Data analysis using Lithops

Dawid Białka, Kamil Burkiewicz

What is Lithops

LITHOPS

Main features:

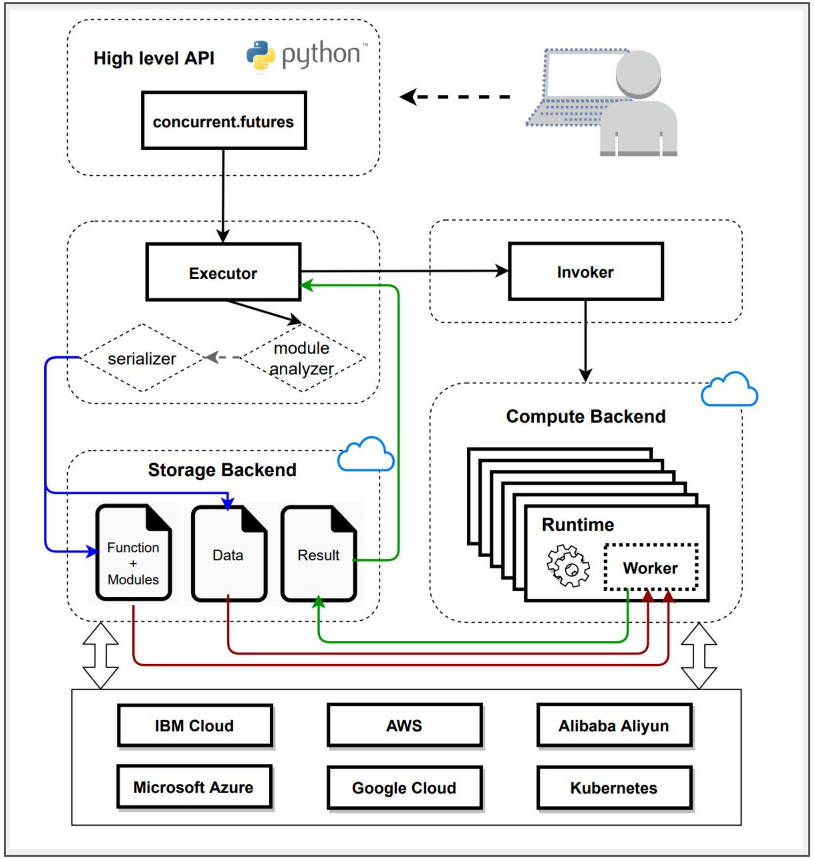
- distributed computing framework
- cloud-agnostic
- suited for highly-parallel jobs

IBM Cloud	aws	Microsoft Azure	Google Cloud	Alibaba Cloud	kubernetes OPENSHIFT
Cloud Functions Code Engine VPC Gen2 --- Cloud Object Storage	AWS Lambda AWS Batch AWS EC2 --- AWS S3	Functions Container APPs --- Blob Storage	Cloud Functions Cloud Run --- Cloud Storage	Functions Compute --- Object Storage Service	Batch/Job - OpenWhisk Knative --- OpenStack Swift - Ceph MinIO - Redis - Infinispan

Lithops Architecture

Components:

- Storage:
  - provides abstraction for storage
- Compute:
  - allows running distributed computations
  - Various kinds of Executors:
    - Localhost
    - Serverless
    - Standalone



Dataset

AWS OpenAQ

Global, aggregated physical air quality data from public data sources provided by government, research-grade and other sources.
Source: https://registry.opendata.aws/openaq/

