Crowdy

A Framework for Supporting Socio-Technical Software Ecosystems with Stream-based Human Computation

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Outline

- Introduction
- Crowd Computing
- Architecture
- Platform
- Tool
- Discussion
- Conclusion
- References

Introduction

- Growing software systems
    - Scale and variety of components
    - Hardware elements
    - Amount of data
- Decentralized and dynamic structure
    - Complex interactions

Introduction

- Ecosystem
  - Various components supported by a common platform
  - Operating through exchange of information
- Social aspect of the ecosystem [1]
  - Components operated by human beings
  - People as an integral part of the system functionality
  - Increase in scale of components
  - Loss of component homogeneity

Introduction

- Scale of collaboration [2]
- New and powerful mechanism of computation
  - Solutions to problems that cannot be easily computerized
    - Recaptcha
    - Galaxyzoo
    - Help Find Jim
- Different terms
  - human computation, crowdsourcing, collective intelligence, social computing etc.

Introduction

Problem

- Typical crowdsourcing task (micro-task)
  - Difficulty
    - Narrowly focused
    - Low complex
    - Little expertise
  - Dependency
    - Independent
    - No information flow

Introduction

Problem

- Simplicity
  - Division and distribution of tasks
  - Parallelizing and bulk processing
- Complex and sophisticated problems
  - Coordination of resources

Introduction

Problem

- Requirement of a new framework
    - More sophisticated problem-solving paradigm [3]
        - Design of a multi-stage workflows
    - Powerful programming metaphors [4]
        - Task decompositions and interdependency management
- Recent research
    - Rigid structure and requirements
    - Being applicable to small set of problems
    - Requiring effort to implement and integrate

Introduction

Purpose

- Analysis of problems and existing solutions
- Proposal of a new general-purpose and extensible framework
  - Enabling users to solve complex problems
  - No rigid structure or requirements
  - Not limited to a specific problem-set
- Application editor, runtime environment and computation resources

