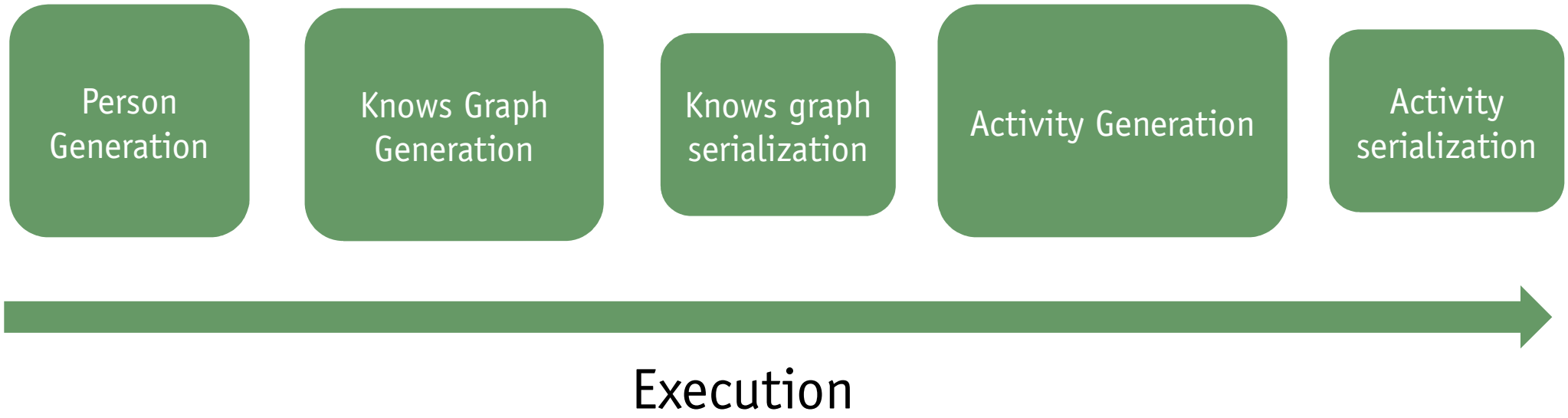
- The probability of creating an edge decreases geometrically with the distance
- Persons with similar characteristics (close in the sorted array) are more likely to be connected, producing a correlated graph
- The amount of edge a person can create depends on its assigned target degree
- A weight is assigned to each edge, which can be overriden by the user

