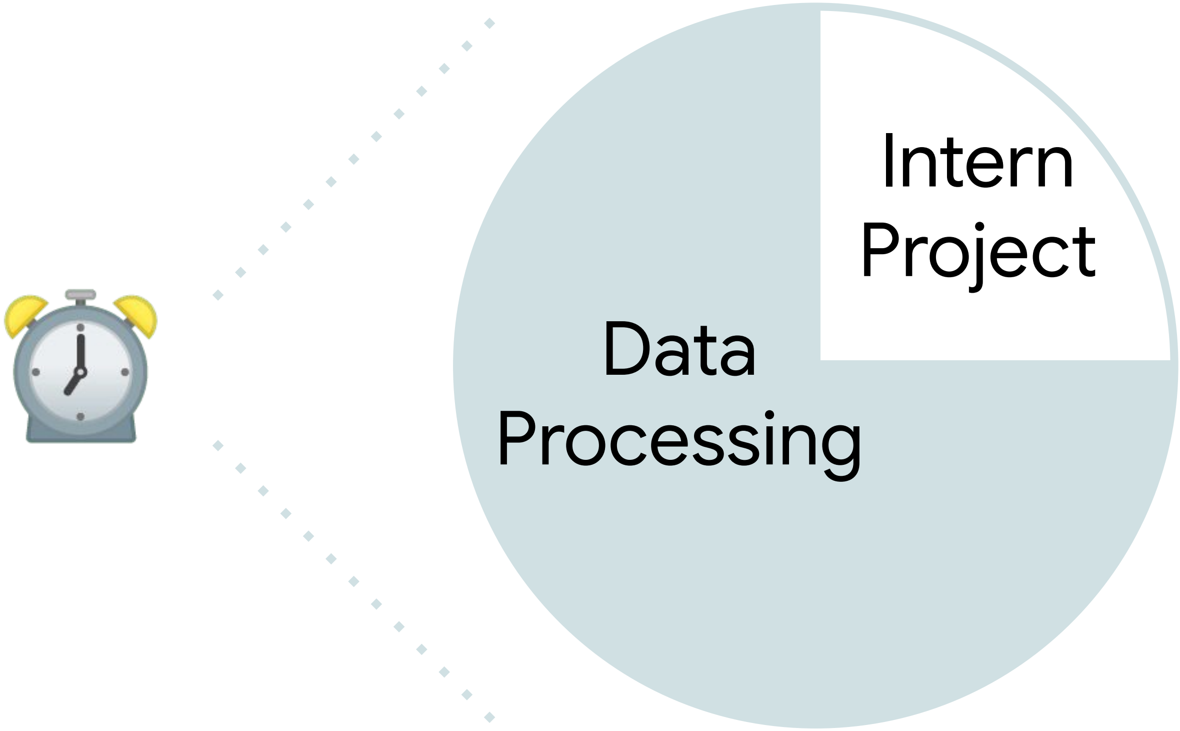
How to Design a Successful (Intern) Project with Apache Beam?

Kir Chou
PyCon TW 2023



Intern Project

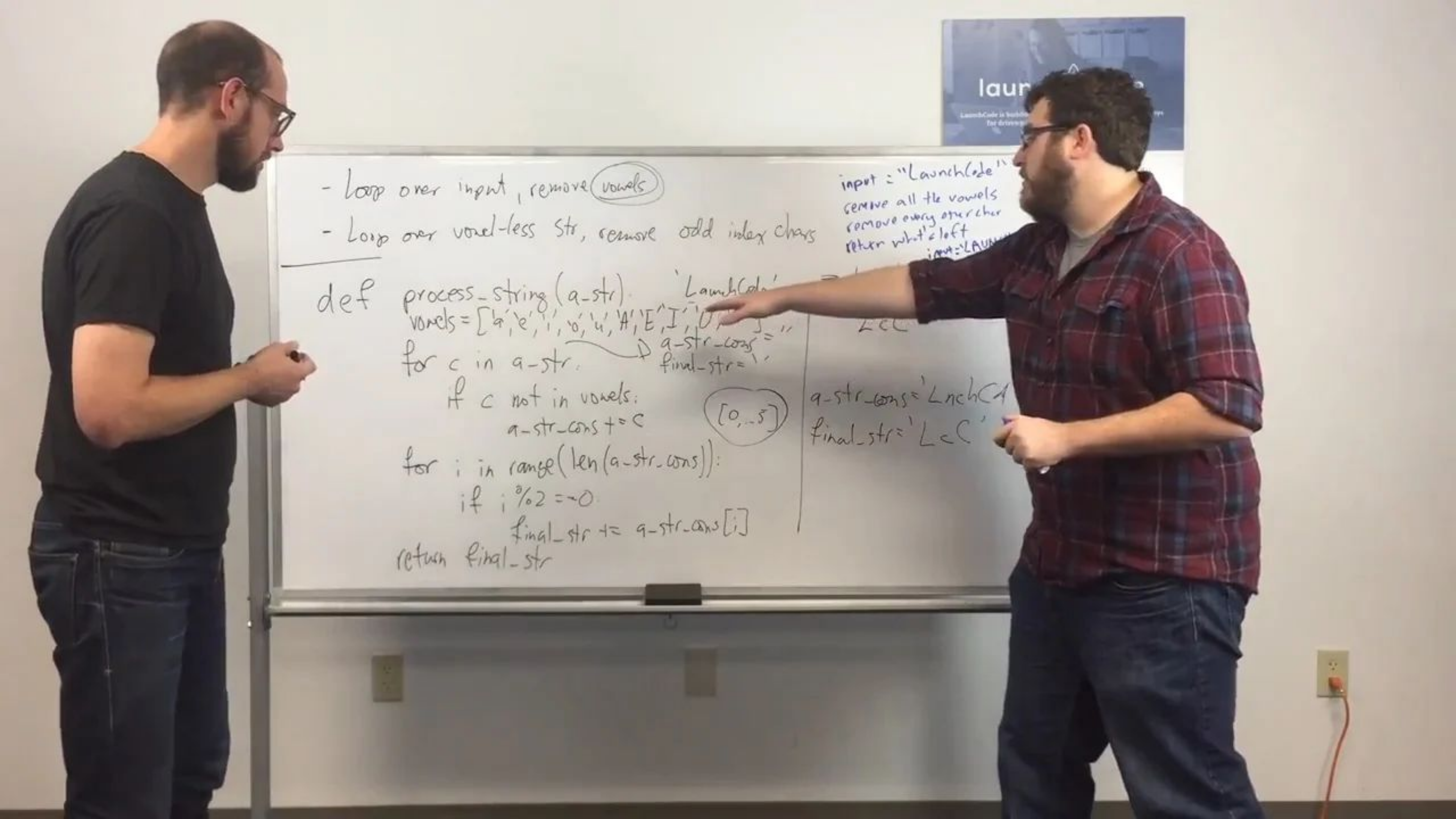
Data Processing

About me:
https://note35.github.io/about

Slide

Code @ Colab

Anyone knows Apache Beam?



- Loop over input, remove vowels
- Loop over vowel-less str, remove odd index chars

```
def process_string(a_str)                      'LaunchCod
    vowels = ['a','e','i','o','u','A','E','I','O',  ]
                                                a_str_cons = ''
    for c in a_str:                             final_str = ''
        if c not in vowels:
            a_str_cons += c                     [0,..5]
    for i in range(len(a_str_cons)):
        if i %2 ==0
            final_str += a_str_cons[i]
    return final_str
```

input = "LaunchCode"
remove all the vowels
remove every other char
return what's left
input='LAUN

LcC

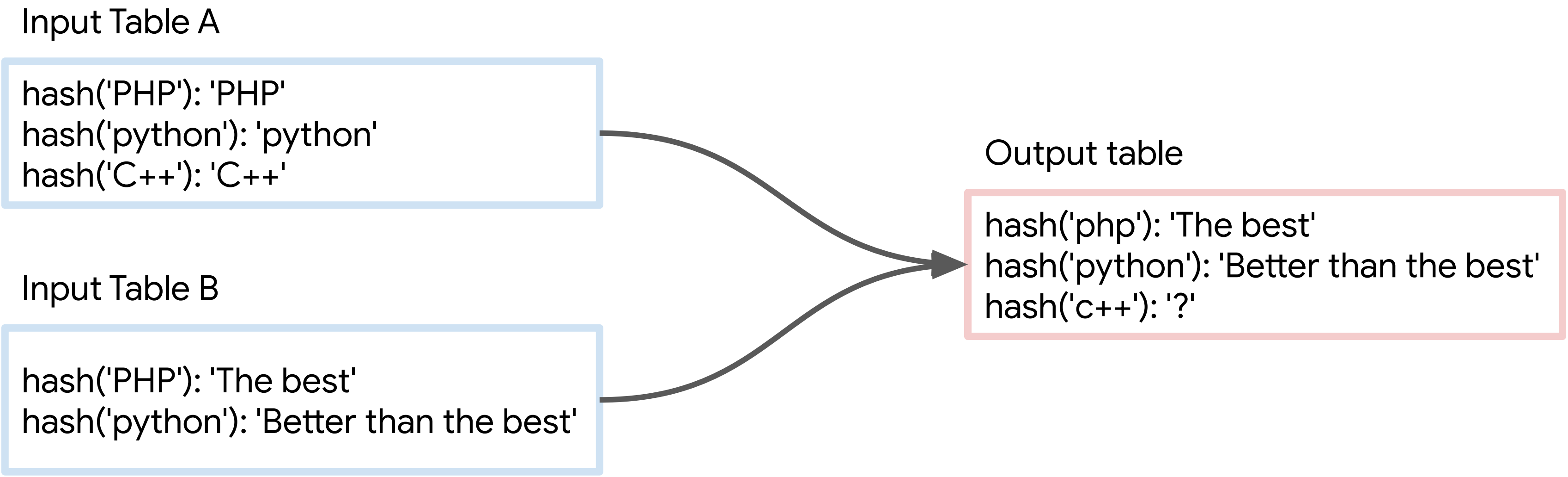
a_str_cons='LnchCd
final_str='LcC'

⏰ 20s

Given two tables:
- Table A: **hash key (string)** to **case sensitive index (string)**
- Table B: **hash key (string)** to data in whatever type

Both tables **hash key** are based on the **case sensitive index**

Generate a new table that maps **new hash key** based on **case insensitive index** to data in Table B.