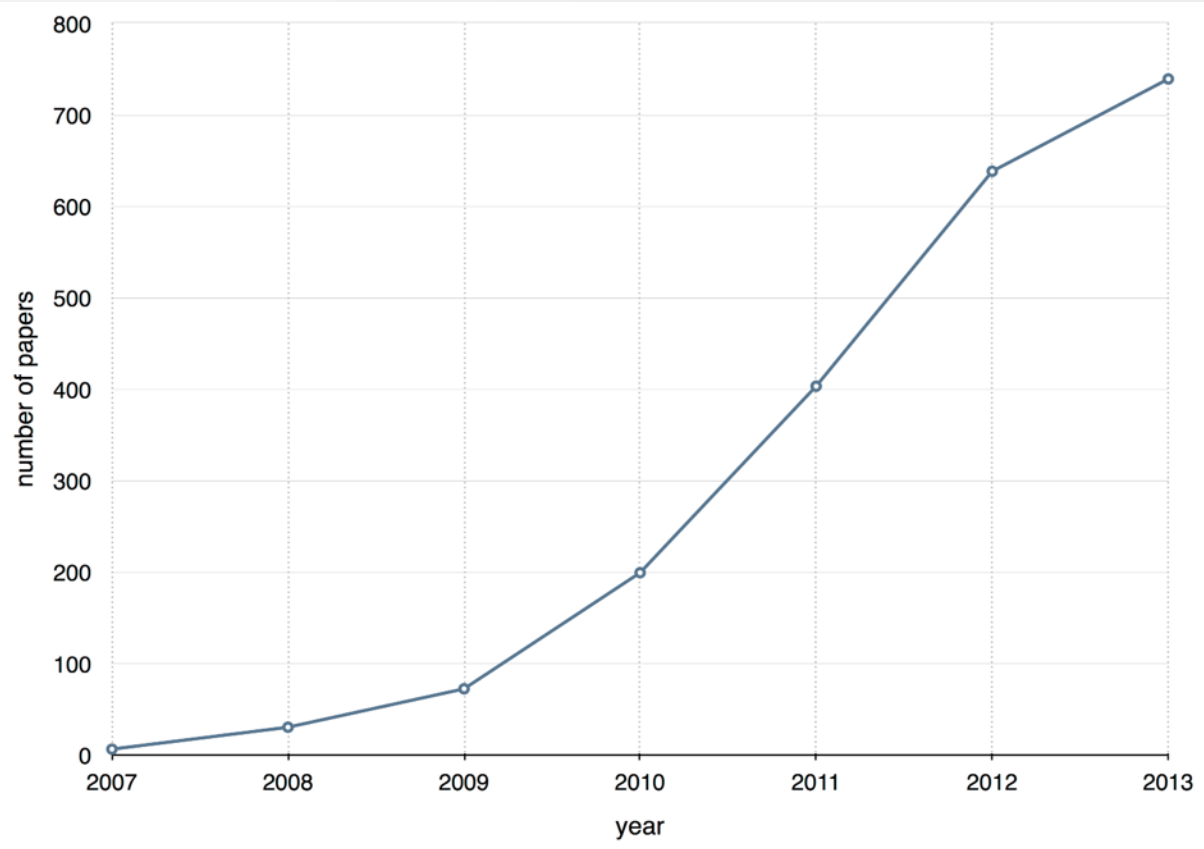
Crowd Computing

- Crowdsourcing
  - Jeff Howe in the June 2006 issue of Wired [5]

    "... taking a function once performed by employees and outsourcing it to an undefined network of people in the form of an open call."

Crowd Computing

- Promisingly increasing popularity in academia



- Different approaches
  - Task creation, quality control, workflow design etc.
- Amazon's Mechanical Turk (MTurk)
  - Intermediary between employers and employees

Crowd Computing

Basic Concepts

- Task
  - The piece of work to be done
  - Micro-task, Human Intelligent Task (HIT)
  - Expressed over an HTML form
- Time
  - Max time allotted per assignment
  - Nearly 20% takes less 1-hour [6]
  - More than half does not take more than 16-hours [6]

Crowd Computing

Basic Concepts

- Payment
  - 90% of tasks pays $0.10 or less [6]
- Acceptance
  - Manual or automatic approval by requester
- Expiration
  - Lifetime of the task

Crowd Computing

Basic Concepts

- Requesters
  - Posting the tasks
  - Obtaining results
  - Paying workers
  - Design tasks with all the details
- Workers
  - Online users or someone from the crowd
  - Completing the assignments in exchange for a payment

Crowd Computing

Building Blocks

- Future of crowdsourcing platform [3]
  - Management of tasks through multi-stage workflows
- Workflow Design
  - Simple approach for complex problems
  - Decomposition of dependent tasks
- Task Assignment
  - Coordination of limited resources
- Quality Control
  - Big challenge