- ~ 50 GB
- uploaded to s3 in the region where computations were performed for data locality
- divided into files ~ 25 MB each

	date	parameter	value	unit	averagingPeriod	location	city	country	coordinates	attribution	sourceName	sourceType	mobile
0	{'utc': '2020-10-31T06:30:00.000Z', 'local': '...	pm25	100.000000	µg/m³	{'value': 1, 'unit': 'hours'}	US Diplomatic Post: Kabul	Kabul	AF	{'latitude': 34.535812, 'longitude': 69.190514}	[{'name': 'EPA AirNow DOS', 'url': 'http://air...	StateAir_Kabul	government	False
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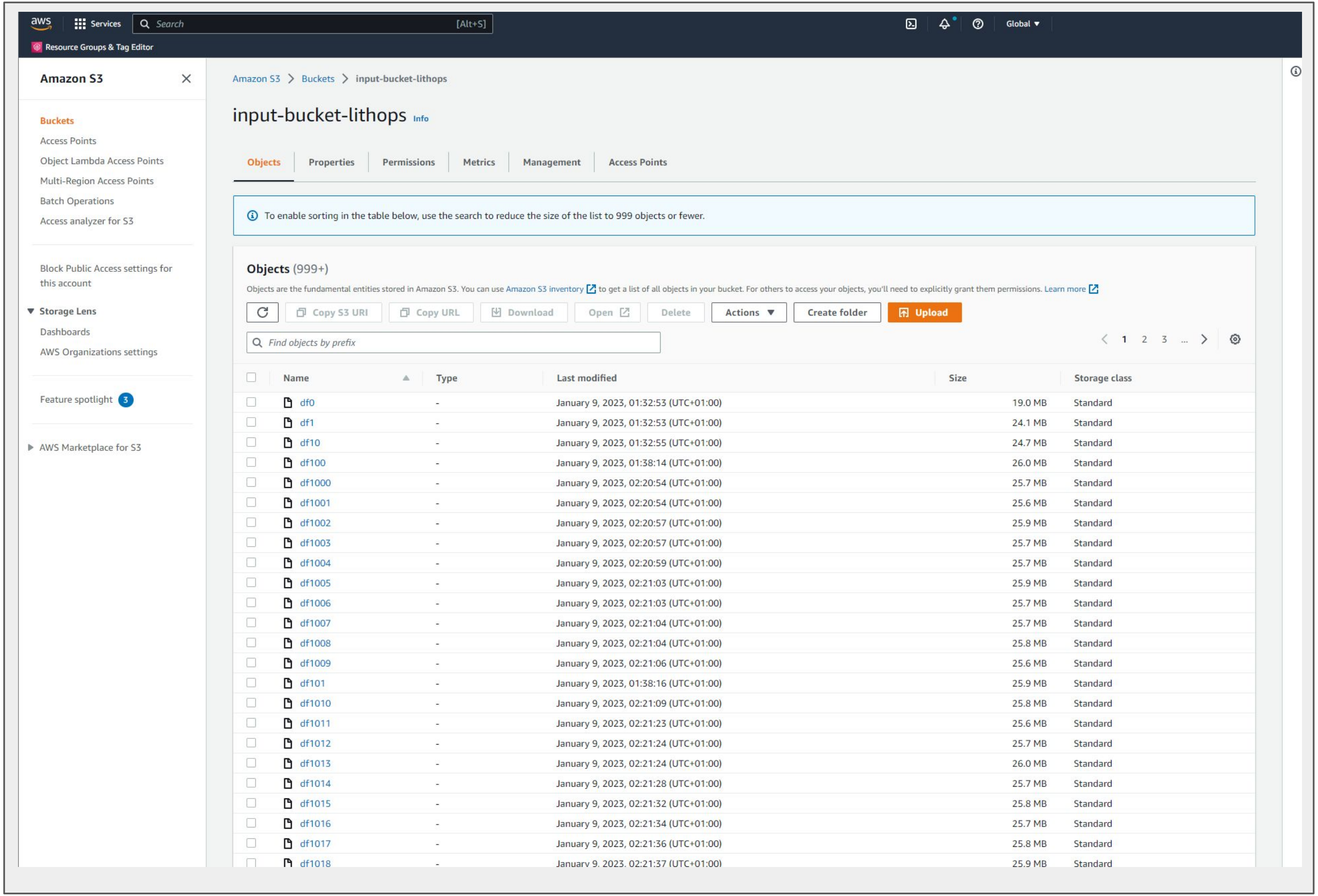
3	{'utc': '2020-10-31T09:30:00.000Z', 'local': '...	pm25	48.000000	µg/m³	{'value': 1, 'unit': 'hours'}	US Diplomatic Post: Kabul	Kabul	AF	{'latitude': 34.535812, 'longitude': 69.190514}	[{'name': 'EPA AirNow DOS', 'url': 'http://air...	StateAir_Kabul	government	False
4	{'utc': '2020-10-31T10:30:00.000Z', 'local': '...	pm25	39.000000	µg/m³	{'value': 1, 'unit': 'hours'}	US Diplomatic Post: Kabul	Kabul	AF	{'latitude': 34.535812, 'longitude': 69.190514}	[{'name': 'EPA AirNow DOS', 'url': 'http://air...	StateAir_Kabul	government	False
...	...	...	...	...	...	...	...	...	...	...	...	...	...