Input Table A

hash('PHP'): 'PHP'
hash('python'): 'python'
hash('C++'): 'C++'

Input Table B

hash('PHP'): 'The best'
hash('python'): 'Better than the best'

Output table

hash('php'): 'The best'
hash('python'): 'Better than the best'
hash('c++'): '?'

```
def generate_case_insensitive_index_to_content(
 hash_to_case_sensitive_index: dict[int, str],
 hash_to_content: dict[int, str]
) -> dict[int, str]:
 case_insensitive_index_to_content: dict[int, str] = {}

 for existing_hash, index in hash_to_case_sensitive_index.items():
  case_insensitive_index: str = index.lower()
  new_hash: int = magic_hash(case_insensitive_index)

  if existing_hash in hash_to_content:
   case_insensitive_index_to_content[new_hash] =\
    hash_to_content[existing_hash]
  else: case_insensitive_index_to_content[new_hash] =\
    NEW_CONTENT_PREFIX.format(case_insensitive_index)

 return case_insensitive_index_to_content
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∅

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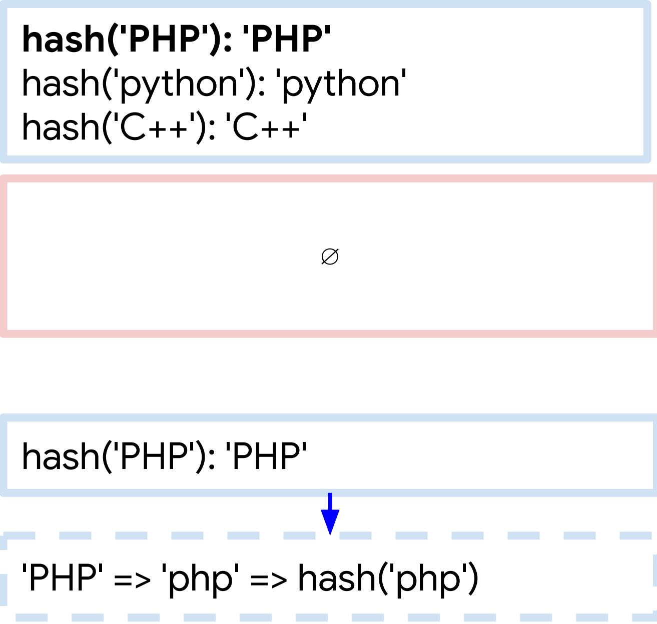

hash('PHP'): 'PHP'
hash('python'): 'python'
hash('C++'): 'C++'

∅

hash('PHP'): 'PHP'

'PHP' => 'php' => hash('php')

```
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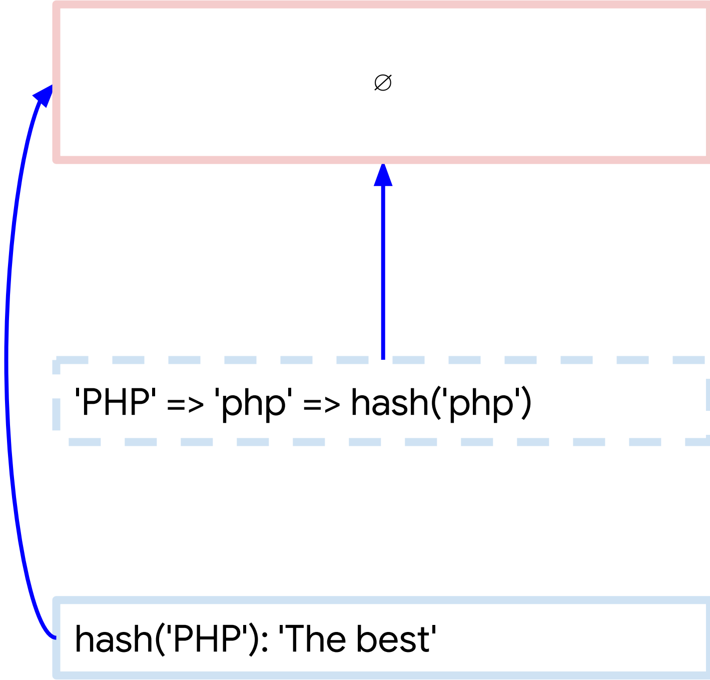

∅

'PHP' => 'php' => hash('php')

hash('PHP'): 'The best'

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hash('python'): 'python'
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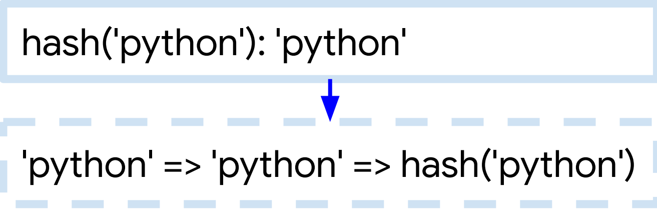

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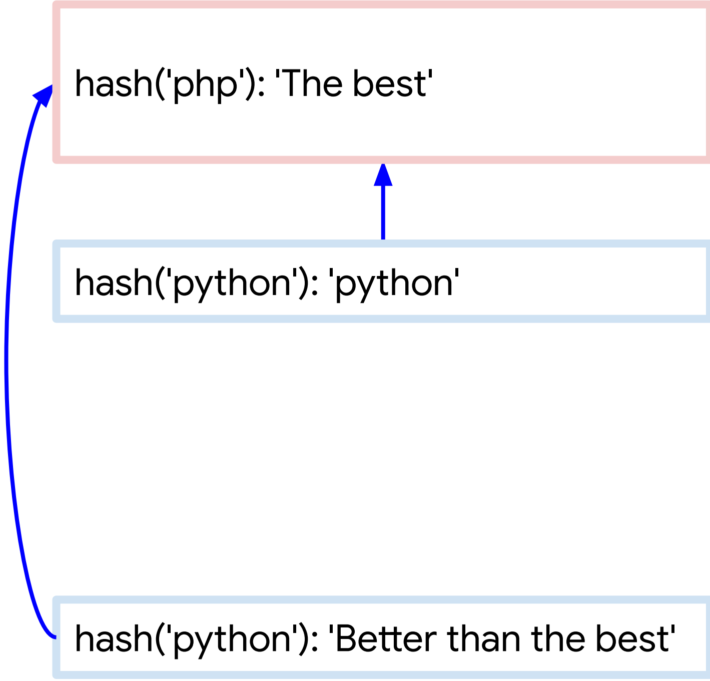

hash('php'): 'The best'

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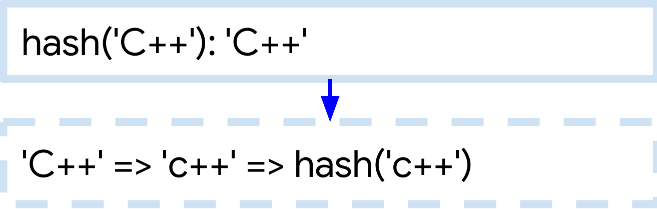

hash('C++'): 'C++'