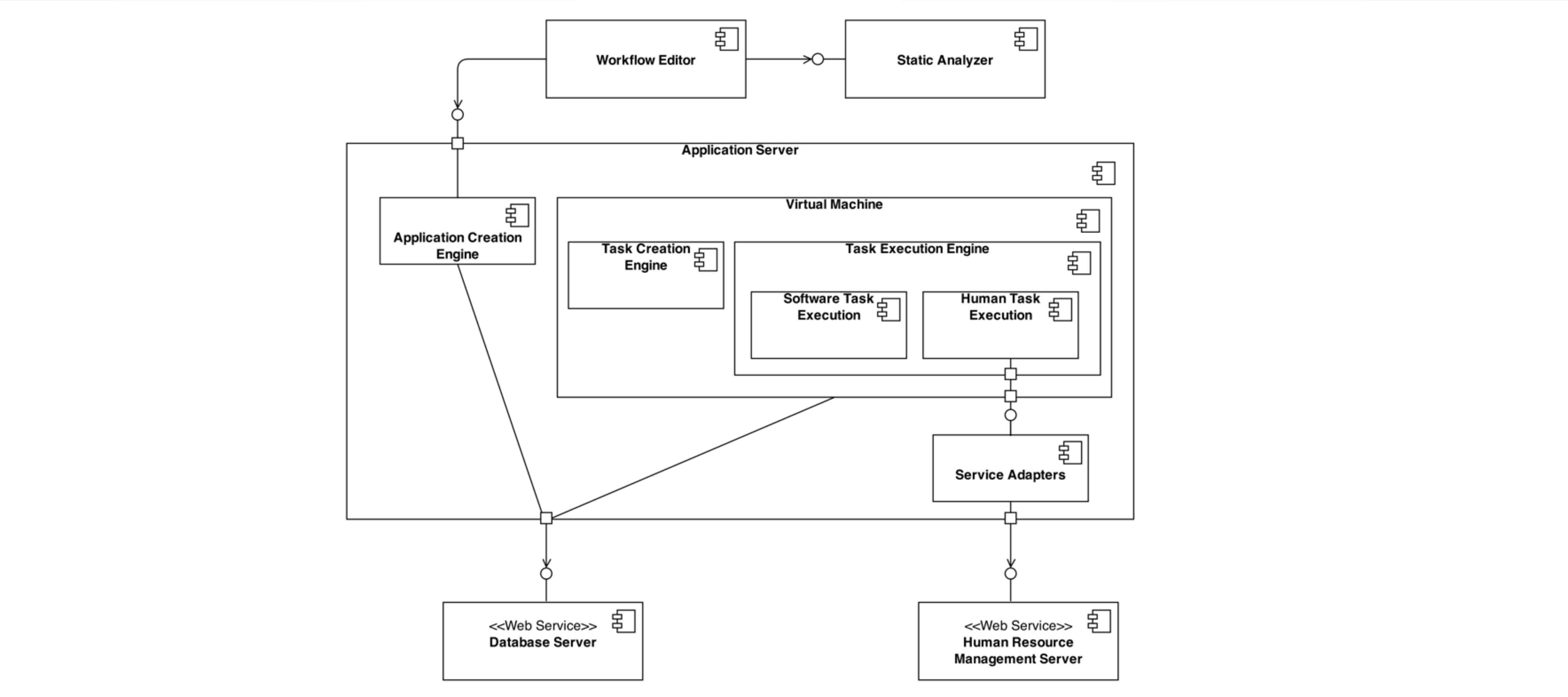
Architecture

- Crowdy
  - Operator-centric
  - Complex problems into crowdsourcing applications
  - Both human and software resources
- Features
  - Standard toolkit of operators
  - Configuration support for resource utilization
  - Customizable collaborations
  - Application runtime interface

Architecture

Platform

- REST architecture [7]
  - Application development on the client-side
  - Execution on the server-side



Architecture

Architecture

- Client-side
    - Workflow editor
        - List of available operators
        - Flow composition panel
    - Static analyzer
        - Validity check of the application