Edge Generation Substep

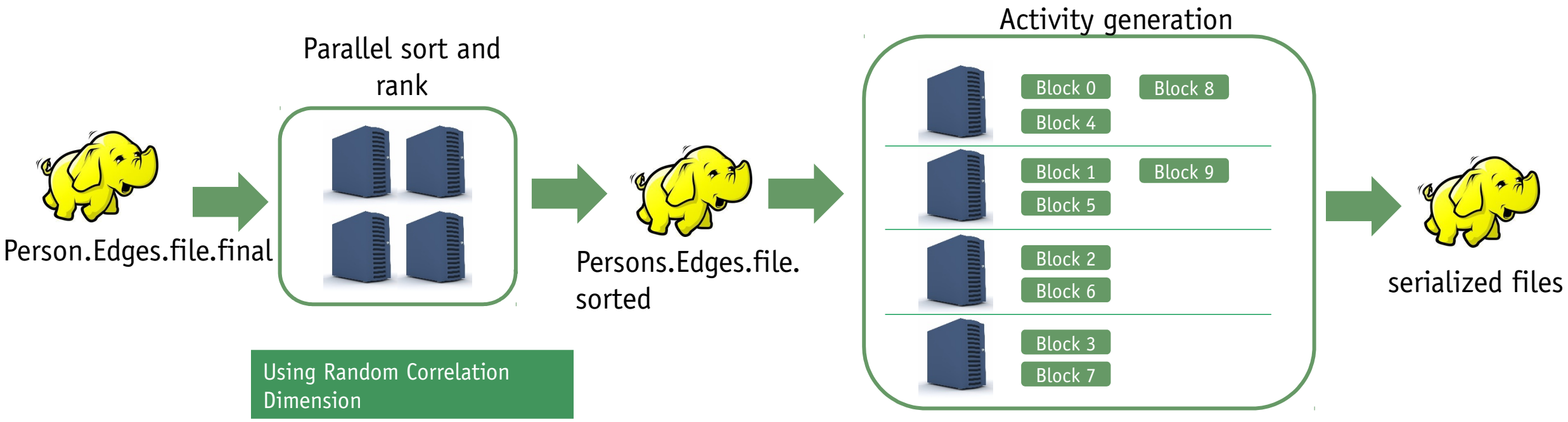


- To eliminate duplicate edges between the same pair of Persons

Data Generation Process

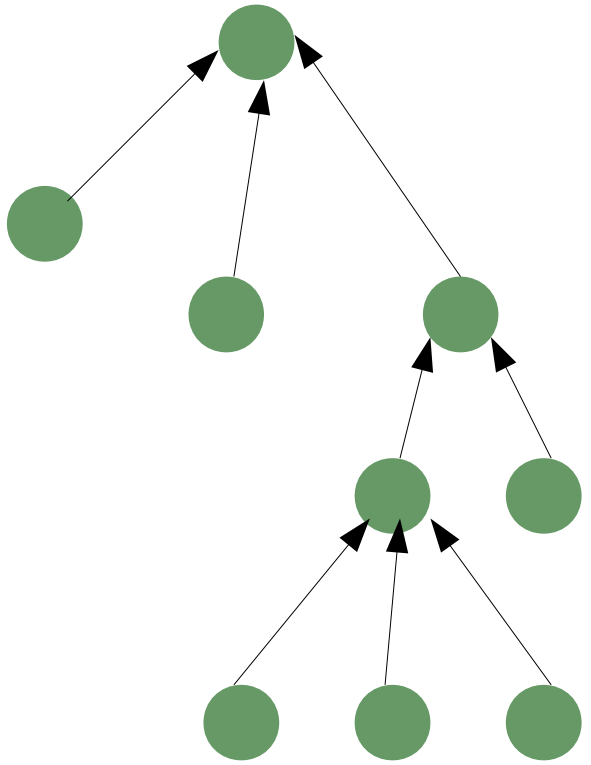


Activity Generation

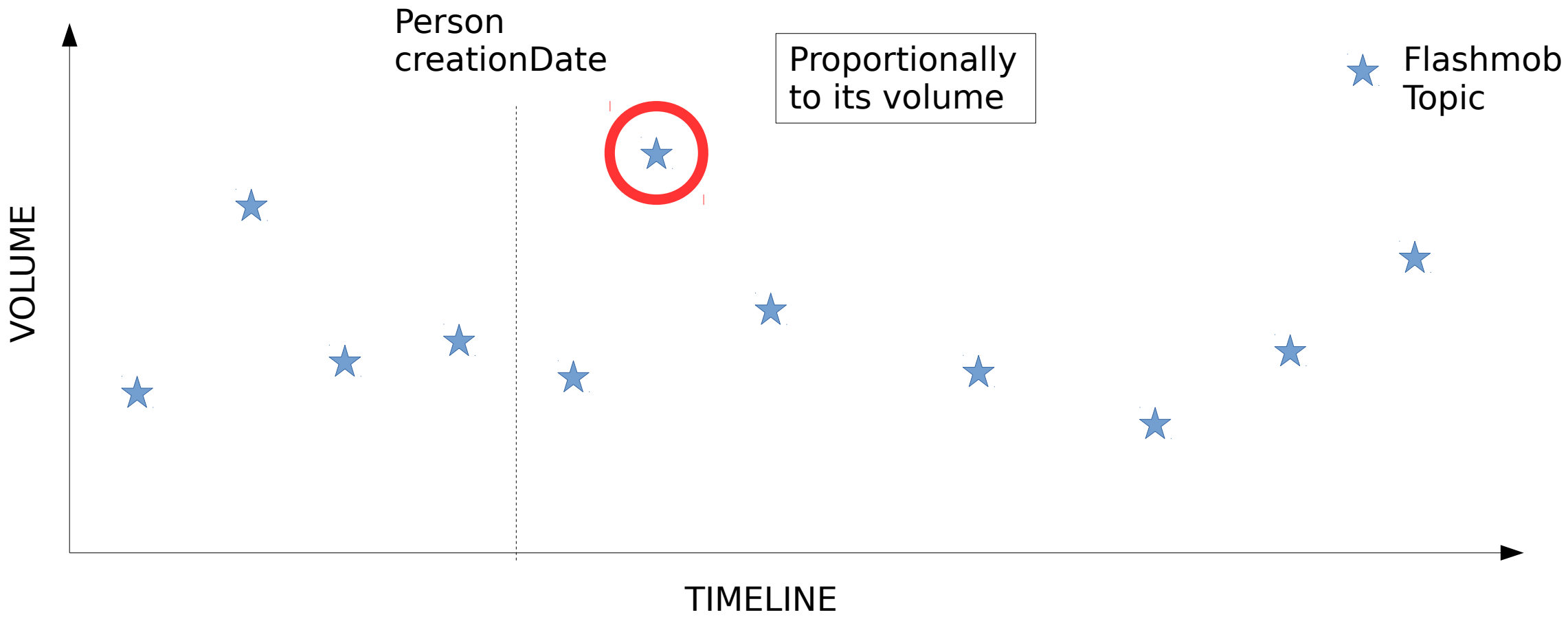


Activity Generation

- Split into two phases: Spiky vs uniform activity generation
- For each Person
  - Generate Wall
    - Generate members (Person friends)
    - Generate message cascade
  - Generate Groups
    - Generate members