'C++' => 'c++' => hash('c++')

```
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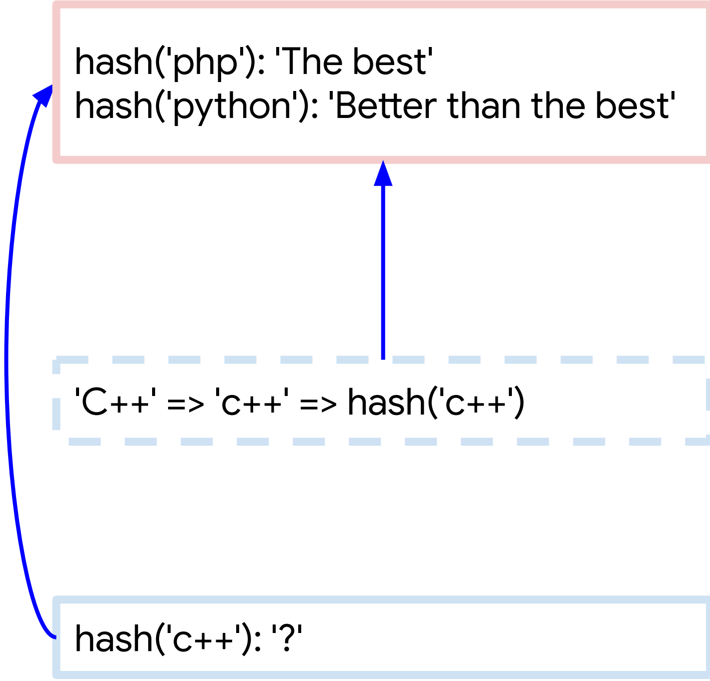
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'C++' => 'c++' => hash('c++')
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hash('php'): 'The best'
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Path to modern data processing

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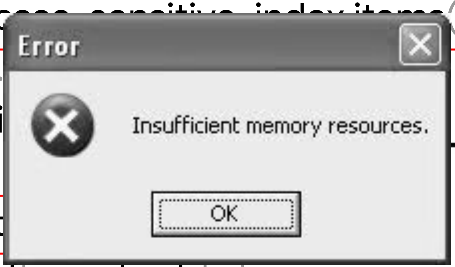
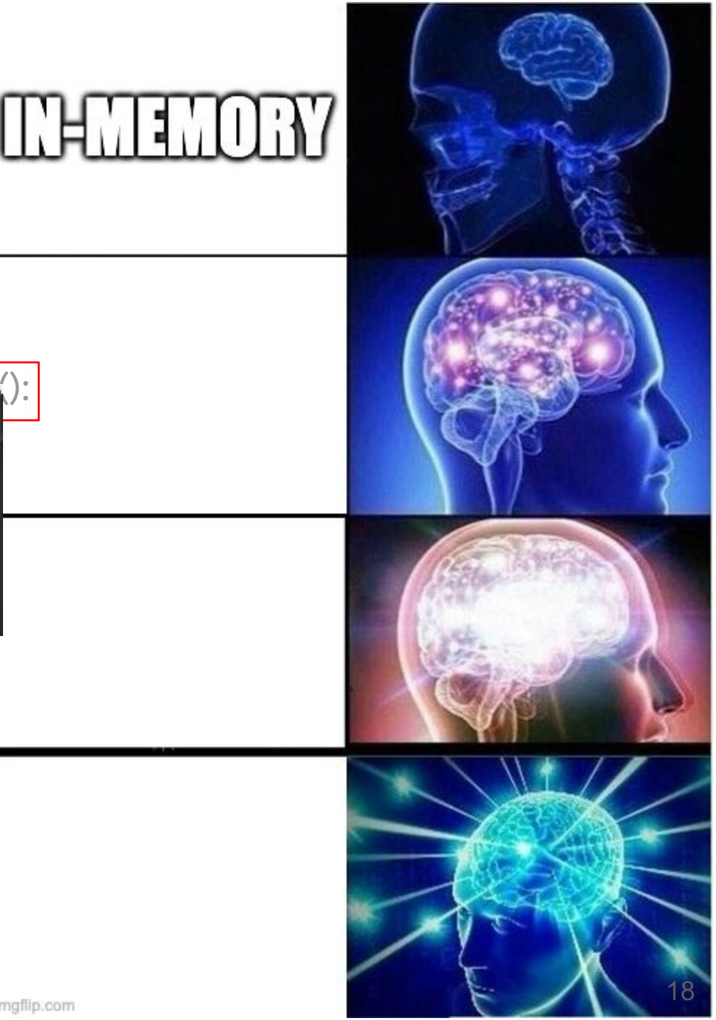
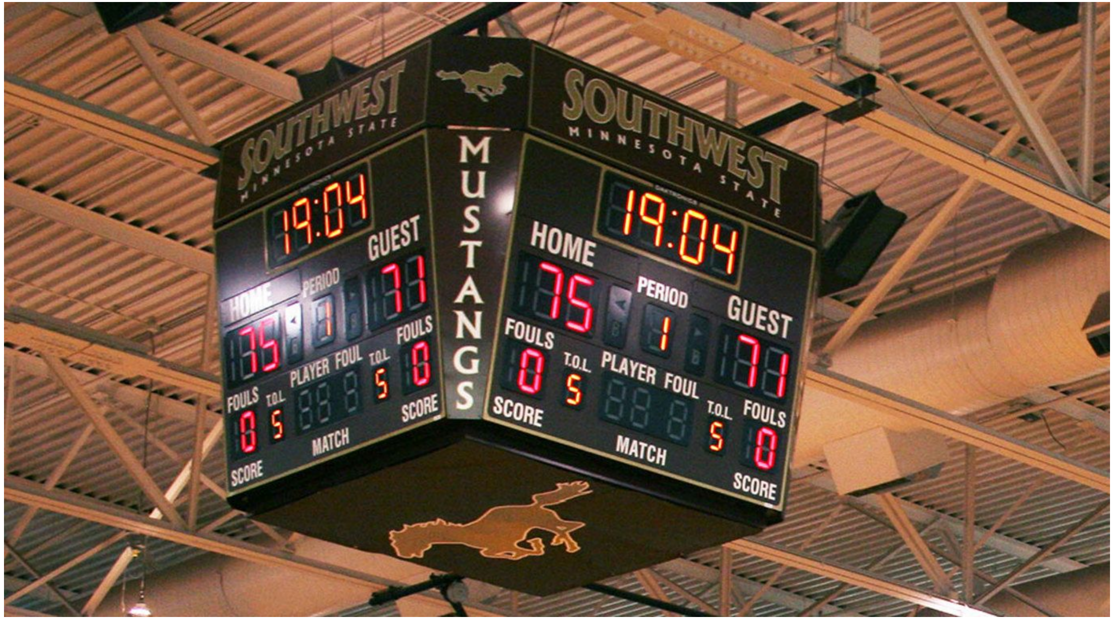


Insufficient memory resources.





hash('php'): 'The best'
hash('python'): 'Better than the best'
hash('c++'): '?'

hash('C++'): 'Stop others from learning it'

1970/01/01 11:11:11

hash('php'): 'The best'
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hash('c++'): 'Stop others from learning it'

1970/01/01 11:11:11

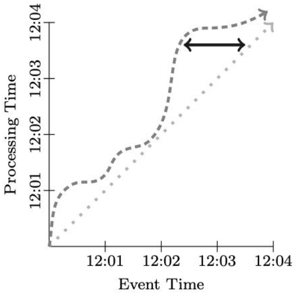
hash('C++'): 'The legend'

1970/01/01 11:11:12 ○

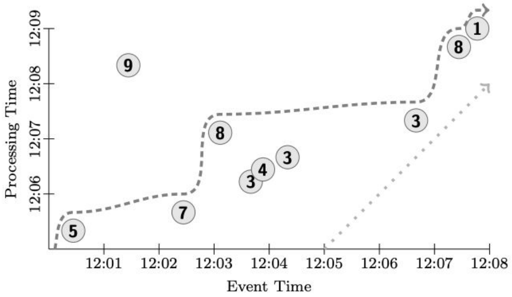
1970/01/01 11:11:10 ❌

Recap: modern data processing

- **Massive-Scale**: data is too big to handle by one instance
- **Unbounded**: data keeps coming, and requires to handle them when receiving
  - eg: peak keywords detection of the search engine
- **Out-of-Order**: the event time and the process time may be different
  - eg: game score update for users who play it without the internet access tentatively

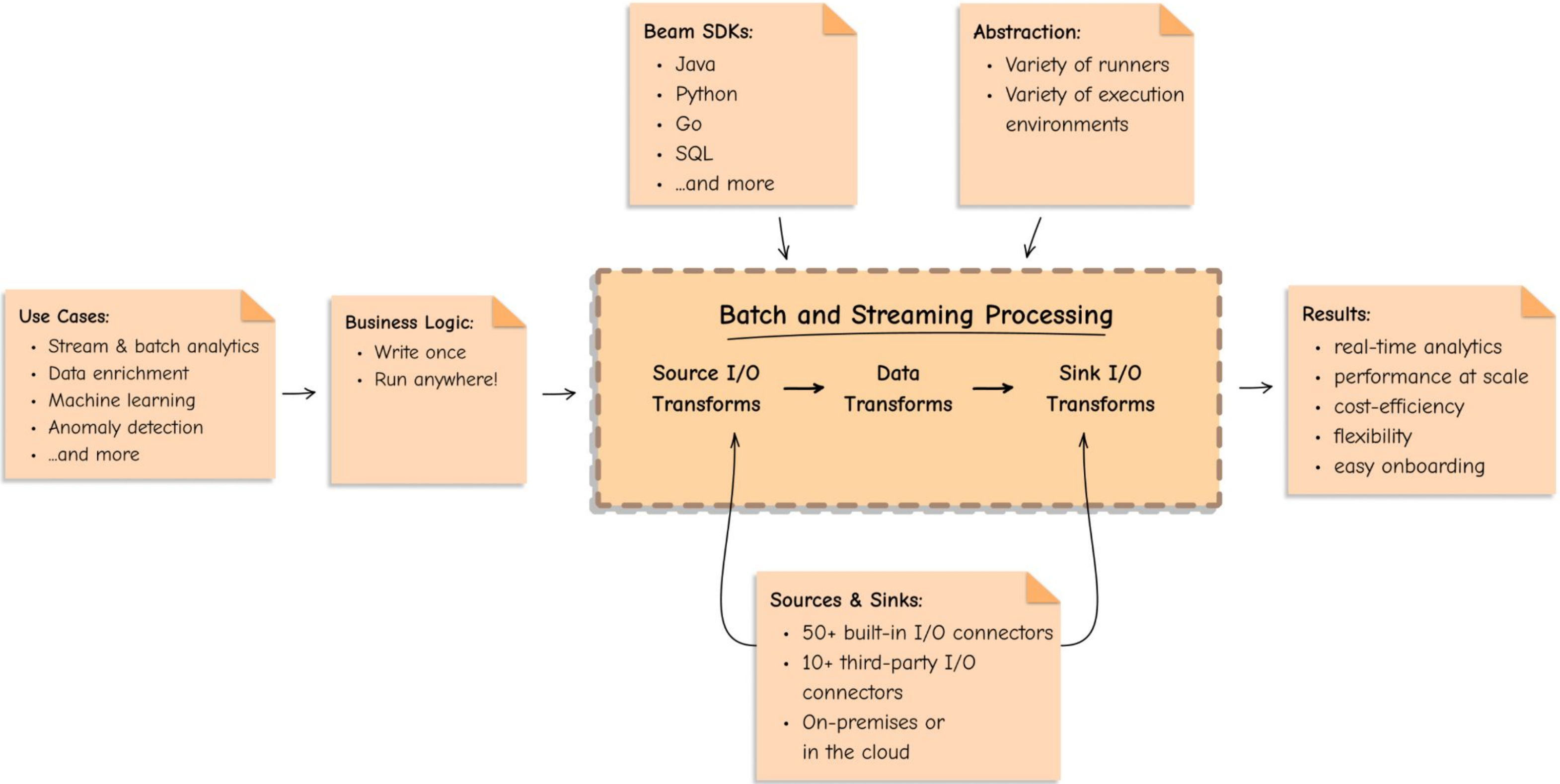


The processing time happens after the event time.



The tasks are unbounded and out-of-order.

beam



Use Cases:

- Stream & batch analytics
- Data enrichment
- Machine learning
- Anomaly detection
- ...and more

Business Logic:

- Write once
- Run anywhere!

Beam SDKs:

- Java
- Python
- Go
- SQL
- ...and more

Abstraction:

- Variety of runners
- Variety of execution environments

Batch and Streaming Processing

Source I/O Transforms → Data Transforms → Sink I/O Transforms

Sources & Sinks:

- 50+ built-in I/O connectors
- 10+ third-party I/O connectors
- On-premises or in the cloud

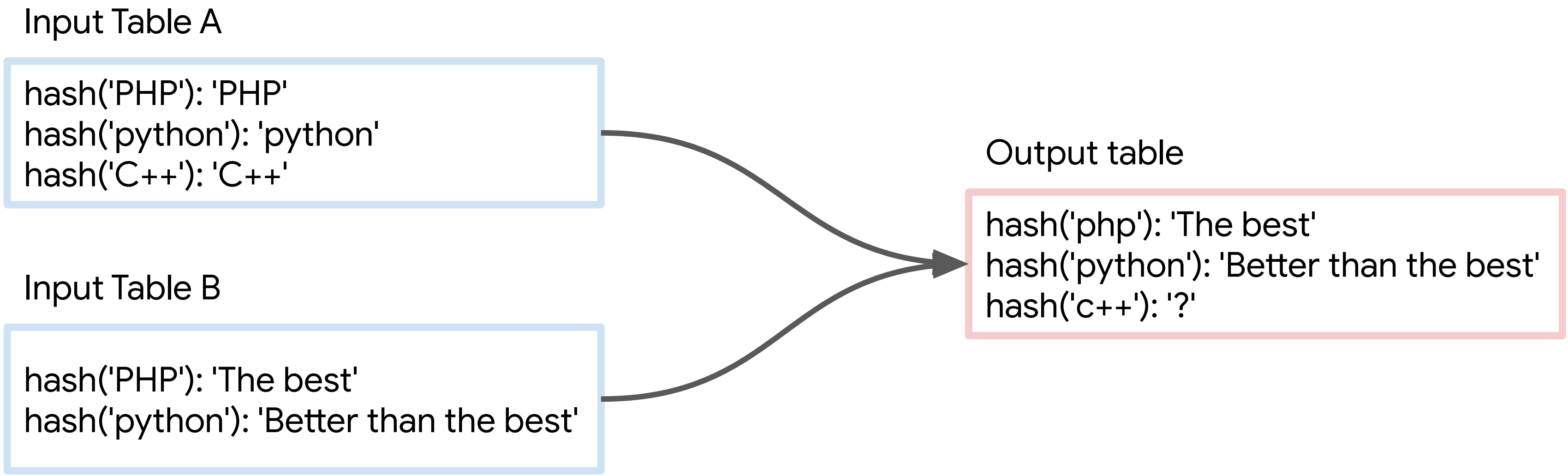
Results:

- real-time analytics
- performance at scale
- cost-efficiency
- flexibility
- easy onboarding

Given two tables:
- Table A: **hash key (string)** to **case sensitive index (string)**
- Table B: **hash key (string)** to data in whatever type

Both tables **hash key** are based on the **case sensitive index**

Generate a new table that maps **new hash key** based on **case insensitive index** to data in Table B.



Input Table A

hash('PHP'): 'PHP'
hash('python'): 'python'
hash('C++'): 'C++'

Input Table B

hash('PHP'): 'The best'
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Output table

hash('php'): 'The best'
hash('python'): 'Better than the best'
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def main():
  p = beam.Pipeline() # Run locally with the direct runner.

  new_hash_collection: list[tuple[int, int]] = LANGUAGE_INDEX_COLLECTION
    | "Map existing hash to new hash" >> beam.Map(
      lambda i: (i[0], magic_hash(i[1].lower())))

  new_language_content = (
    ({
      "index": LANGUAGE_INDEX_COLLECTION,
      "content": LANGUAGE_CONTENT_COLLECTION,
      "new_hash": new_hash_collection,
    })
    | "CoGroupByKey" >> beam.CoGroupByKey()
    | "Maybe rehash" >> beam.ParDo(
      lambda hash_to_all: maybe_rehash(hash_to_all))
  )
  p.run()
```