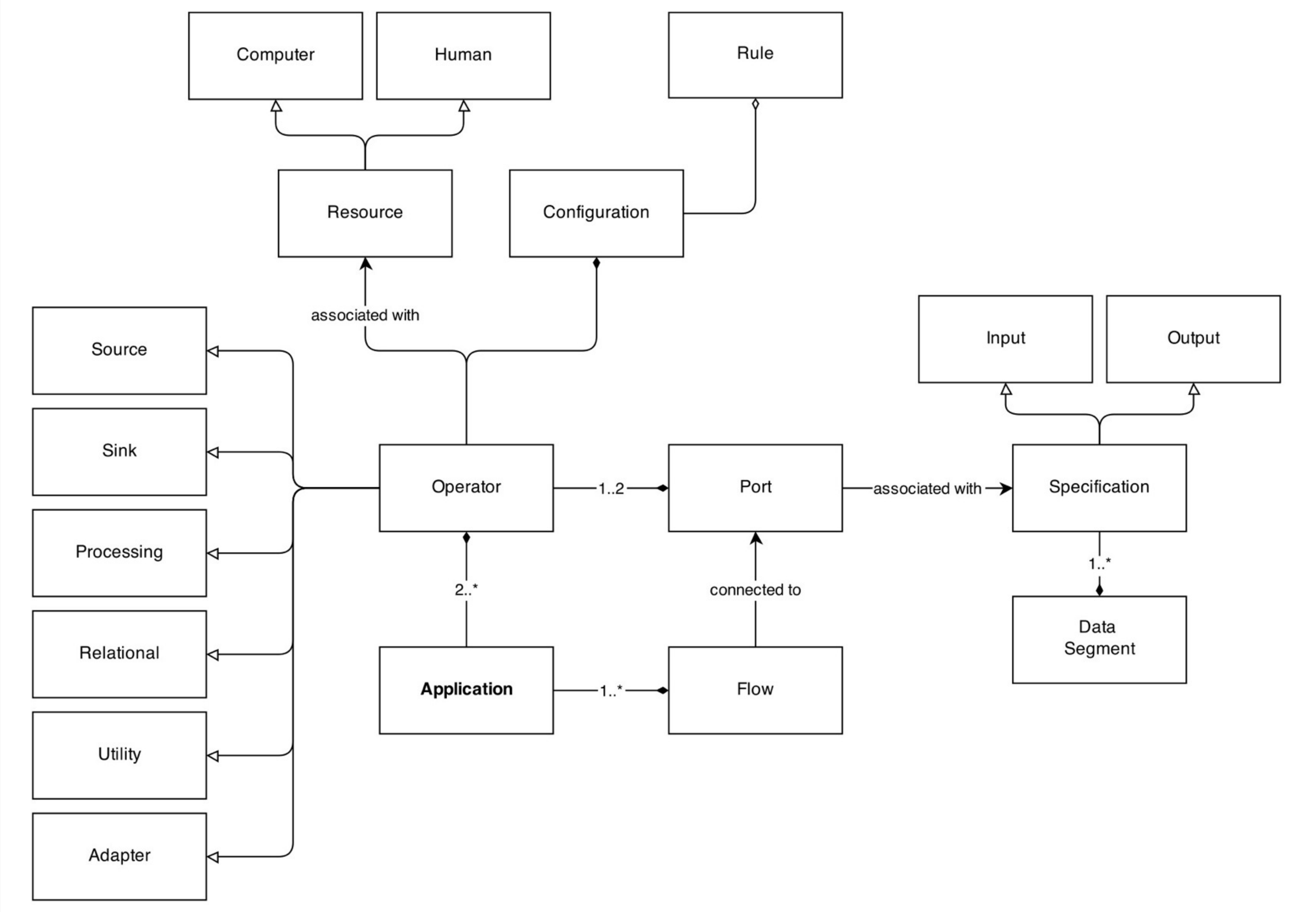
Architecture

Platform

- Server-side
  - API
    - Interaction with client-side
  - Virtual Machine
    - Execution of applications (resource allocation, keeping state)
  - Service Adapters
    - Execution of human computation
  - Database

Platform

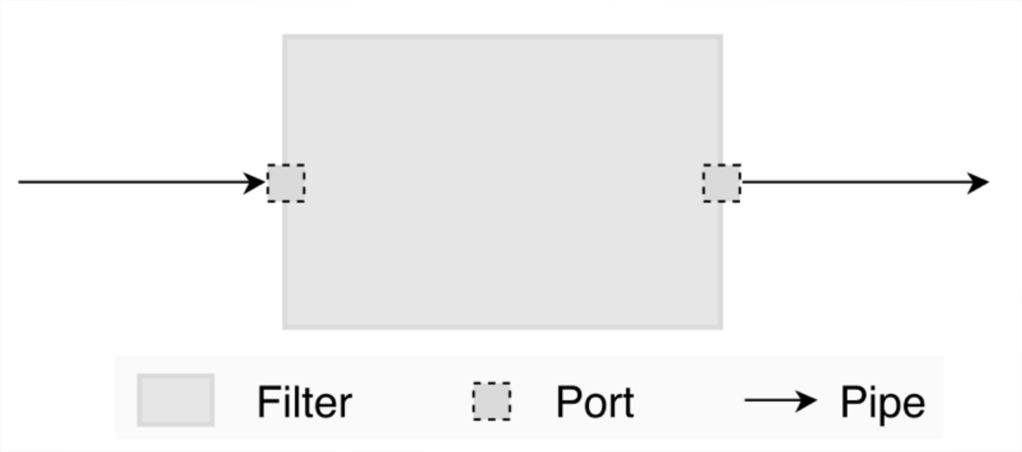
Concepts

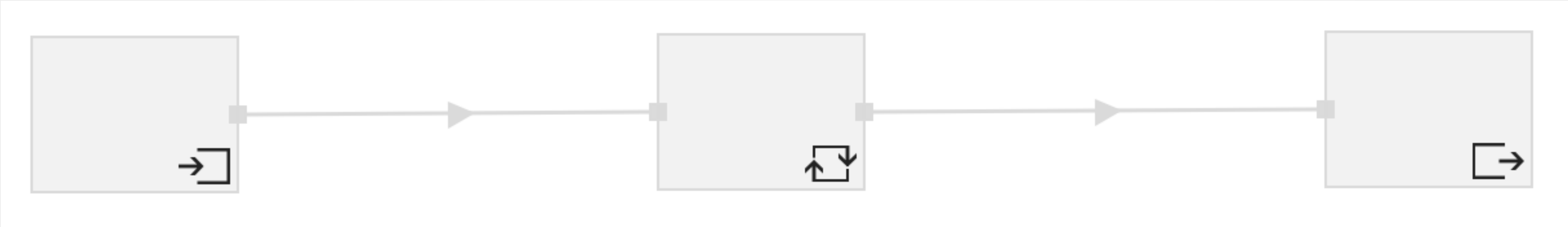


Platform

Concepts

- Typical application
  - Data ingest, processing and egress
- Pipe-and-Filter style [8]