4995	{'utc': '2020-10-31T12:00:00.000Z', 'local': '...	so2	6.000000	µg/m³	{'unit': 'hours', 'value': 1}	GR0020A	KENTPIKH MAKEΔONIA	GR	{'latitude': 40.67354965, 'longitude': 22.8934...	[{'name': 'EEA', 'url': 'http://www.eea.europa...	EEA Greece	government	False
4996	{'utc': '2020-11-01T04:00:00.000Z', 'local': '...	pm10	12.500000	µg/m³	{'unit': 'hours', 'value': 1}	FR05090	Seine-Maritime	FR	{'latitude': 49.5146953797856, 'longitude': 0....	[{'name': 'EEA', 'url': 'http://www.eea.europa...	EEA France	government	False
4997	{'utc': '2020-11-01T04:00:00.000Z', 'local': '...	o3	44.113987	µg/m³	{'unit': 'hours', 'value': 1}	FI00357	Lapland	FI	{'latitude': 68.477009999634, 'longitude': 28....	[{'name': 'EEA', 'url': 'http://www.eea.europa...	EEA Finland	government	False
4998	{'utc': '2020-11-01T06:00:00.000Z', 'local': '...	pm25	2.137920	µg/m³	{'value': 24, 'unit': 'hours'}	Heerlen-Jamboreepad	Heerlen	NL	{'latitude': 50.9003, 'longitude': 5.986850000...	[{'name': 'RIVM', 'url': 'http://www.lml.rivm....	Netherlands	government	False
4999	{'utc': '2020-11-01T06:00:00.000Z', 'local': '...	no2	0.005300	ppm	{'unit': 'hours', 'value': 1}	Renwu	高雄市	TW	{'latitude': 22.689056, 'longitude': 120.332631}	[{'name': 'http://opendata.epa.gov.tw/', 'url'...	Taiwan	government	False