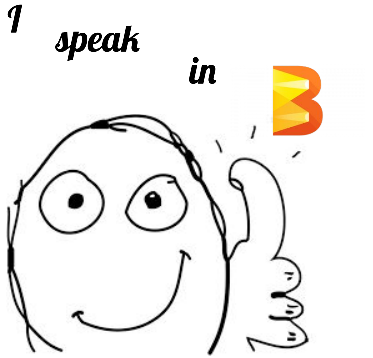

Step 1

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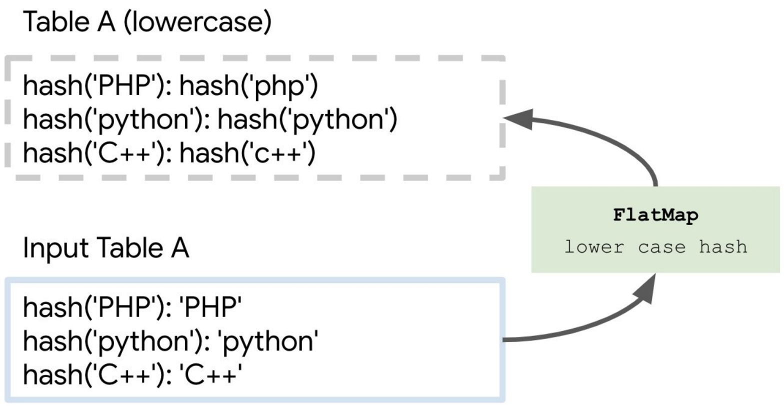

Table A (lowercase)

hash('PHP'): hash('php')
hash('python'): hash('python')
hash('C++'): hash('c++')

FlatMap
lower case hash

Input Table A

hash('PHP'): 'PHP'
hash('python'): 'python'
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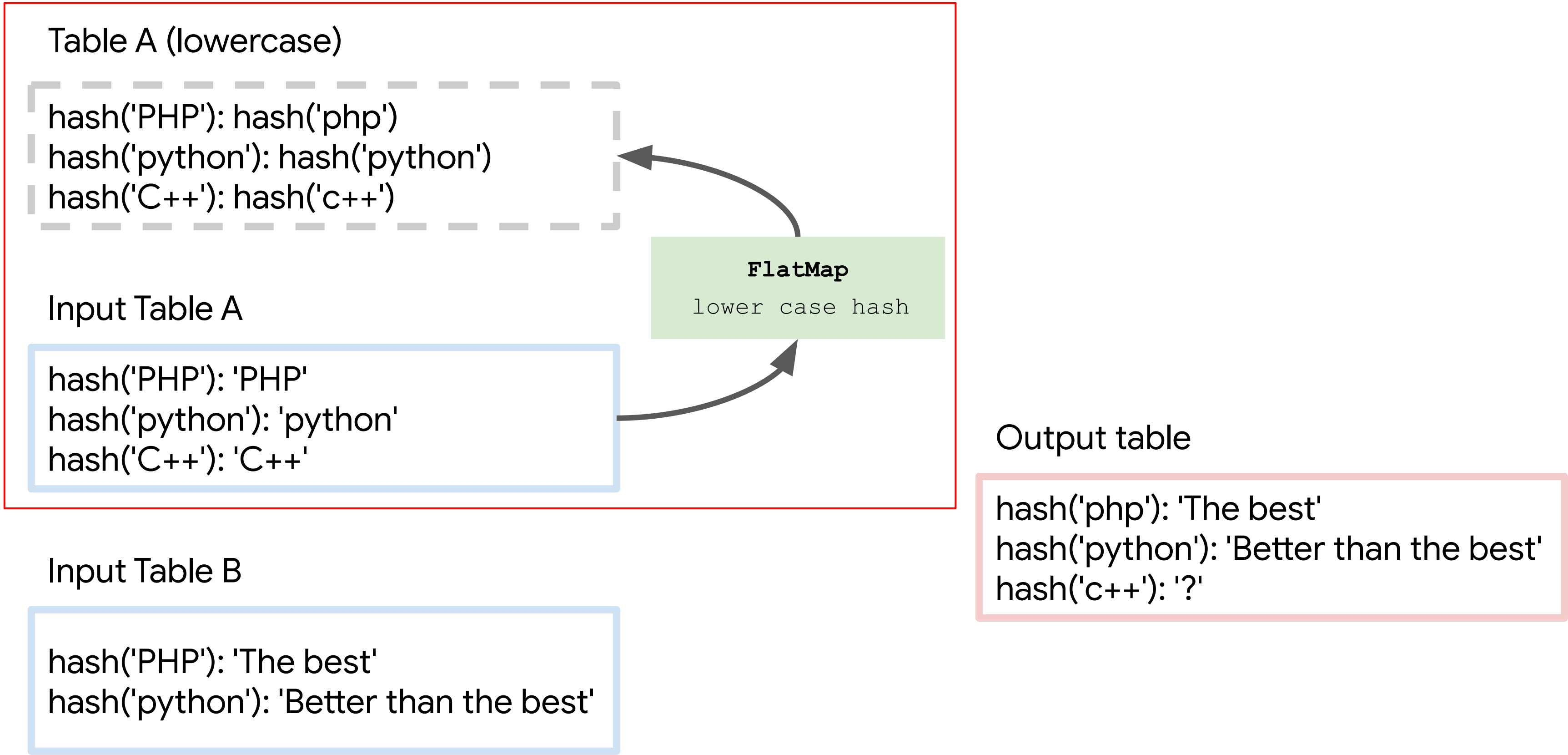

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FlatMap

`lower case hash`

Input Table A

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Input Table B

hash('PHP'): 'The best'
hash('python'): 'Better than the best'

Output table

hash('php'): 'The best'
hash('python'): 'Better than the best'
hash('c++'): '?'

Step 1 - detail

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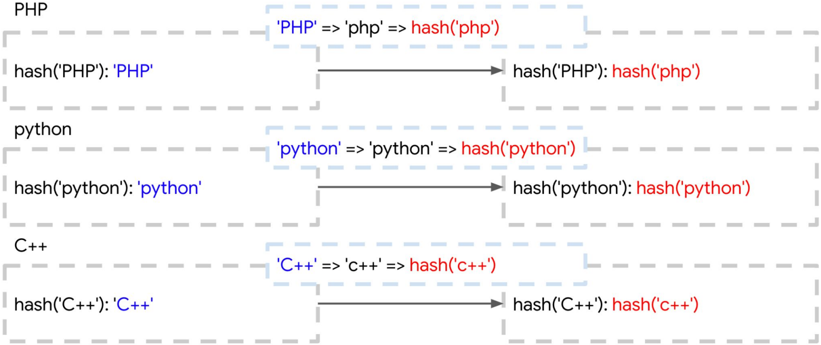


PHP

'PHP' => 'php' => hash('php')

hash('PHP'): 'PHP'

hash('PHP'): hash('php')

python

'python' => 'python' => hash('python')

hash('python'): 'python'

hash('python'): hash('python')

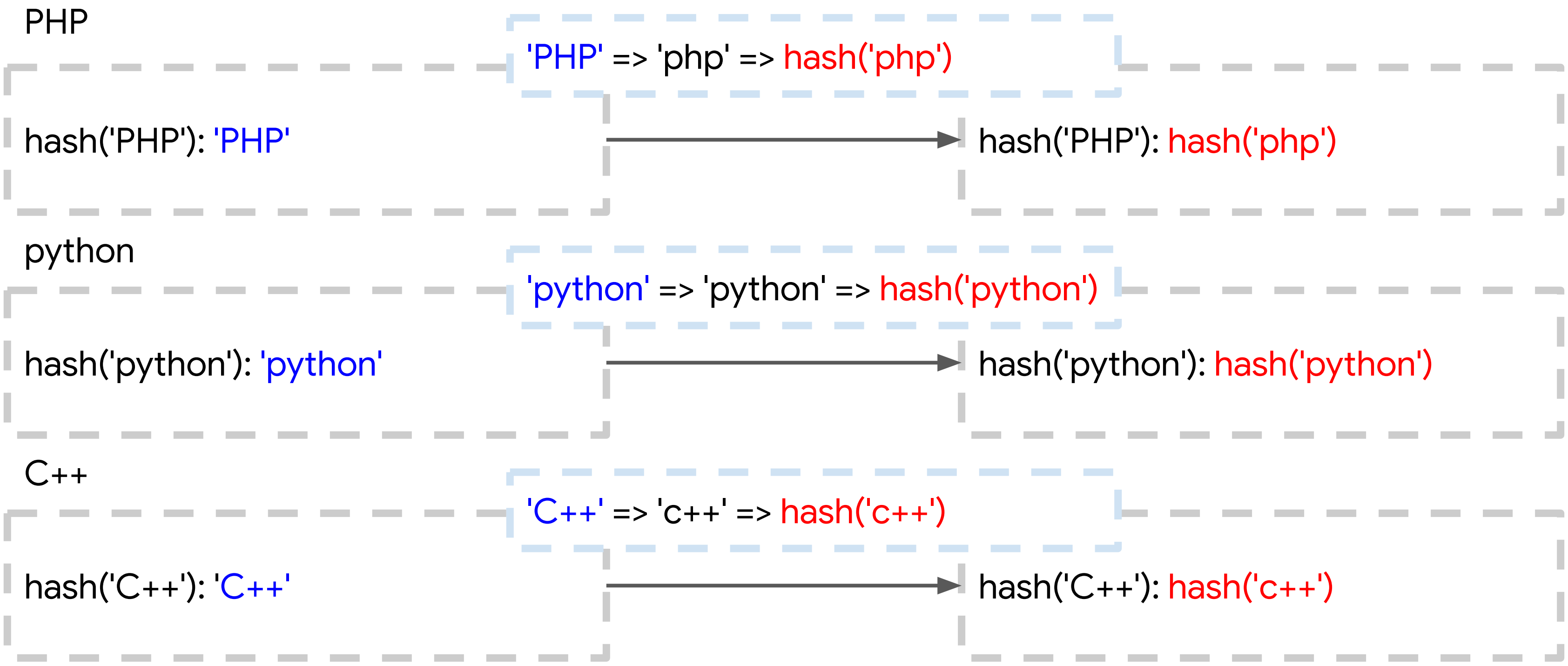
C++

'C++' => 'c++' => hash('c++')

hash('C++'): 'C++'

hash('C++'): hash('c++')