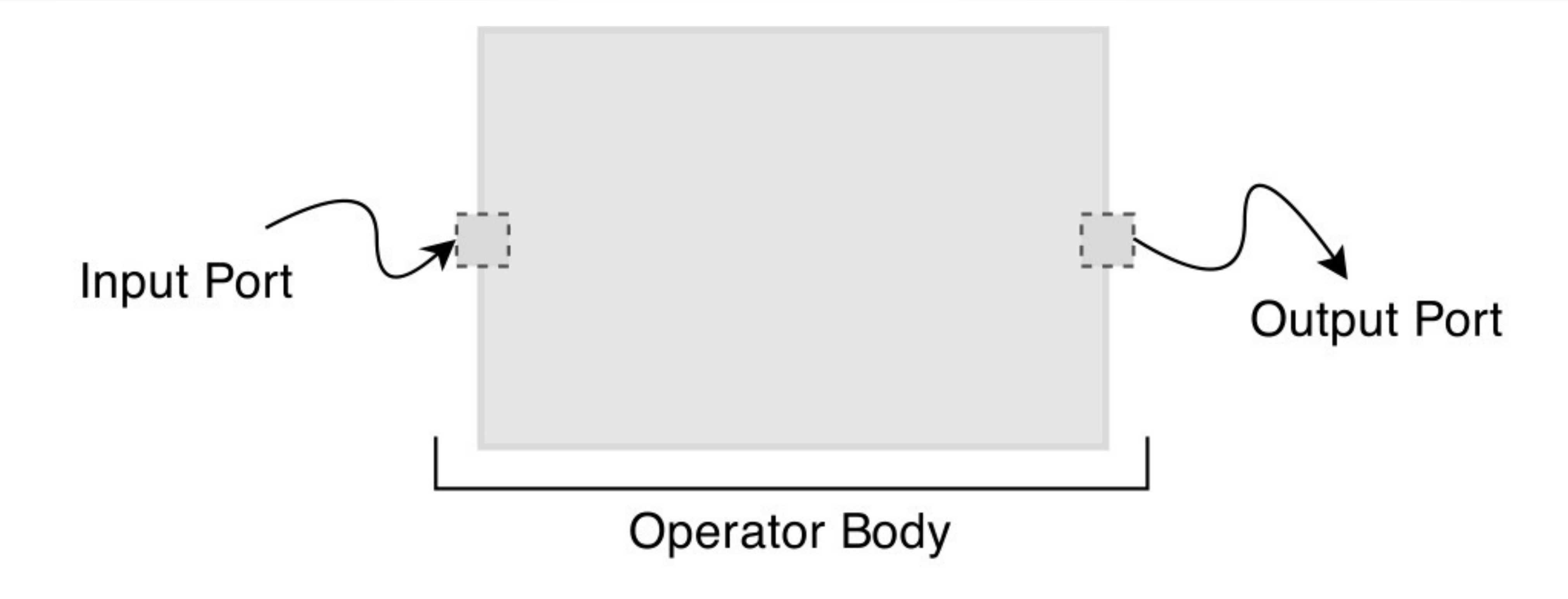




Platform

Concepts

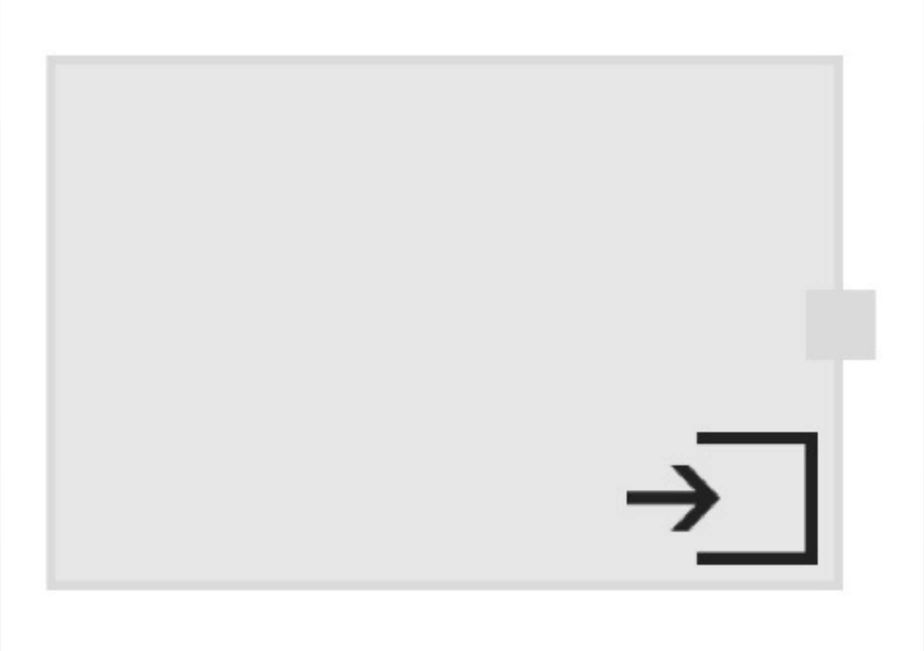
- Operator
  - Building block of an application
  - Type associated with it
  - Configuration based on it's type



