Visually Programming Dataflows for Distributed Data Analytics

Lauritz Thamsen, Thomas Renner, Marvin Byfeld,
Markus Paeschke, Daniel Schröder, Felix Böhm

Technische Universität Berlin

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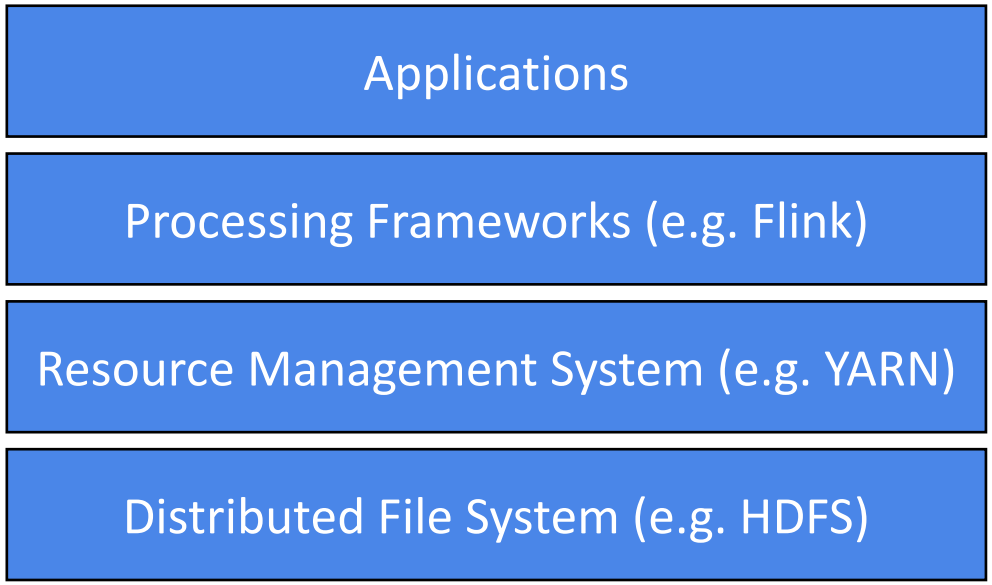
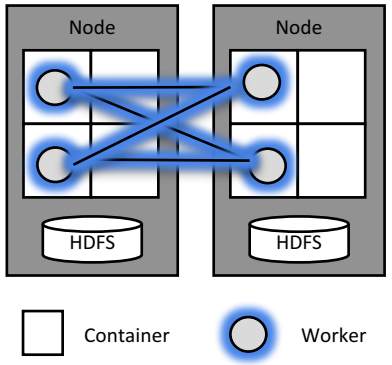
StratoSphere Above the Clouds

Distributed Data Analytics

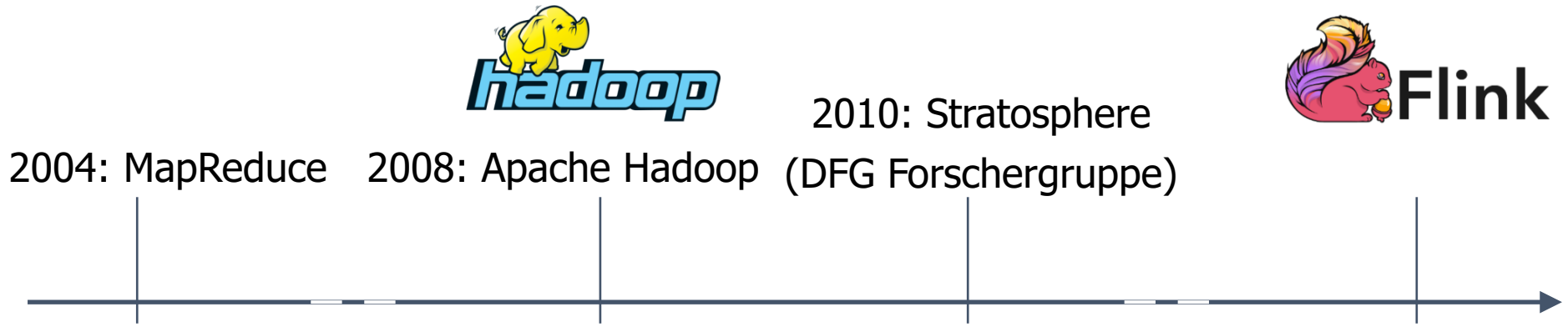
- Systems like MapReduce, Spark, and Flink allow to analyze large datasets in parallel using clusters of computers:





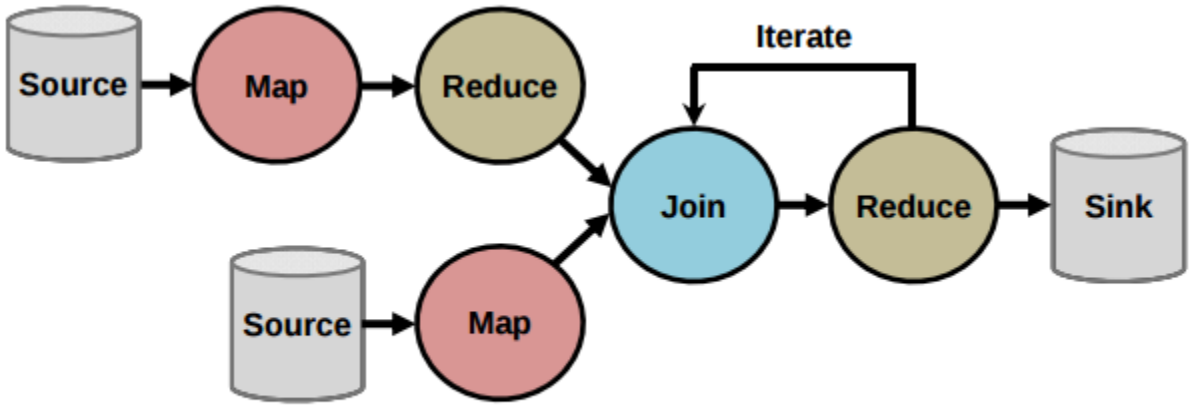
Apache Flink

- Open Source distributed dataflow system for general-purpose data analysis:
  - suited for batch and stream processing,
  - native support for iterative jobs,
  - efficient distributed execution,
  - high-level programming abstractions



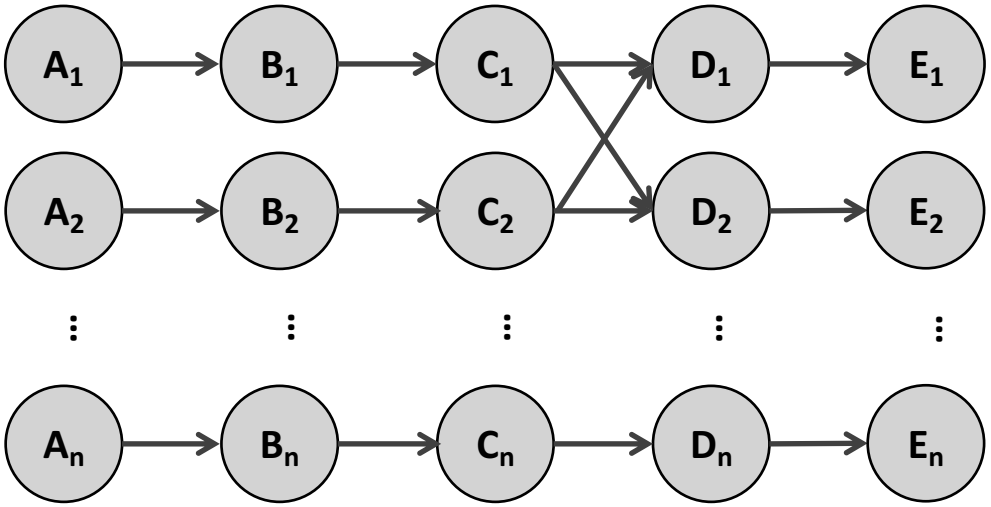
Jobs

- Jobs are directed graphs of transformations tasks
- Available transformations: Map, Reduce, Join, CoGroup, Union, Iterate, Filter, FlatMap, …