Data is processed **parallelly in different workers.*



PHP

'PHP' => 'php' => hash('php')

hash('PHP'): 'PHP'

hash('PHP'): hash('php')

python

'python' => 'python' => hash('python')

hash('python'): 'python'

hash('python'): hash('python')

C++

'C++' => 'c++' => hash('c++')

hash('C++'): 'C++'

hash('C++'): hash('c++')

Step 2

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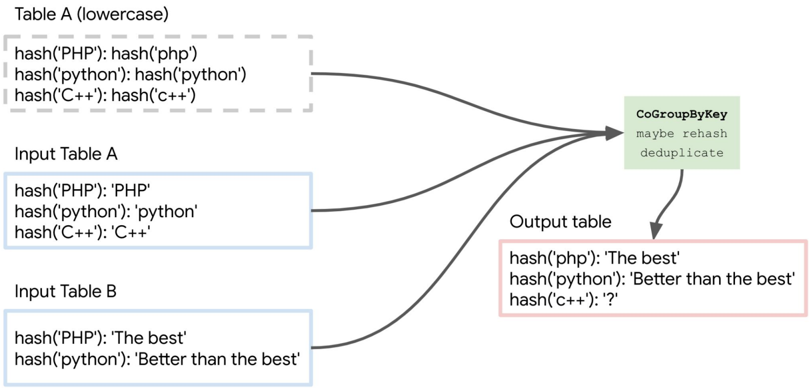

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hash('PHP'): 'The best'
hash('python'): 'Better than the best'

CoGroupByKey
maybe rehash
deduplicate

Output table

hash('php'): 'The best'
hash('python'): 'Better than the best'
hash('c++'): '?'

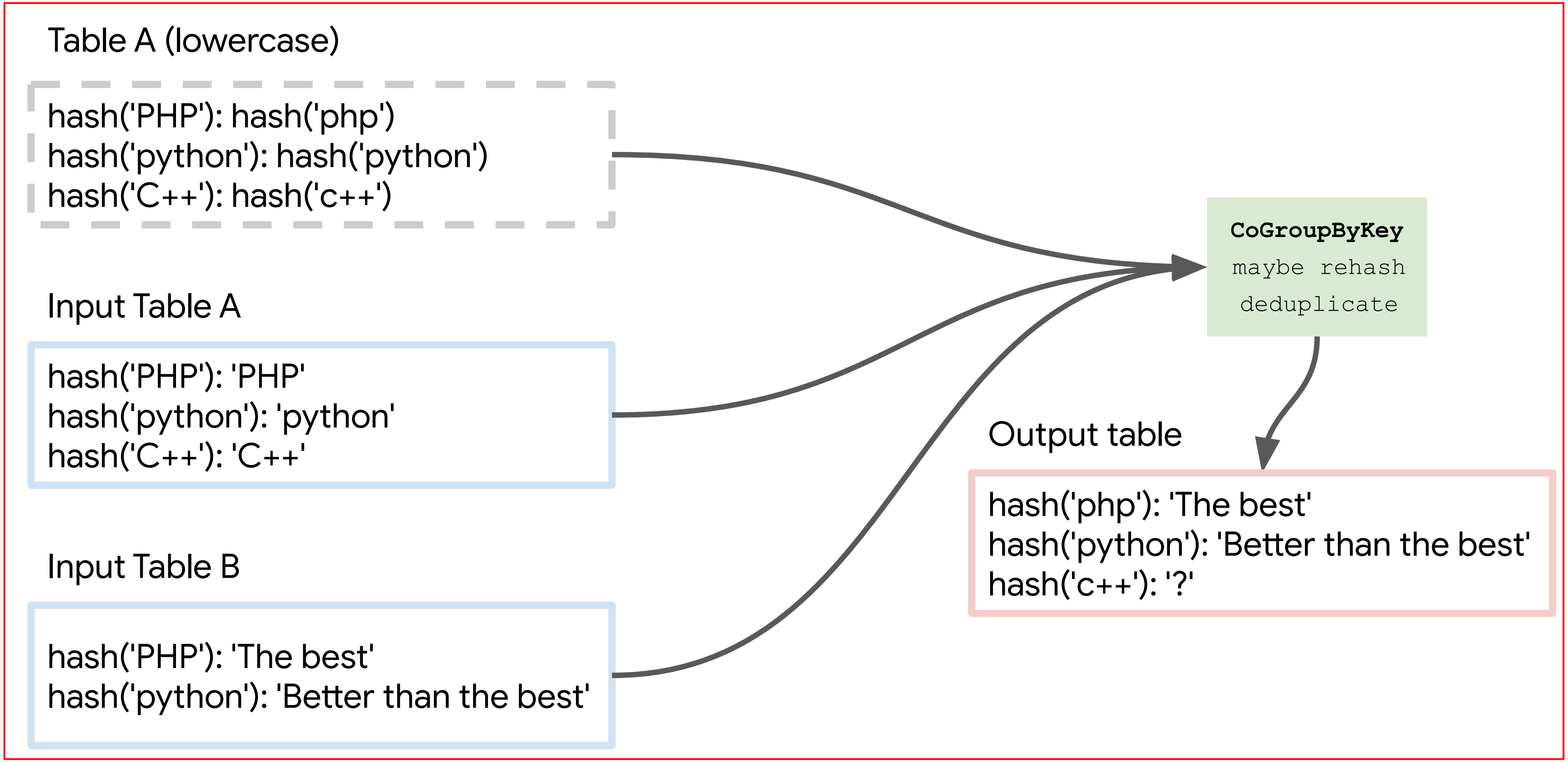

Table A (lowercase)

hash('PHP'): hash('php')
hash('python'): hash('python')
hash('C++'): hash('c++')

Input Table A

hash('PHP'): 'PHP'
hash('python'): 'python'
hash('C++'): 'C++'

Input Table B

hash('PHP'): 'The best'
hash('python'): 'Better than the best'

```
CoGroupByKey
maybe rehash
deduplicate
```

Output table

hash('php'): 'The best'
hash('python'): 'Better than the best'
hash('c++'): '?'

Step 2 - detail 1

```
def main():
  p = beam.Pipeline() # Run locally with the direct runner.

  new_hash_collection: list[tuple[int, int]] = LANGUAGE_INDEX_COLLECTION
    | "Map existing hash to new hash" >> beam.Map(
      lambda i: (i[0], magic_hash(i[1].lower())))

  new_language_content = (
    ({
      "index": LANGUAGE_INDEX_COLLECTION,
      "content": LANGUAGE_CONTENT_COLLECTION,
      "new_hash": new_hash_collection,
    })
    | "CoGroupByKey" >> beam.CoGroupByKey()
    | "Maybe rehash" >> beam.ParDo(
      lambda hash_to_all: maybe_rehash(hash_to_all))
  )
  p.run()
```

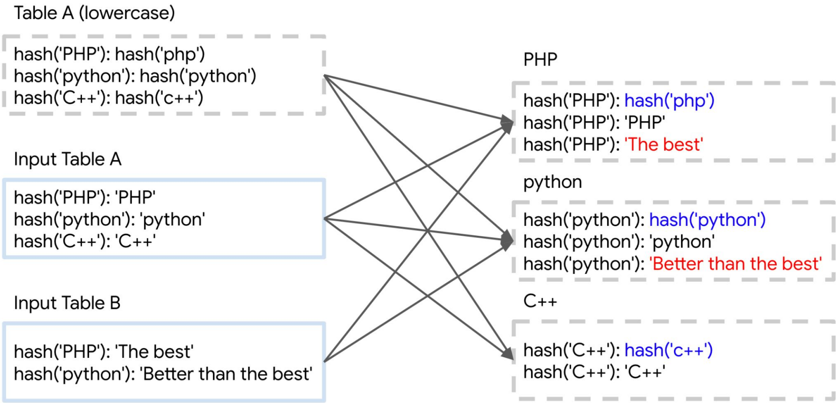

Table A (lowercase)

hash('PHP'): hash('php')
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hash('C++'): hash('c++')

Input Table A

hash('PHP'): 'PHP'
hash('python'): 'python'
hash('C++'): 'C++'

Input Table B

hash('PHP'): 'The best'
hash('python'): 'Better than the best'

PHP

hash('PHP'): hash('php')
hash('PHP'): 'PHP'
hash('PHP'): 'The best'

python

hash('python'): hash('python')
hash('python'): 'python'
hash('python'): 'Better than the best'

C++

hash('C++'): hash('c++')
hash('C++'): 'C++'