Platform

Concepts

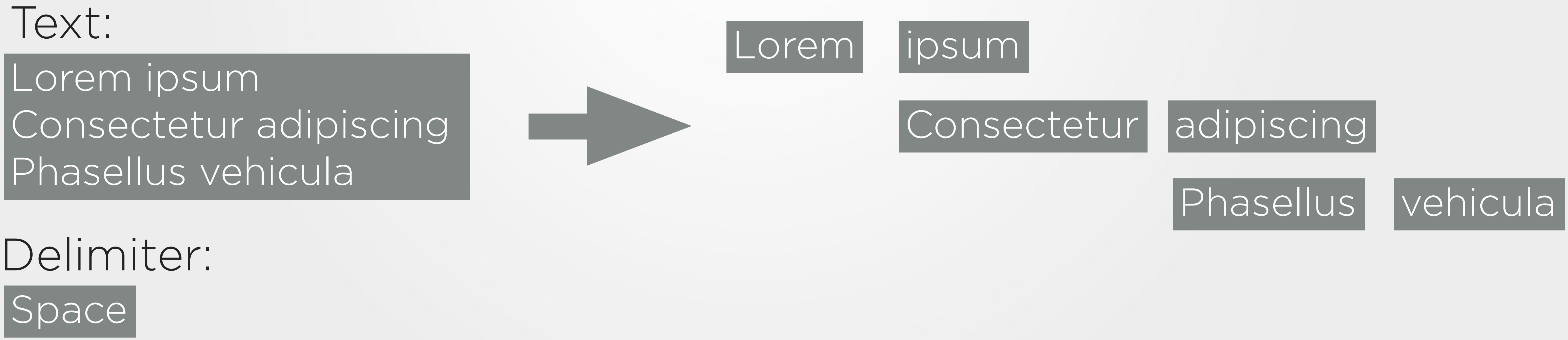
- Source operators
  - Generate data tuples
  - No input port, but output port
  - Output specification
  - Available: Human, Manual



Platform

Concepts

- Manual source operator
  - New tuples from manually entered text
  - Text is parsed based on configuration
  - Example scenario



Text:

Lorem ipsum
Consectetur adipiscing
Phasellus vehicula

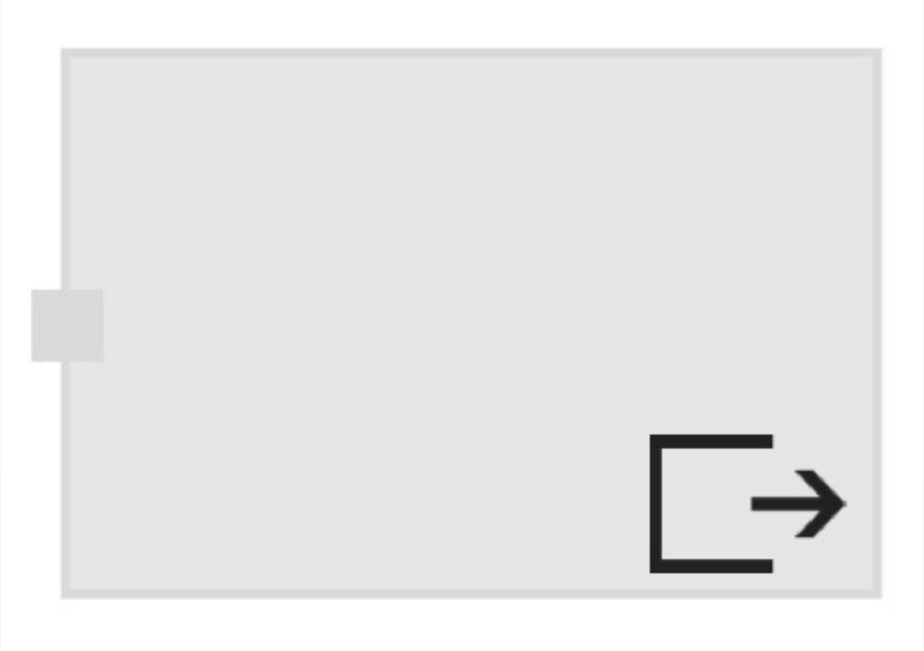
Delimiter:

Space

Platform

Concepts

- Sink operators
  - Serialization of data tuples
  - Input port, but no output port
  - Available: Email, File