5000 rows × 13 columns


aws
Services
Search
[Alt+S]
Global
Resource Groups & Tag Editor
Amazon S3
Buckets
Access Points
Object Lambda Access Points
Multi-Region Access Points
Batch Operations
Access analyzer for S3
Block Public Access settings for this account
Storage Lens
Dashboards
AWS Organizations settings
Feature spotlight 3
AWS Marketplace for S3
Amazon S3 > Buckets > input-bucket-lithops
input-bucket-lithops Info
Objects
Properties
Permissions
Metrics
Management
Access Points
To enable sorting in the table below, use the search to reduce the size of the list to 999 objects or fewer.
Objects (999+)
Objects are the fundamental entities stored in Amazon S3. You can use Amazon S3 inventory to get a list of all objects in your bucket. For others to access your objects, you'll need to explicitly grant them permissions. Learn more
Copy S3 URI
Copy URL
Download
Open
Delete
Actions
Create folder
Upload
Find objects by prefix
1 2 3 ...
Name Type Last modified Size Storage class
df0 - January 9, 2023, 01:32:53 (UTC+01:00) 19.0 MB Standard
df1 - January 9, 2023, 01:32:53 (UTC+01:00) 24.1 MB Standard
df10 - January 9, 2023, 01:32:55 (UTC+01:00) 24.7 MB Standard
df100 - January 9, 2023, 01:38:14 (UTC+01:00) 26.0 MB Standard
df1000 - January 9, 2023, 02:20:54 (UTC+01:00) 25.7 MB Standard
df1001 - January 9, 2023, 02:20:54 (UTC+01:00) 25.6 MB Standard
df1002 - January 9, 2023, 02:20:57 (UTC+01:00) 25.9 MB Standard
df1003 - January 9, 2023, 02:20:57 (UTC+01:00) 25.7 MB Standard
df1004 - January 9, 2023, 02:20:59 (UTC+01:00) 25.7 MB Standard
df1005 - January 9, 2023, 02:21:03 (UTC+01:00) 25.9 MB Standard
df1006 - January 9, 2023, 02:21:03 (UTC+01:00) 25.7 MB Standard
df1007 - January 9, 2023, 02:21:04 (UTC+01:00) 25.7 MB Standard
df1008 - January 9, 2023, 02:21:04 (UTC+01:00) 25.8 MB Standard
df1009 - January 9, 2023, 02:21:06 (UTC+01:00) 25.6 MB Standard
df101 - January 9, 2023, 01:38:16 (UTC+01:00) 25.9 MB Standard
df1010 - January 9, 2023, 02:21:09 (UTC+01:00) 25.8 MB Standard
df1011 - January 9, 2023, 02:21:23 (UTC+01:00) 25.6 MB Standard
df1012 - January 9, 2023, 02:21:24 (UTC+01:00) 25.7 MB Standard
df1013 - January 9, 2023, 02:21:24 (UTC+01:00) 26.0 MB Standard
df1014 - January 9, 2023, 02:21:28 (UTC+01:00) 25.7 MB Standard
df1015 - January 9, 2023, 02:21:32 (UTC+01:00) 25.8 MB Standard
df1016 - January 9, 2023, 02:21:34 (UTC+01:00) 25.7 MB Standard
df1017 - January 9, 2023, 02:21:36 (UTC+01:00) 25.8 MB Standard
df1018 - January 9, 2023, 02:21:37 (UTC+01:00) 25.9 MB Standard

Computation of average levels of air pollution with map-reduce model

[25]
```
def day_average_map(x):
  if isinstance(x, str):
    df = pd.DataFrame(loads_recursive(json.loads(download_bytes(os.path.basename(x), input_bucket).decode(encoding='utf-8'))))
  else:
    df = x
  df_to_process = preprocess(df)
  df_sum = df_to_process.groupby(['country', 'city', 'date', 'parameter', 'latitude', 'longitude'])['value'].agg(['sum','count'])
  df_to_process = df_to_process.drop(columns=['value'], axis=1)
  df_merged = pd.merge(df_sum, df_to_process, on=['country', 'city', 'date',  'parameter', 'latitude', 'longitude']).drop_duplicates()
  return df_merged.to_json()
```