    - Generate message (Person friends and others in the block)
- Uniform:
  - Cascade initiator topic is correlated with author interests
  - Creation Date is selected uniformly from max(author creation date, parent creation date) until end of simulation



Spiky - Activity Generation



Spiky - Activity Generation

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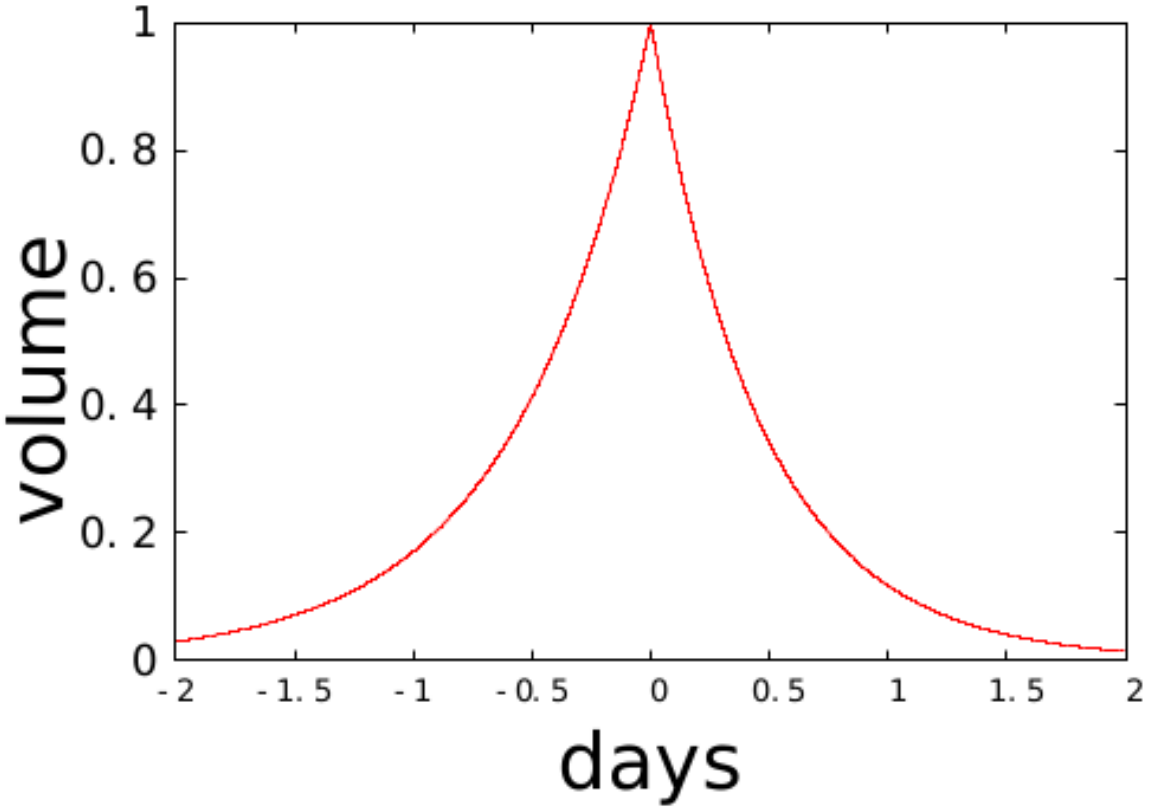
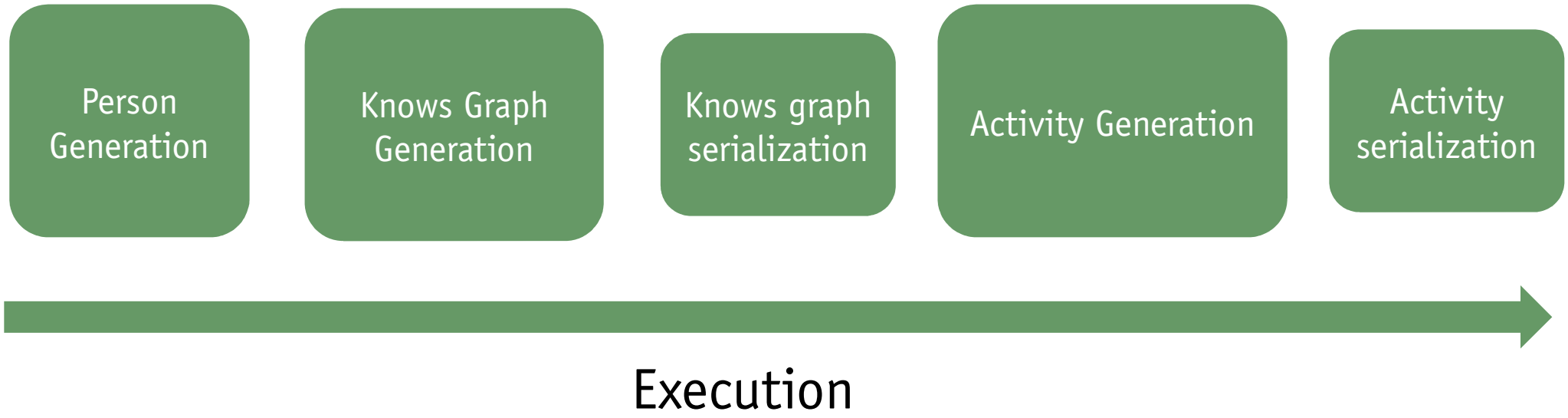
Post/Comment creationDates are clustered around the flashmob tag following this shape.