Platform

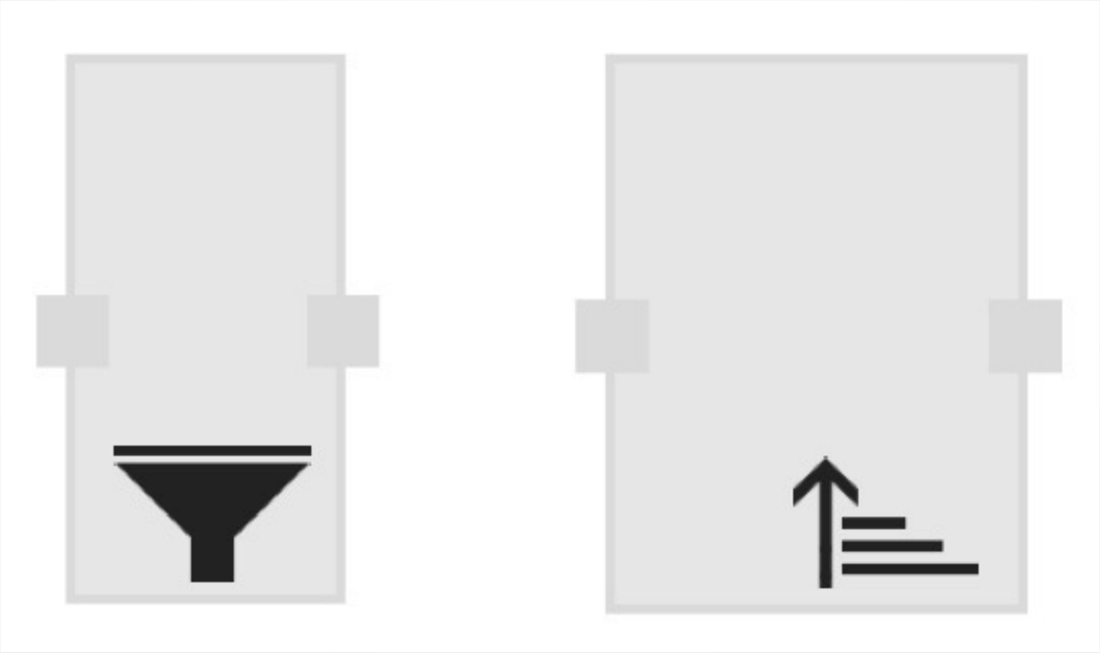
Concepts

- Processing operators
  - Processing of data tuples
  - Both input and output ports
  - Given the list of available segments
    - Humans asked to work on tasks

Platform

Concepts

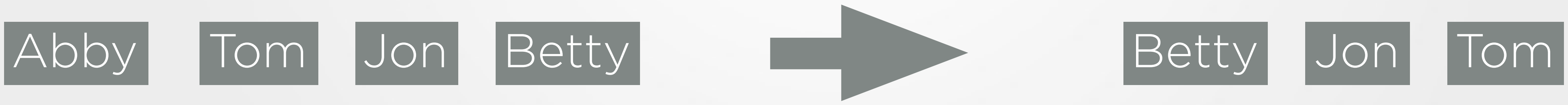
- Relational operators
  - Manipulation of the flow
  - Both input and output ports
  - Available: Selection, Sort



Platform

Concepts

- Sort operator
  - Stateful and windowed operator
  - Tuples are sorted based on given rule-set
  - Example scenario