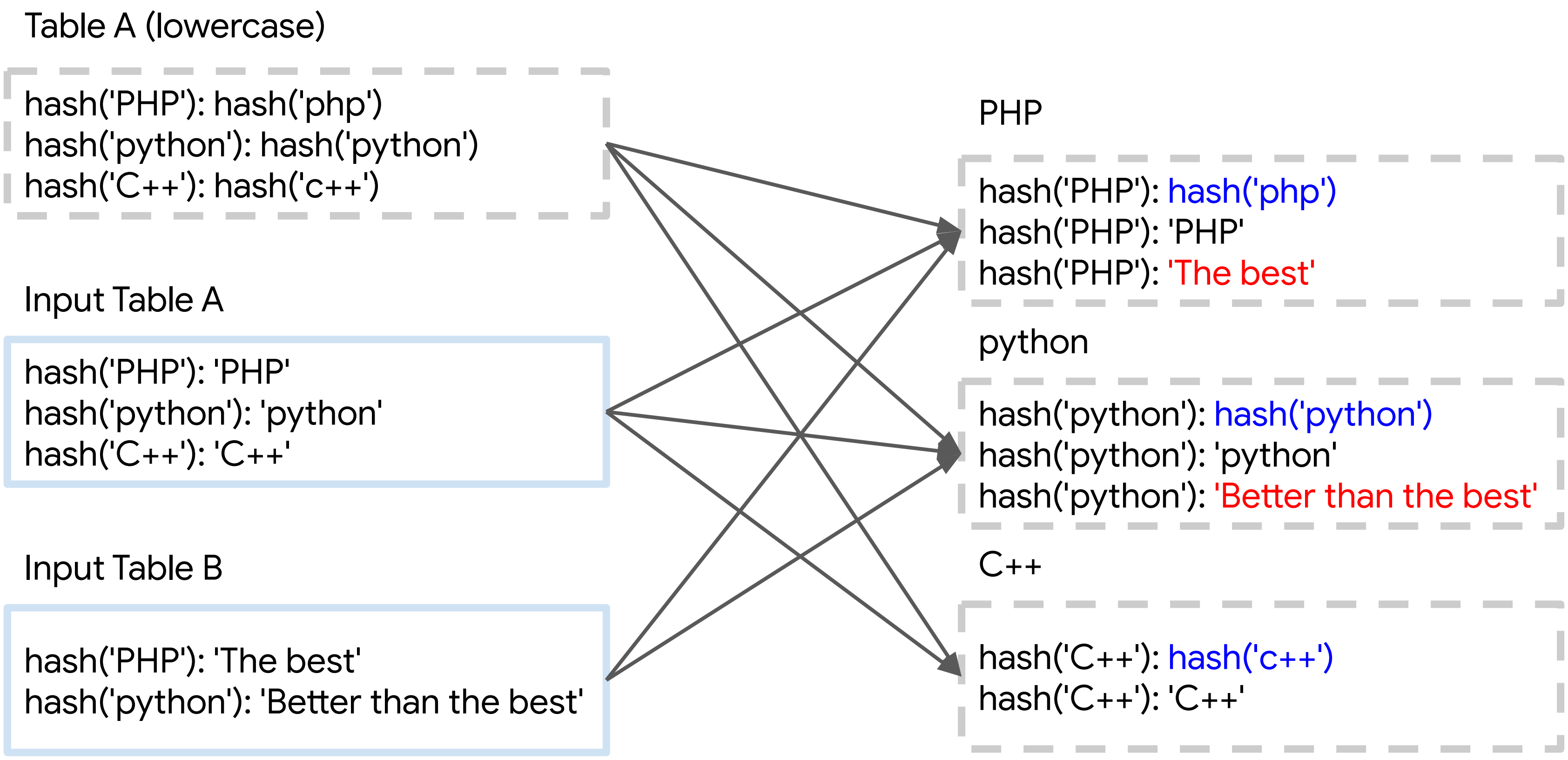

Table A (lowercase)

hash('PHP'): hash('php')
hash('python'): hash('python')
hash('C++'): hash('c++')

Input Table A

hash('PHP'): 'PHP'
hash('python'): 'python'
hash('C++'): 'C++'

Input Table B

hash('PHP'): 'The best'
hash('python'): 'Better than the best'

PHP

hash('PHP'): hash('php')
hash('PHP'): 'PHP'
hash('PHP'): 'The best'

python

hash('python'): hash('python')
hash('python'): 'python'
hash('python'): 'Better than the best'

C++

hash('C++'): hash('c++')
hash('C++'): 'C++'

Step 2 - detail 2

```
def main():
  p = beam.Pipeline() # Run locally with the direct runner.

  new_hash_collection: list[tuple[int, int]] = LANGUAGE_INDEX_COLLECTION
    | "Map existing hash to new hash" >> beam.Map(
      lambda i: (i[0], magic_hash(i[1].lower())))

  new_language_content = (
    ({
      "index": LANGUAGE_INDEX_COLLECTION,
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      "new_hash": new_hash_collection,
    })
    | "CoGroupByKey" >> beam.CoGroupByKey()
    | "Maybe rehash" >> beam.ParDo(
      lambda hash_to_all: maybe_rehash(hash_to_all))
  )
  p.run()
```
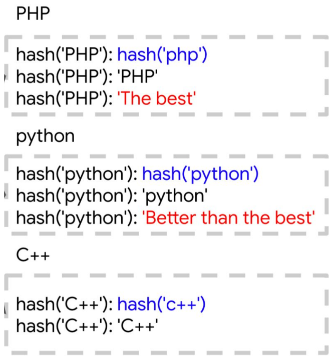



PHP

hash('PHP'): hash('php')
hash('PHP'): 'PHP'
hash('PHP'): 'The best'

python

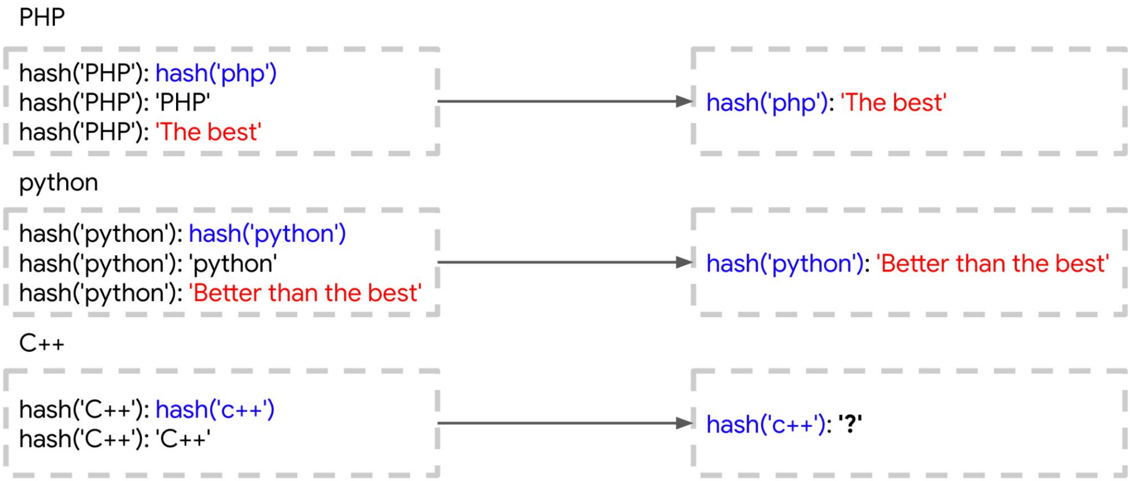
hash('python'): hash('python')
hash('python'): 'python'
hash('python'): 'Better than the best'

C++

hash('C++'): hash('c++')
hash('C++'): 'C++'

Step 2 - detail 2

```
def maybe_rehash(hash_to_all):
 for k in hash_to_all[1]["new_hash"]:
  if hash_to_all[1]["content"]:   // dedup
   yield (k, hash_to_all[1]["content"][0])
  else:   // dedup + create
   yield (k,
NEW_CONTENT_PREFIX.format(hash_to_all[1]['index'][0].lower()))
```



PHP

hash('PHP'): hash('php')
hash('PHP'): 'PHP'
hash('PHP'): 'The best'

hash('php'): 'The best'

python

hash('python'): hash('python')
hash('python'): 'python'
hash('python'): 'Better than the best'

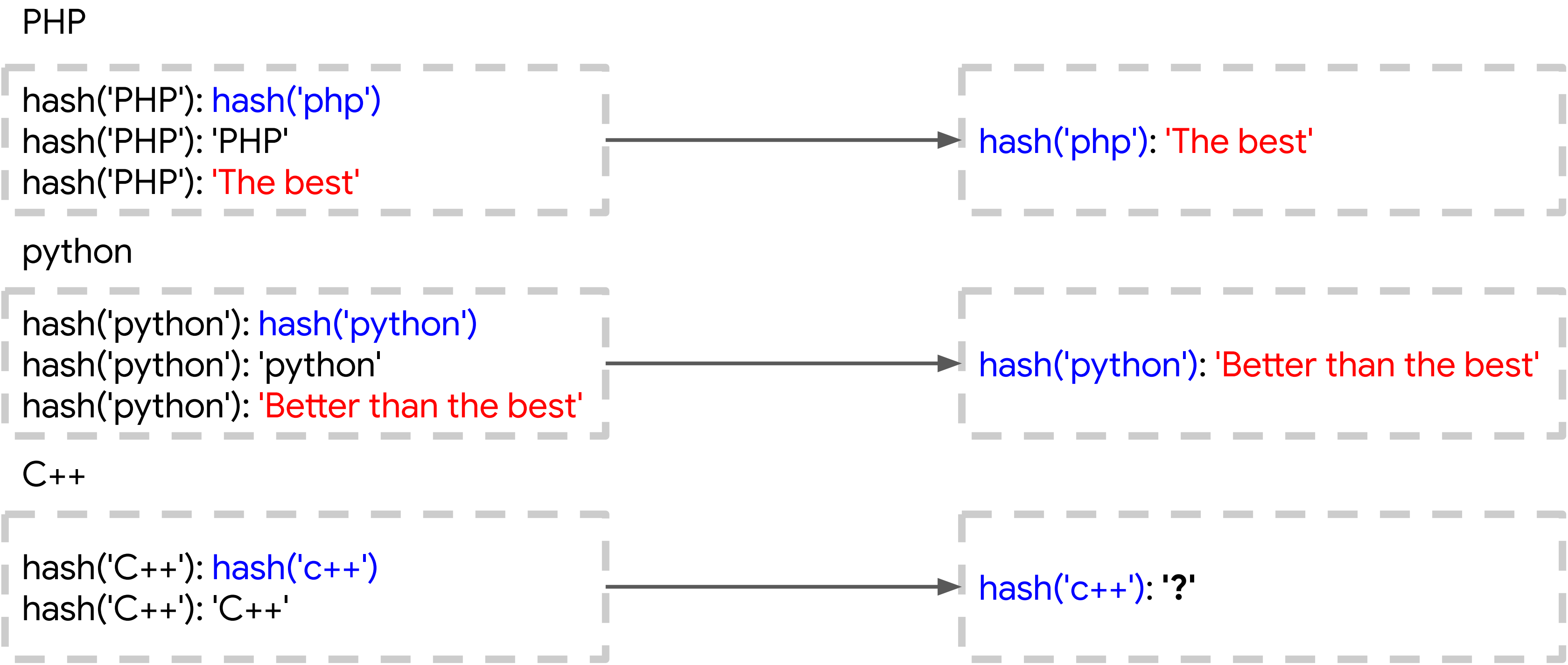
hash('python'): 'Better than the best'

C++

hash('C++'): hash('c++')
hash('C++'): 'C++'

hash('c++'): **'?'**

Data is processed **parallelly in different workers.*



PHP

hash('PHP'): hash('php')
hash('PHP'): 'PHP'
hash('PHP'): 'The best'

hash('php'): 'The best'

python

hash('python'): hash('python')
hash('python'): 'python'
hash('python'): 'Better than the best'