Jure Leskovec, Lars Backstrom, Ravi Kumar, and Andrew Tomkins. Microscopic evolution of social networks. In KDD, pages 462–470, 2008.

Data Generation Process



Other features

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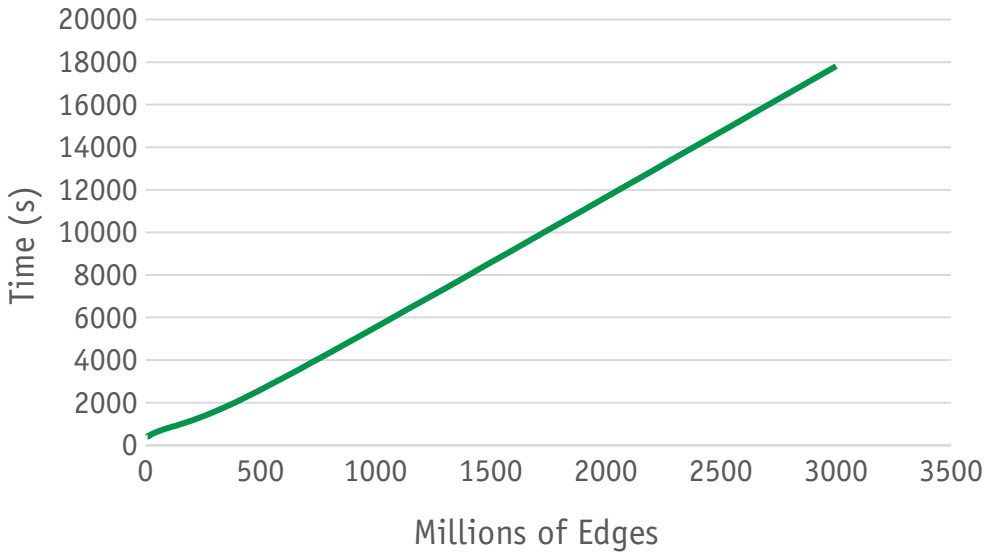
- Control the size of the graph
  - person based
  - knows graph based
- Generate only the knows graph without all the activity
- Customize:
  - the Knows graph degree distribution
  - edge weights
  - serializers
  - the knows generation step
  - message text generation
  - data formatting



Conclusions, known issues and next steps

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- Datagen allows you to generate a realistic Social Network based on a Map/Reduce approach
- It scales to terabytes of data and billion edge graphs
- Monolithic execution model
    - Things are generated even if they are not needed
    - Why do we need to generate all Person attributes if we only need 20% of them when generating the graph for Graphalytics?
    - Why do we need to populate “Knows” with person attributes if we are not going to generate activity?
- Leads to a bad use of resources and larger execution times
- LDBC Datagen 2:
    - New architecture/execution model,
    - In-Place data generation
    - Language driven data/properties definition

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THANK YOU!

(and we are recruiting)