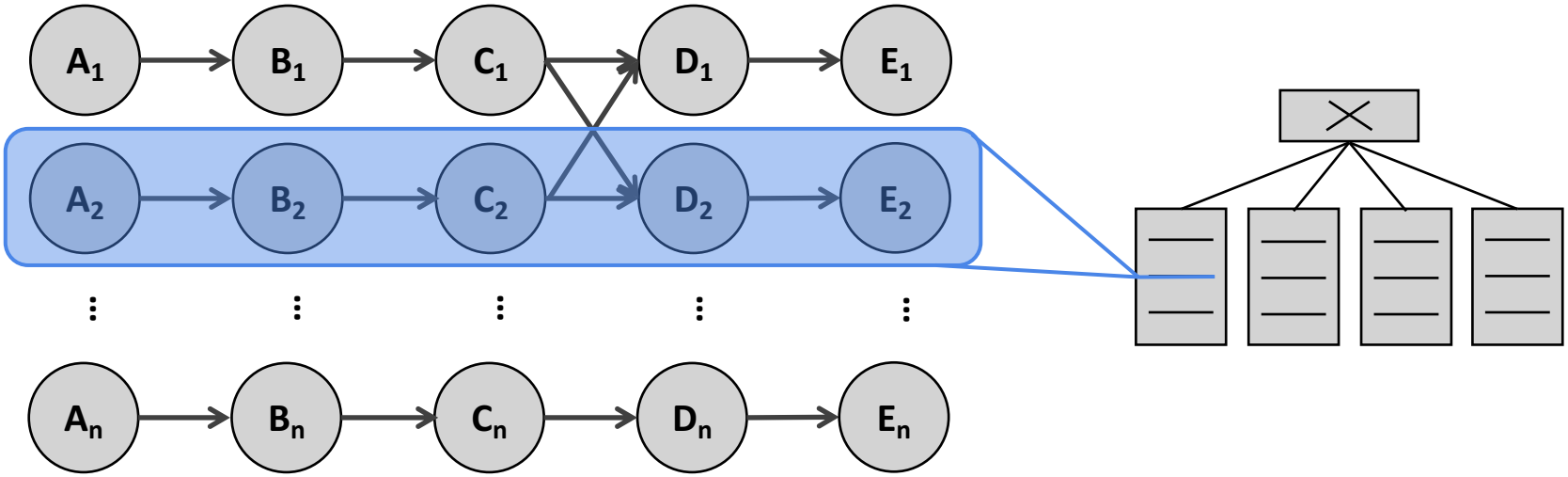
Parallelism

- Data partitioning and data-parallel task instances
- Synchronized when necessary for transformations, otherwise also pipeline parallelism



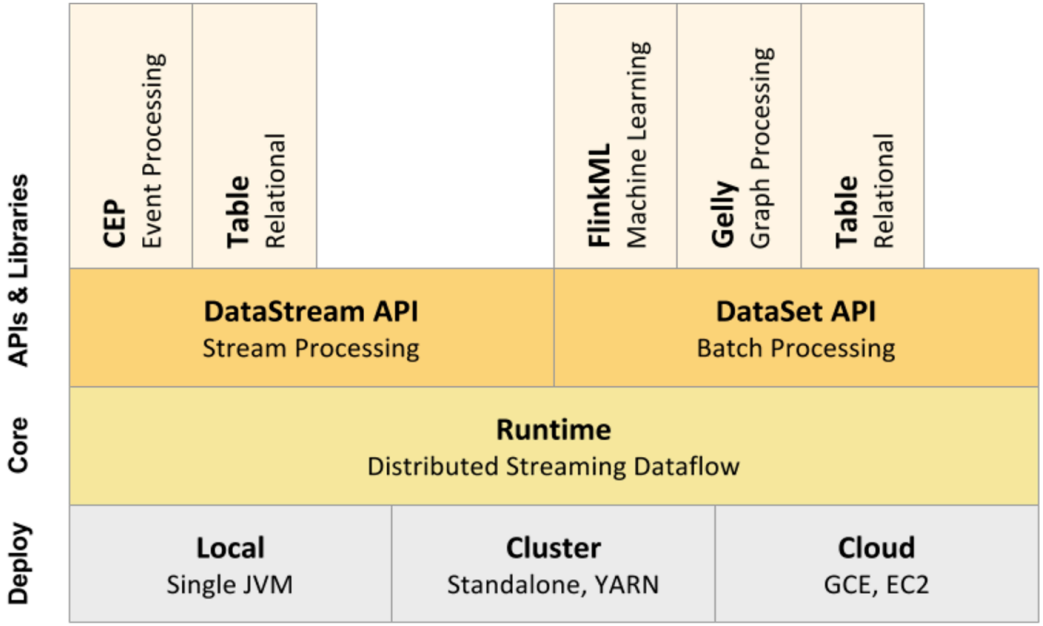
Distributed Execution

- Parallel pipelines scheduled on to shared nothing workers



Programming Abstractions

- General-purpose APIs for batch and stream
- Domain-specific abstractions for relational data, graph processing, and machine learning