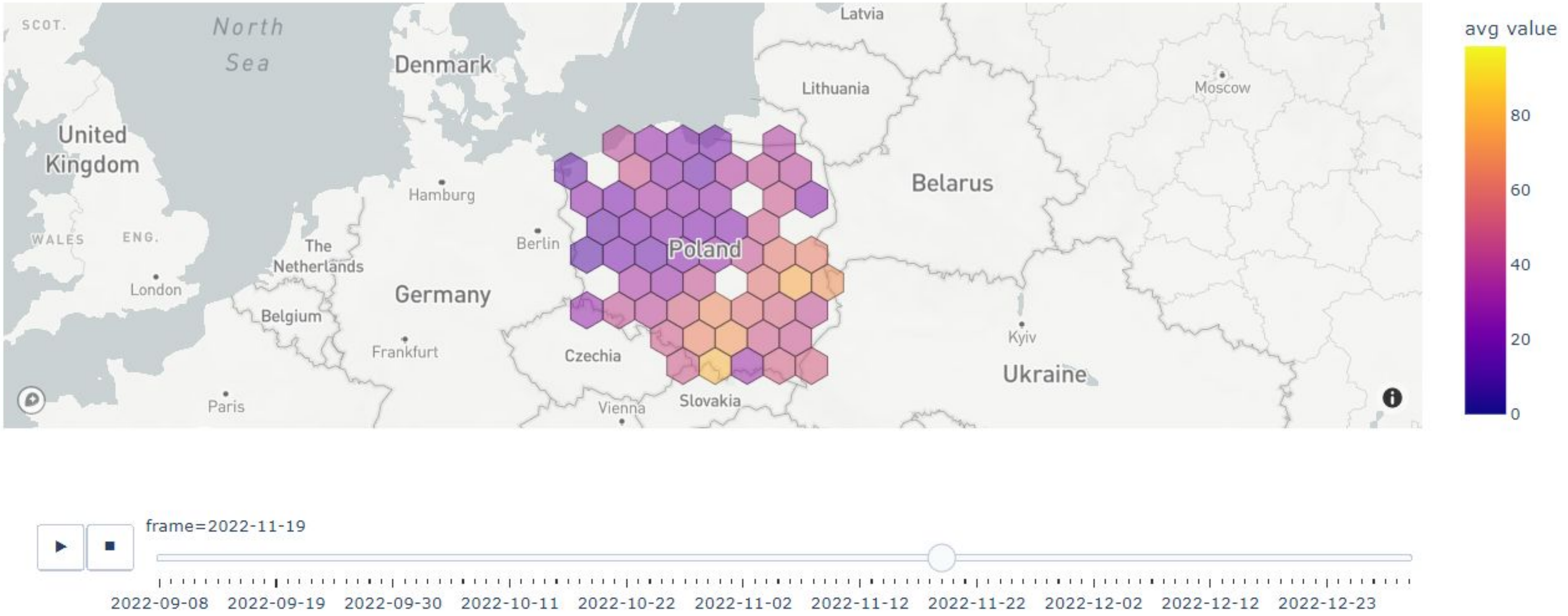
[26]
```
def day_average_reduce(results):
  dfs = [pd.read_json(result) for result in results]
  df_concatenated = pd.concat(dfs)
  df_concatenated.reset_index(drop=True, inplace=True)

  df_avg = df_concatenated.groupby(['country', 'city', 'date', 'parameter', 'latitude', 'longitude']).sum(['count', 'sum'])
  df_avg['average'] = df_avg.apply(lambda row: row['sum'] / row['count'], axis=1)

  df_avg = df_avg.drop(columns=['count', 'sum'], axis=1).dropna()
  df_concatenated = df_concatenated.drop(columns=['count', 'sum'], axis=1).dropna()

  df_merged = pd.merge(df_avg, df_concatenated, on=['country', 'city', 'date', 'parameter', 'latitude', 'longitude']).drop_duplicates()
  return df_merged.to_json()
```