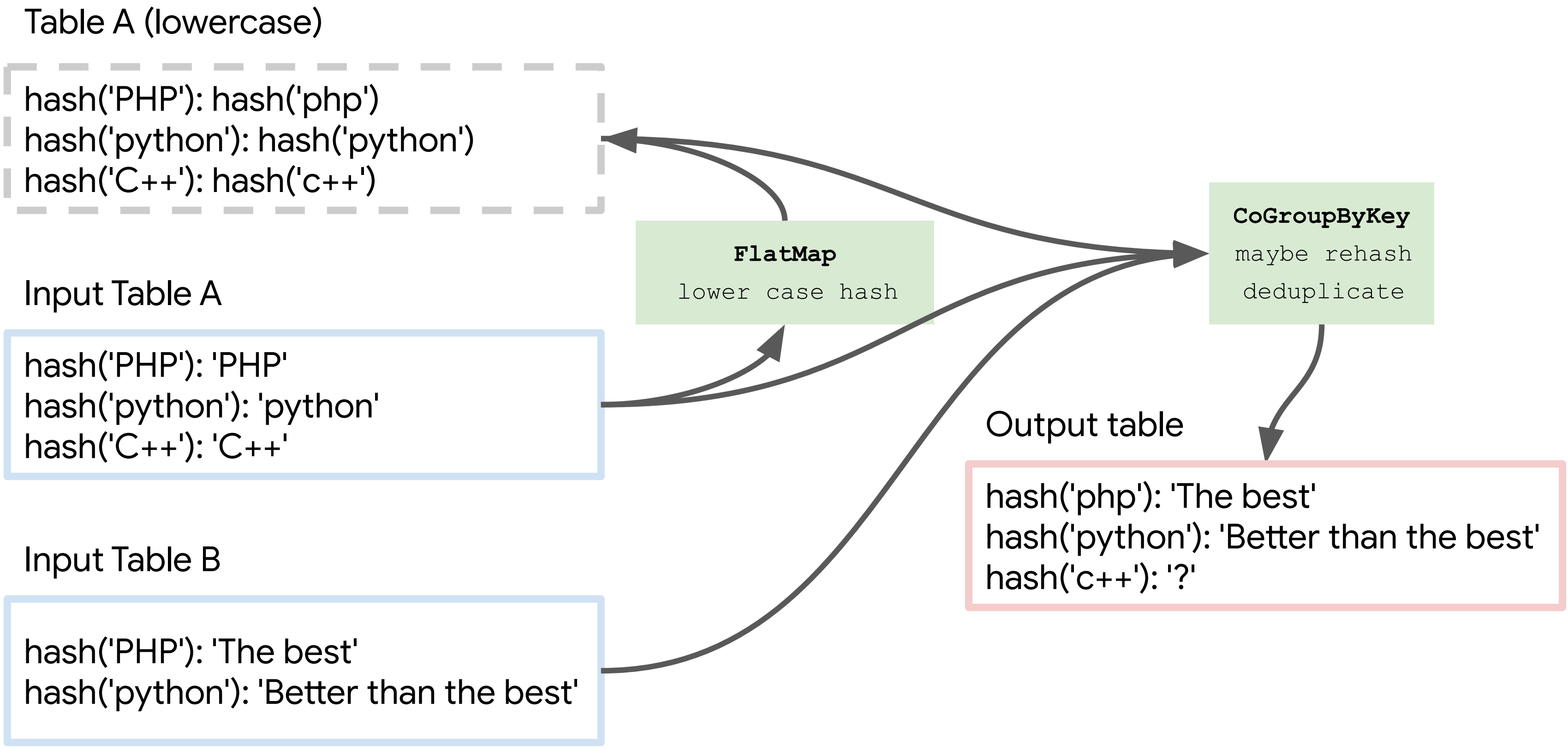
hash('python'): 'Better than the best'

C++

hash('C++'): hash('c++')
hash('C++'): 'C++'

hash('c++'): **'?'**

Beam Flow



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Input Table B

hash('PHP'): 'The best'
hash('python'): 'Better than the best'

FlatMap
lower case hash

CoGroupByKey
maybe rehash
deduplicate

Output table

hash('php'): 'The best'
hash('python'): 'Better than the best'
hash('c++'): '?'

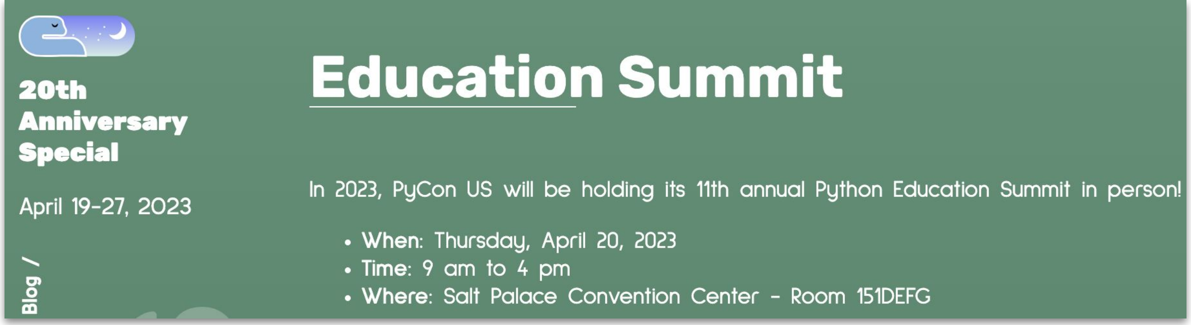
Researches

- FlumeJava 2010: Bounded
    - One pipeline to handle many MapReduce jobs
- Millwheel 2013: Unbounded
    - Fault-tolerant stream processing systems
- Dataflow Model 2015: Bounded + Unbounded
    - A flexible abstraction for modern data processing problems
    - Apache Beam is based on this

More examples

- Bounded
  - Text analysis
- Unbounded
  - Online game real time scoring system
  - Grocery store's barcode system [PyCon APAC 2018]

A Successful (Intern) Project



20th Anniversary Special

April 19-27, 2023

Blog /

Education Summit

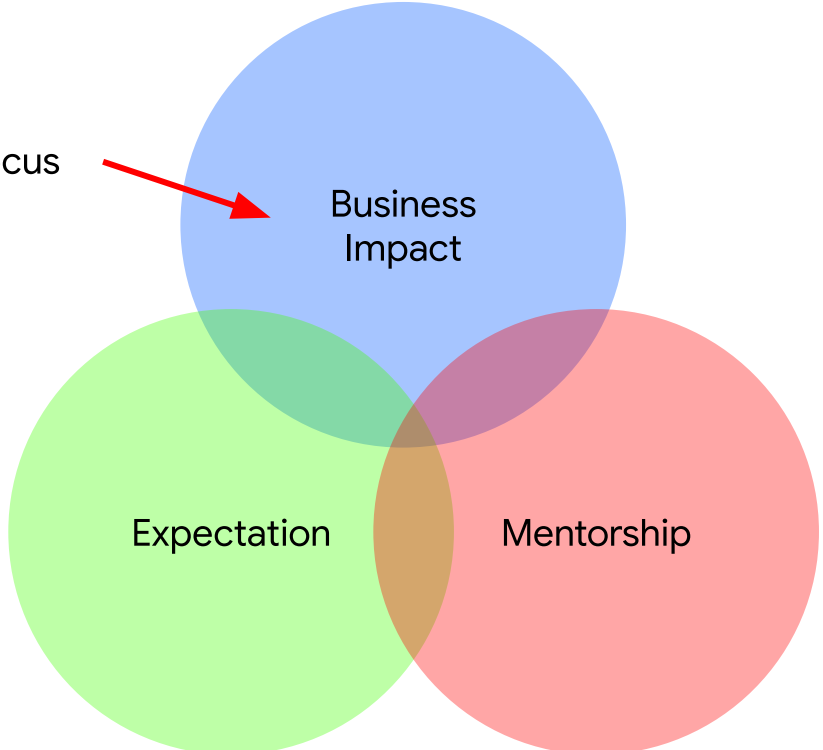
In 2023, PyCon US will be holding its 11th annual Python Education Summit in person!

- **When**: Thursday, April 20, 2023
- **Time**: 9 am to 4 pm
- **Where**: Salt Palace Convention Center - Room 151DEFG