http://flink.apache.org/

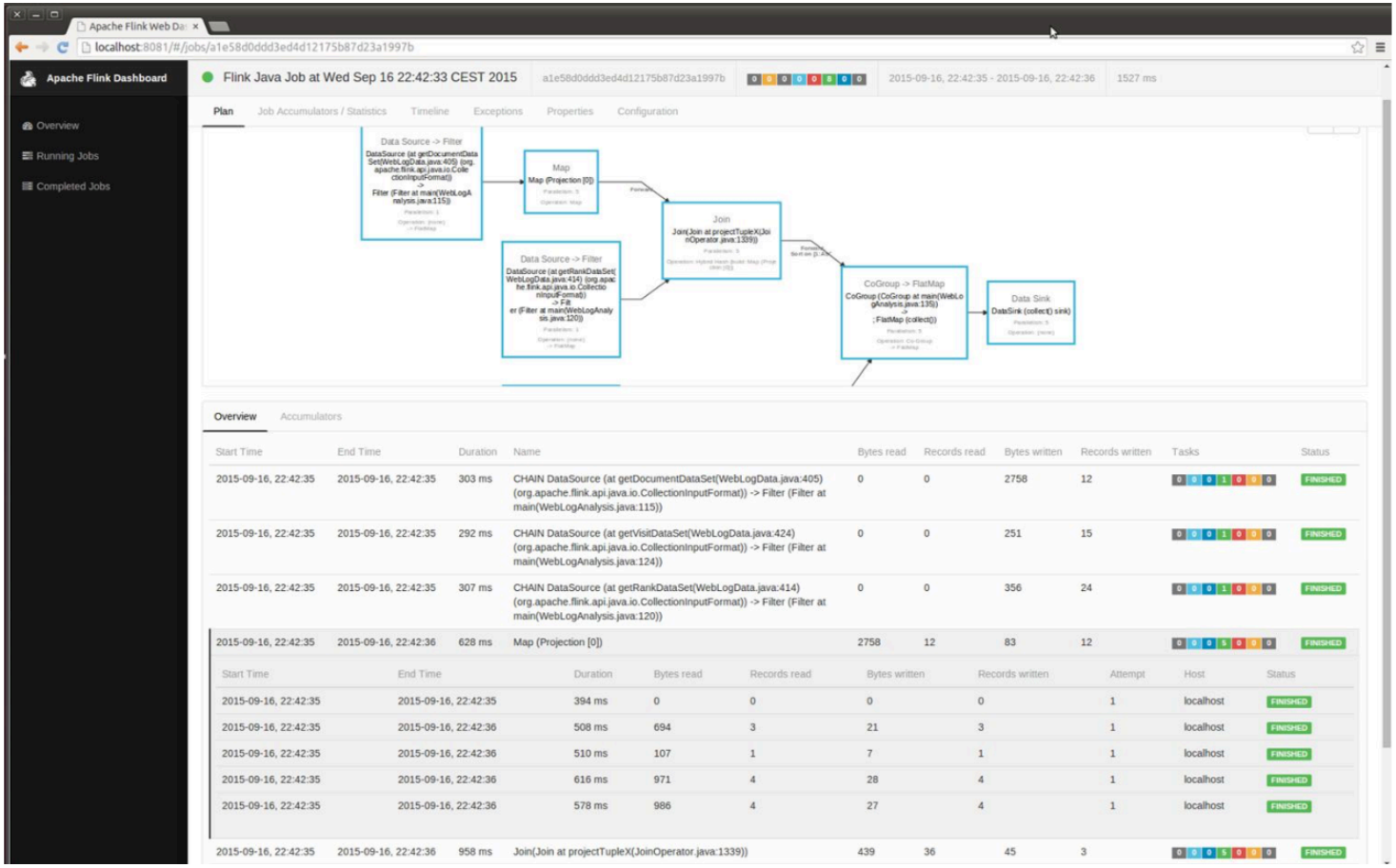
Flink WordCount Example

```
public static void main(String[] args) throws Exception {
  final ParameterTool params = ParameterTool.fromArgs(args);
  final ExecutionEnvironment env =
    ExecutionEnvironment.getExecutionEnvironment();
  env.getConfig().setGlobalJobParameters(params);

  DataSet<String> text = env.readTextFile(params.get("input"));
  DataSet<Tuple2<String, Integer>> wc =
    text.flatMap(new Tokenizer()).groupBy(0).sum(1);
  wc.writeAsCsv(params.get("output"), "\n", " ");

  env.execute("WordCount Example");
}
```