Abby Tom Jon Betty

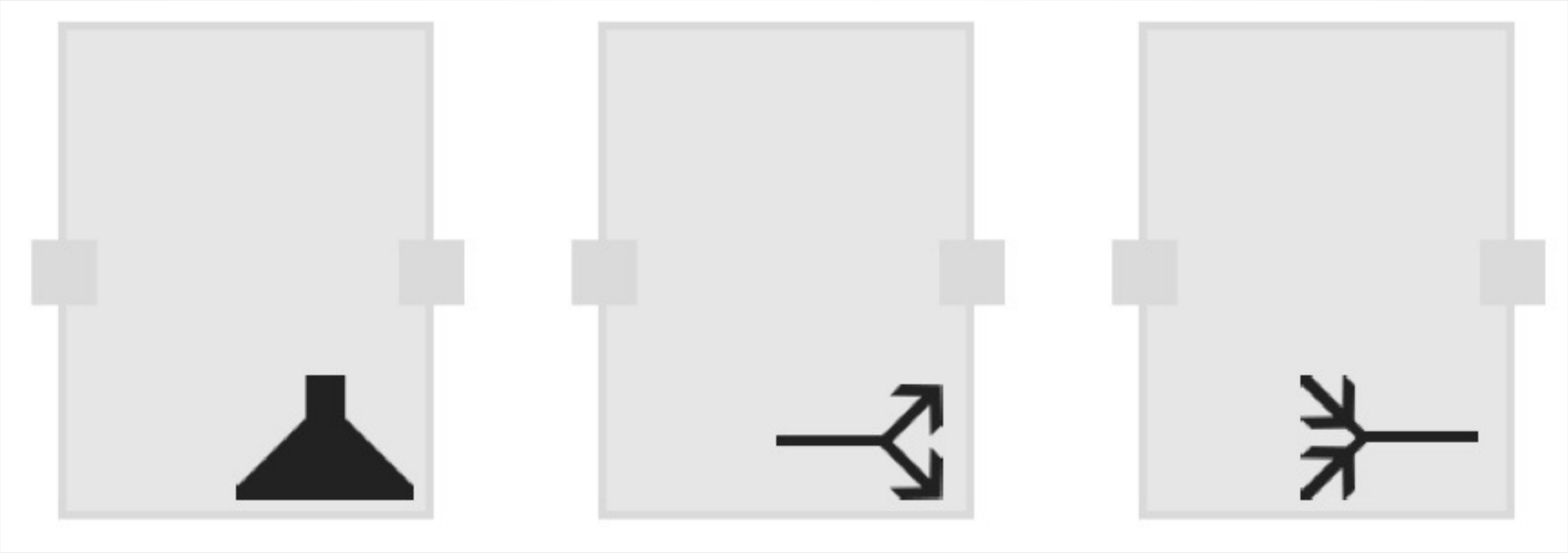
Betty Jon Tom

Window:
3

Platform

Concepts

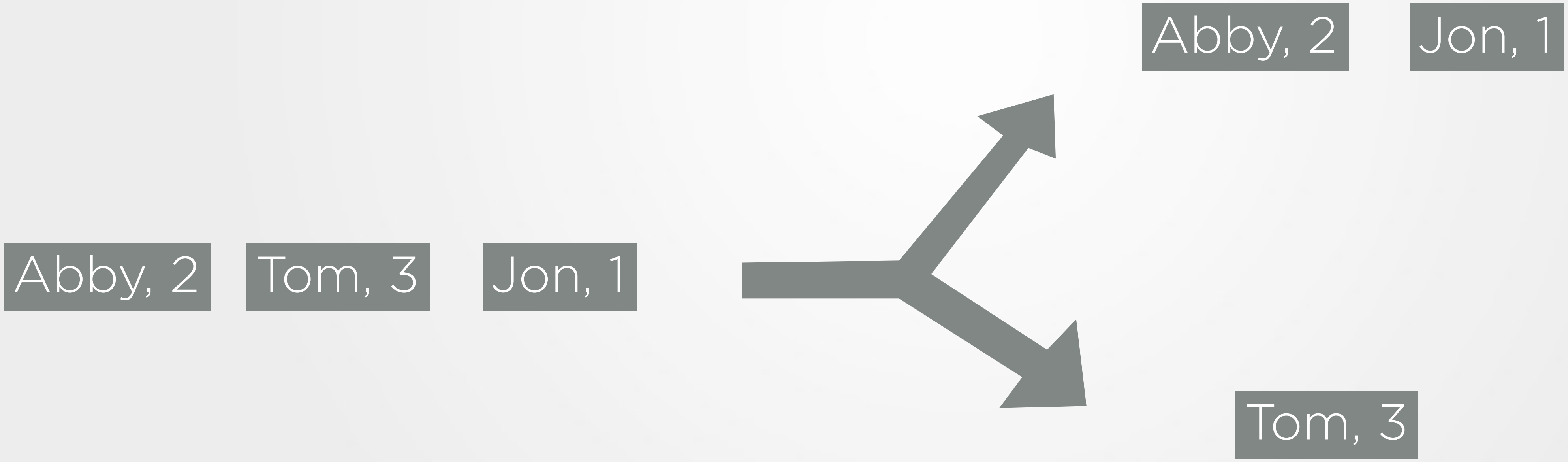
- Utility operators
  - Flow management functions
  - Both input and output ports
  - Available: Enrich, Split, Union



Platform

Concepts

- Split operator
  - Divide an inbound flow into multiple flows
  - Boolean predicates evaluation on incoming data tuples



Platform

Concepts

- Flow
  - Connection between operators
  - Move data tuples (information) from one to another
  - Similar to hash table
    - Segment identifiers and their values

```
{
        “key-1”: “value-1”,
        “key-2”: “value-2”,
        .
        .

        “key-n”: “value-n”

}
```

Tool

- Web based tool for requesters
  - Javascript for client-side
  - Python for server-side
- Demo

Discussion

- Limitations
  - Decomposition of problem
  - Iteration support
  - Human collaboration on the same task
  - Quality control

Conclusion

- An extensible and general-purpose framework
  - Easier and efficient management of collaboration
  - Handling complex and sophisticated problems
  - Solving problems in different ways

Conclusion

Future Work

- Extending the operator set
  - RSS readers, API
- Improving existing operators
  - Media capabilities for human operator, integration of more services
- More quality control
  - Collecting various statistics (key strokes, mouse movements)

References

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Thanks

Questions?
Comments?