note35.github.io/talks

What a Great Software Engineer Intern Host Looks Like

Today's focus

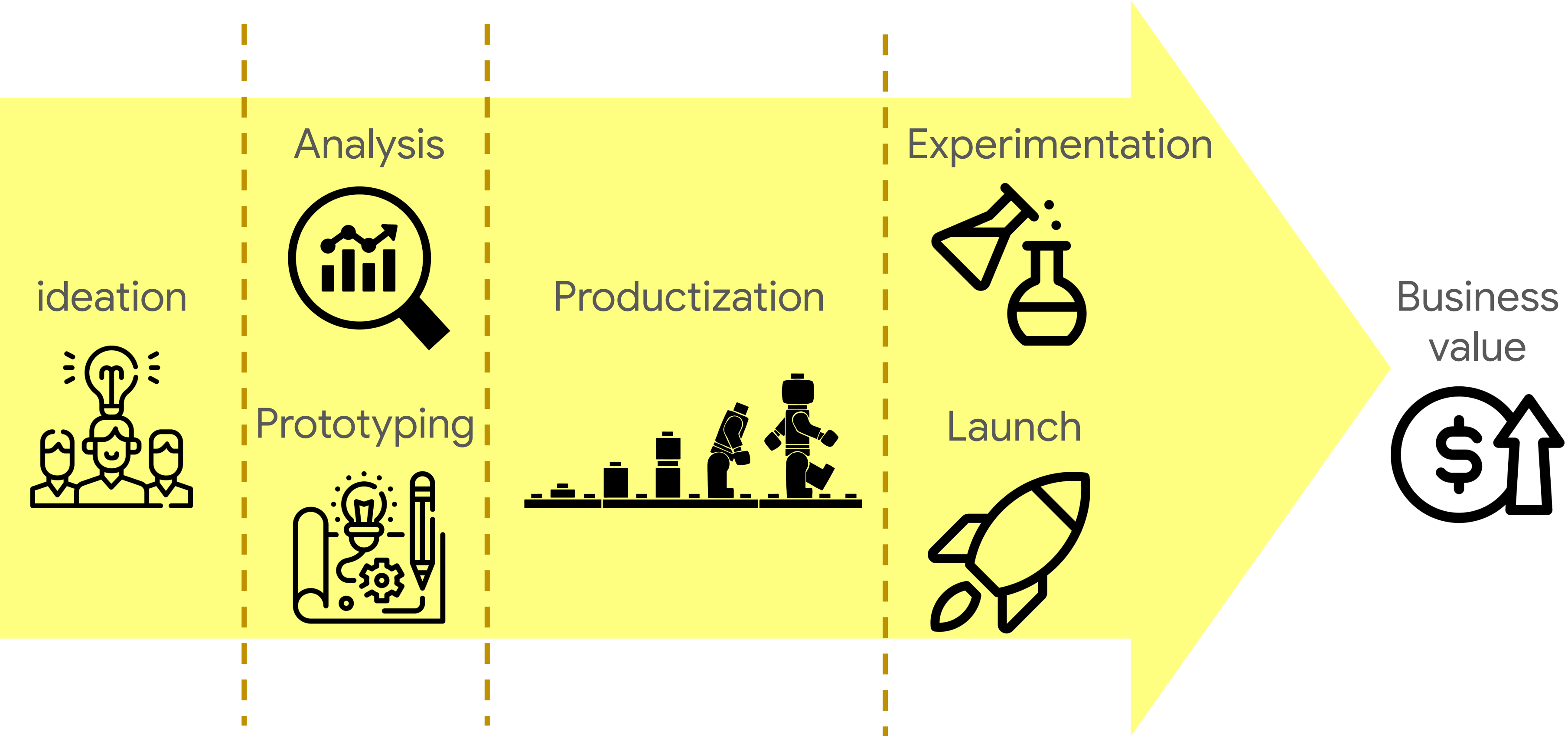


Business Impact

Expectation

Mentorship

The lifecycle of a project



ideation

Analysis

Prototyping

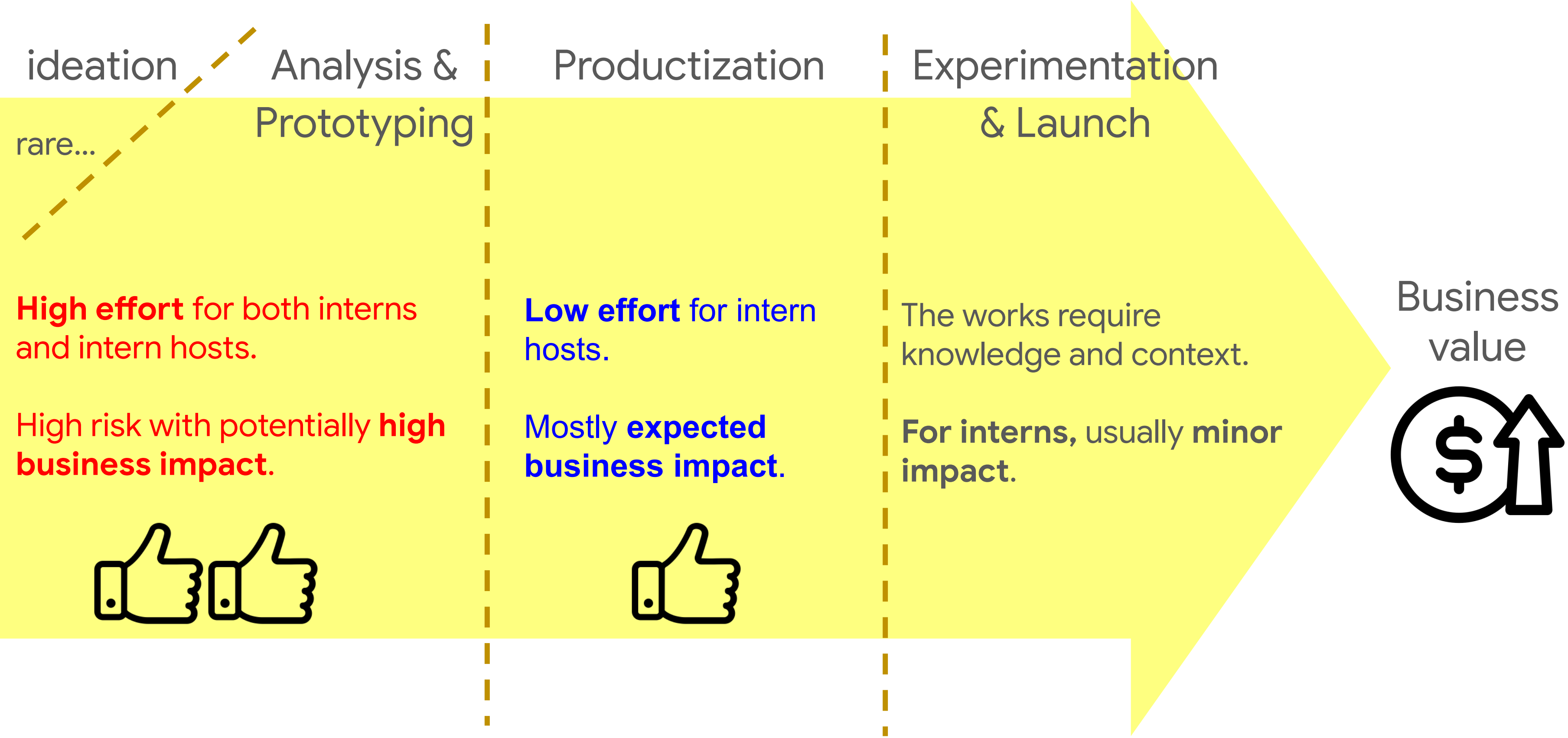
Productization

Experimentation

Launch

Business value

Intern project recommendations



ideation

rare...

Analysis & Prototyping

High effort for both interns and intern hosts.

High risk with potentially **high business impact.**

👍👍

Productization

Low effort for intern hosts.

Mostly **expected business impact**.

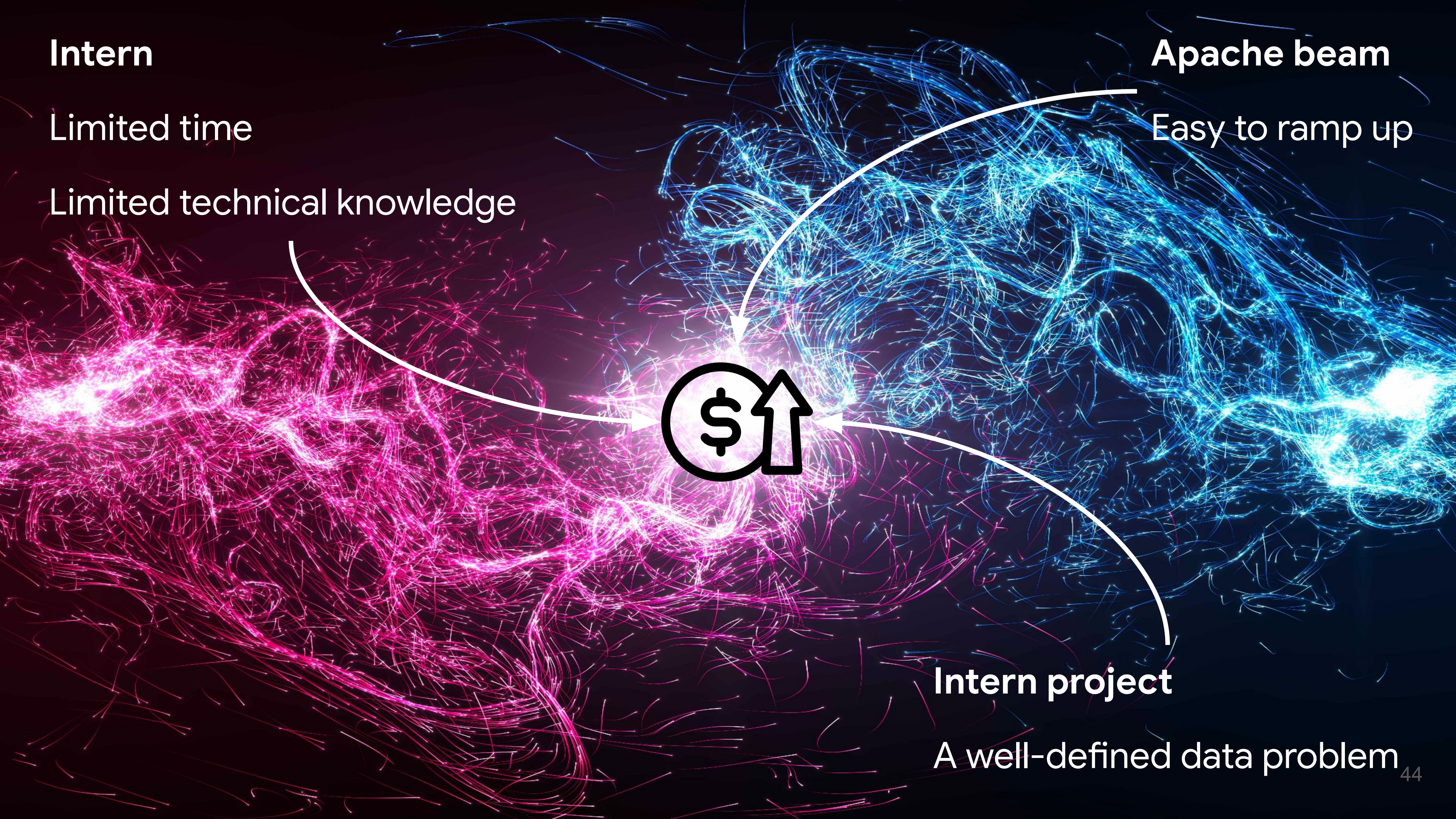
👍

Experimentation & Launch

The works require knowledge and context.

For interns, usually **minor impact**.

Business value



Intern

Limited time

Limited technical knowledge

Apache beam

Easy to ramp up

Intern project

A well-defined data problem

Takeaway

In-memory data processing

Modern data processing

Apach Beam

Apache Beam in the project life cycle

Homework/Promotion

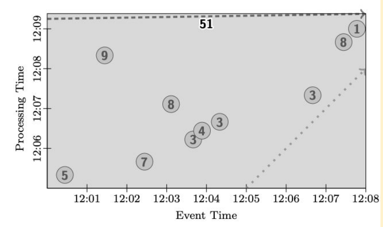
colab

Thank you for listening! 🙏

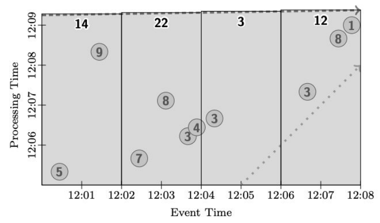
No time to talk slides 🚮

Batch vs Streaming

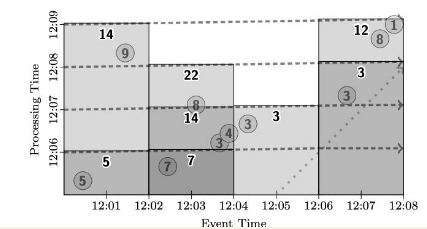
Simple Batch



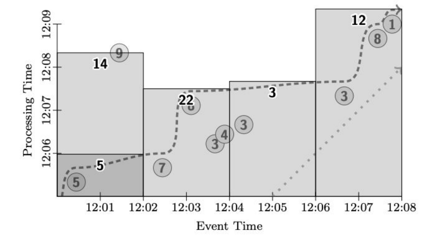
Fixed-window Batch



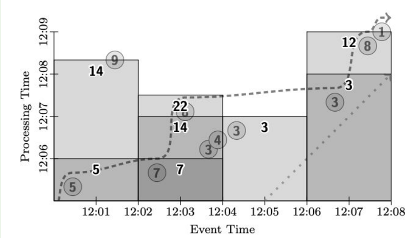
Fixed-window Batchs



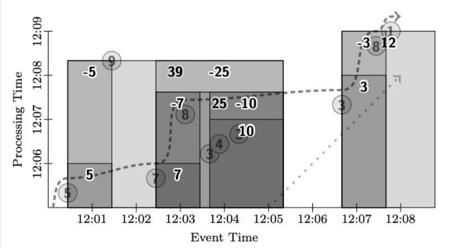
Streaming



Partial streaming



Sessions


Processing Time
12:06
12:07
12:08
12:09
Event Time
12:01
12:02
12:03
12:04
12:05
12:06
12:07
12:08