Web Dashboard

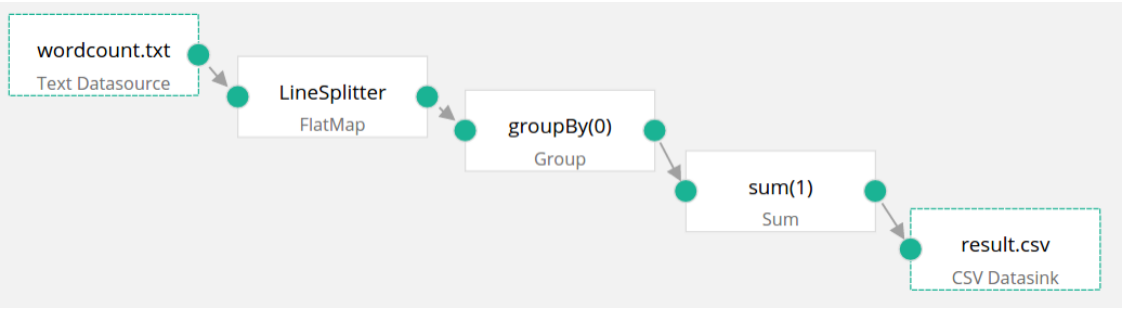


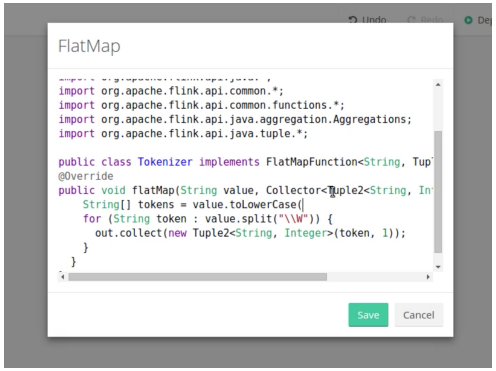
https://cloud.githubusercontent.com/assets/1727146/9918196/beccacfa-5cc5-11e5-89f4-b26ffbdf2ef9.png

Identified Issues

- **Representation mismatch**: job graph vs. linear text
- **Invisible operator set**: code completion, no graphical view of available components
- **UDF clutter**: user code either inline or defined elsewhere
- **General-purpose coding environment**: no job submission and monitoring

Visually Programming Dataflows

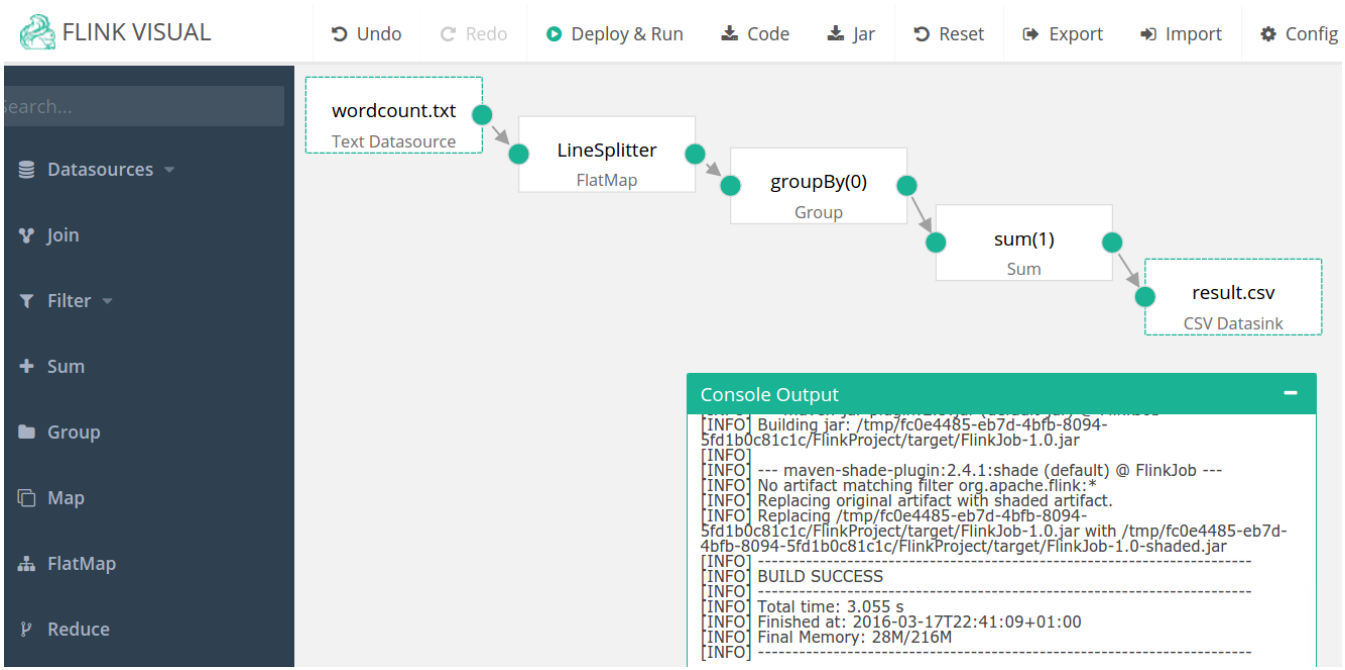


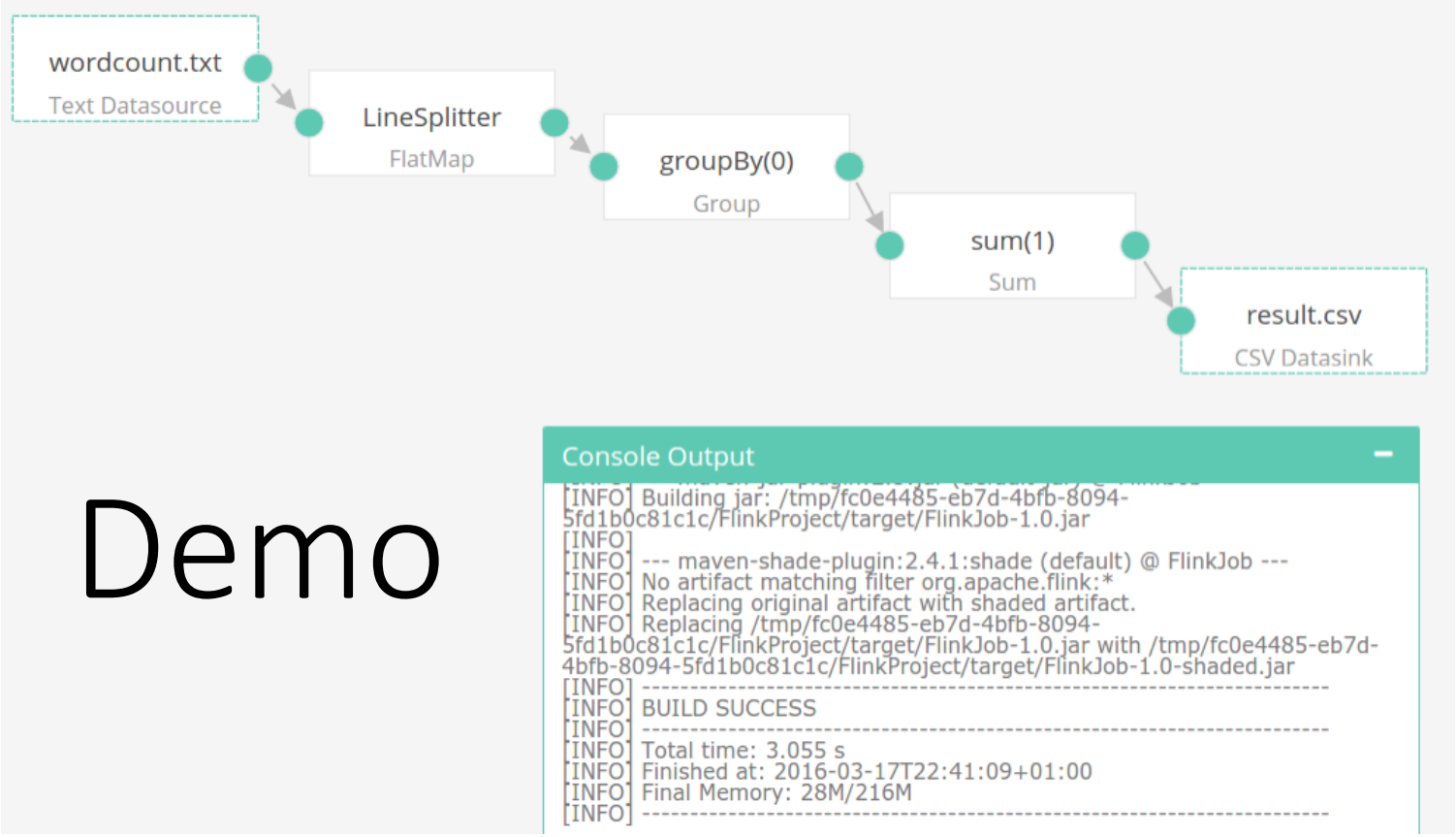


- Use visual programming for programming distributed dataflow systems:
  - Job graph view
  - Visible operator set
  - Operator configuration and UDF coding in windows
  - Integrated job submission and monitoring

Flision Prototype

- Web-based visual programming environment for Apache Flink, developed by a student project



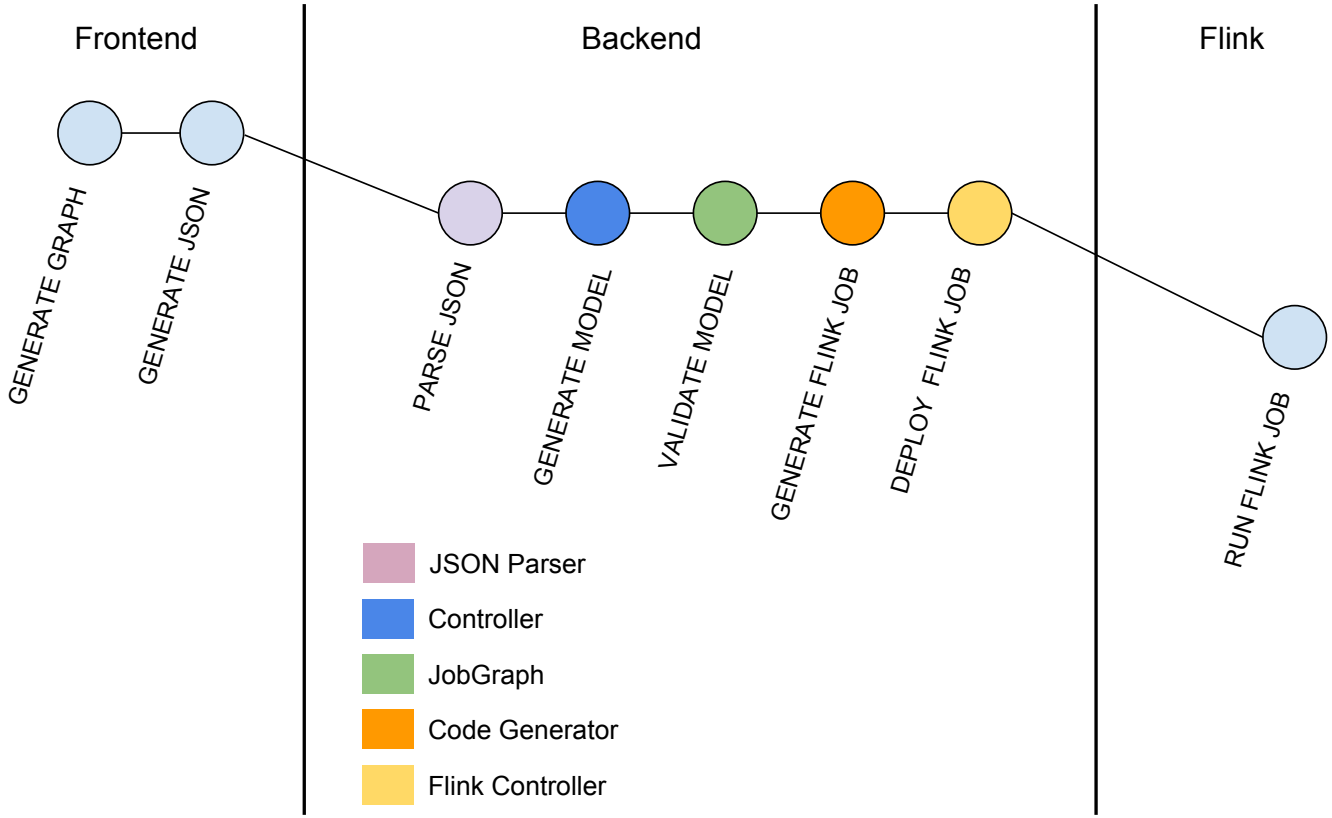


Demo

→ https://vimeo.com/166030396

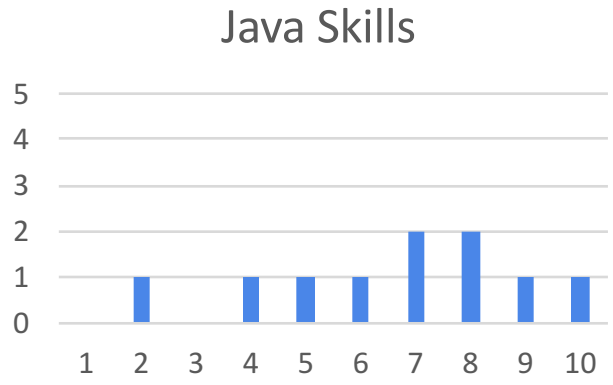
Prototype Implementation

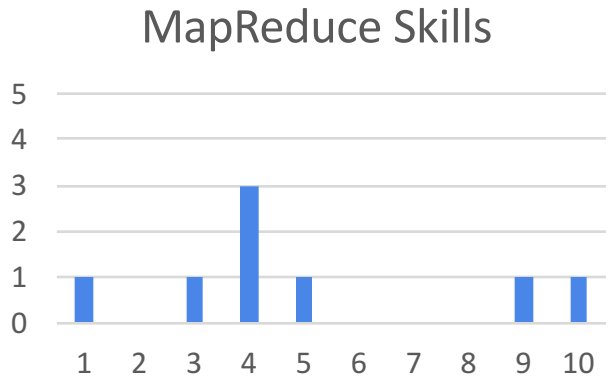
- Implemented as a Web application



Evaluation Setup

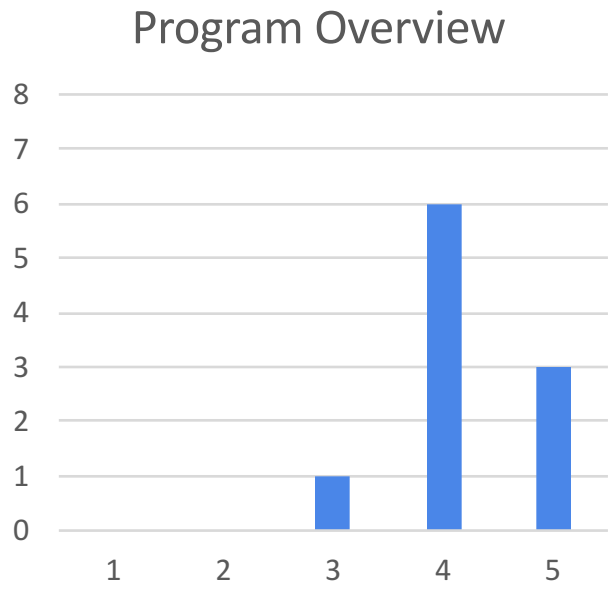
- Qualitative user testing:
  - implementation of WordCount and a questionnaire
  - with ten participants, with between 3.5 and 20 years of programming experience (average: 7.85 years)

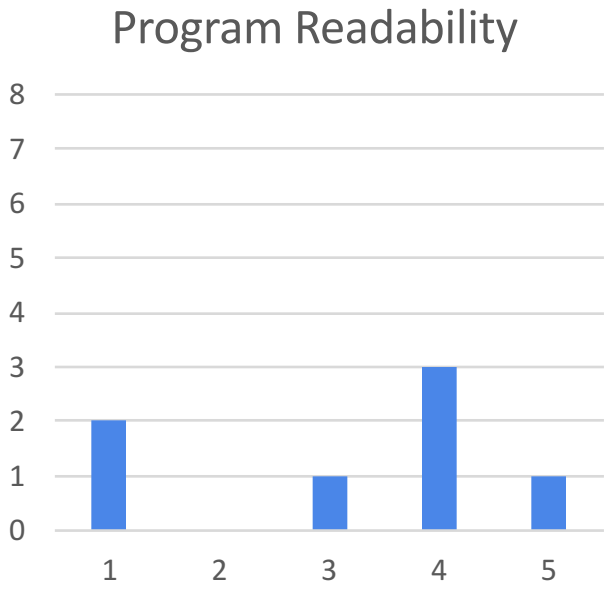




Evaluation Results (1/2)

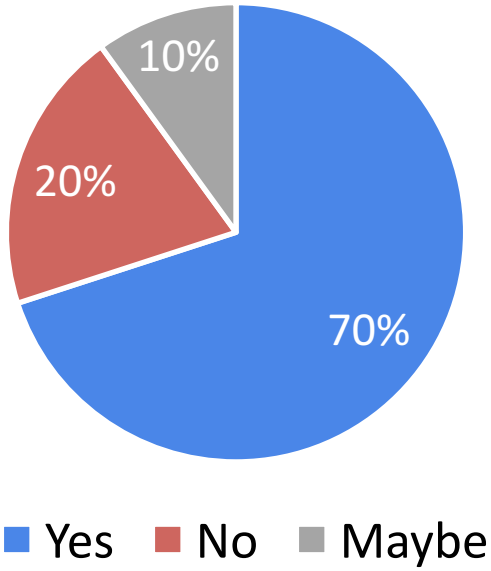
- Good overview, good for new users, yet some developers still might prefer their textual IDEs





Evaluation Results (2/2)

- Would you be willing to use such an environment in future data analysis projects?



Conclusion

- Visual programming might be a good fit for distributed dataflow systems
- User feedback: Increased overview, easier for new users and non-programmers, but maybe not the best choice for professional developers
- Interesting future directions:
  - Abstract entire subgraphs
  - Shared component repositories
  - Job progress and debugging