Map of average concentration of PM10 in Poland based on localization and time



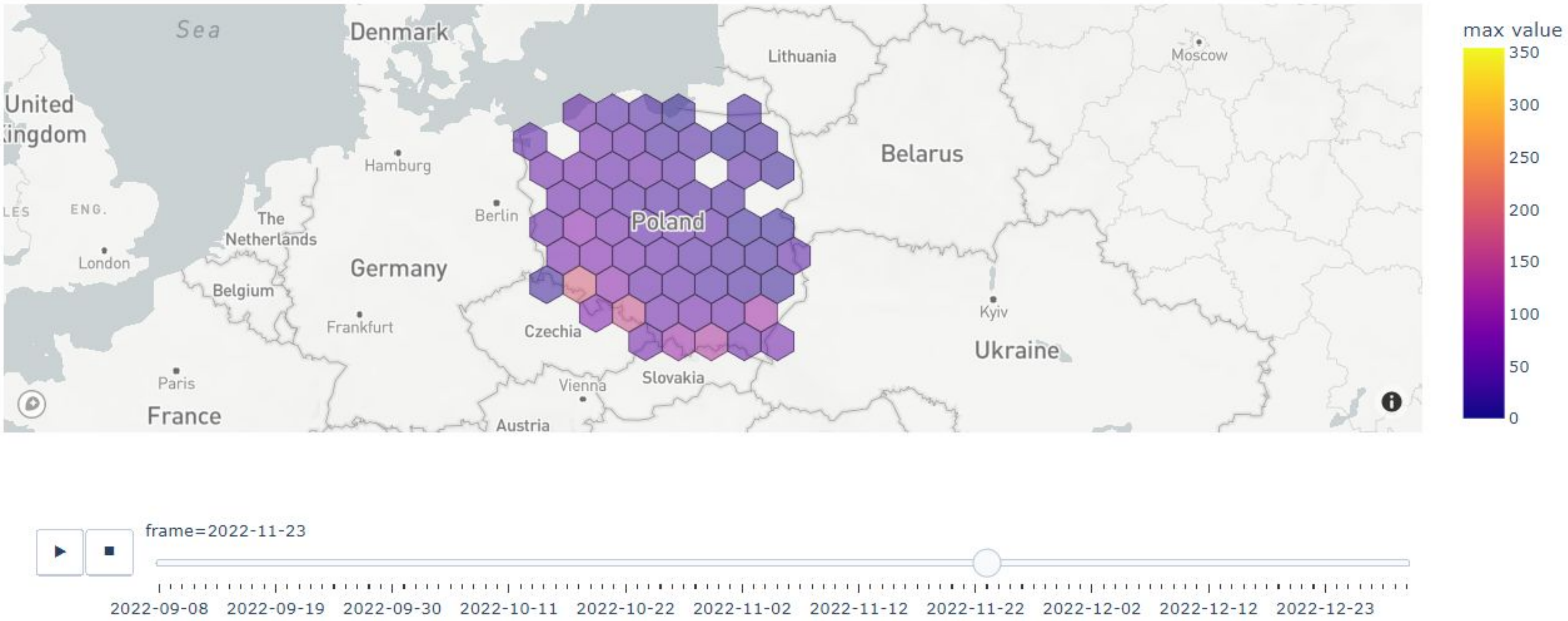
Computation of maximum levels of air pollution with map-reduce model

```
[ ]  def day_max_map(x):
       df = pd.DataFrame(loads_recursive(json.loads(download_bytes(os.path.basename(x), input_bucket).decode(encoding='utf-8'))))
       df_to_process = preprocess(df)
       df_sum = df_to_process.groupby(['country', 'city', 'date', 'parameter', 'latitude', 'longitude'])['value'].agg(['max'])
       df_to_process = df_to_process.drop(columns=['value'], axis=1)

       df_merged = pd.merge(df_sum, df_to_process, on=['country', 'city', 'date',  'parameter', 'latitude', 'longitude']).drop_duplicates()
       return df_merged.to_json()

     def day_max_reduce(results):
       dfs = [pd.read_json(result) for result in results]
       df_concatenated = pd.concat(dfs)
       df_concatenated.reset_index(drop=True, inplace=True)
       return df_concatenated.to_json()
```

Map of maximum concentration of PM10 in Poland based on localization and time



Warmup

To avoid cold start there was a warmup.

990 Lambdas processing whole dataset in about a minute

Warmup

```
[21] fexec = lithops.ServerlessExecutor(config=config)
     fexec.map(map_function=day_average_map, map_iterdata=objs, chunksize=2)
     result = fexec.get_result()
```

```
2023-01-16 02:10:12,323 [INFO] config.py:131 -- Lithops v2.7.1
2023-01-16 02:10:12,339 [INFO] aws_s3.py:60 -- S3 client created - Region: us-east-1
2023-01-16 02:10:12,422 [INFO] aws_lambda.py:94 -- AWS Lambda client created - Region: us-east-1
2023-01-16 02:10:12,427 [INFO] invokers.py:108 -- ExecutorID cc0069-1 | JobID M000 - Selected Runtime: lithops-default-runtime-v38 - 1024MB
2023-01-16 02:10:12,711 [INFO] invokers.py:172 -- ExecutorID cc0069-1 | JobID M000 - Starting function invocation: day_average_map() - Total: 1979 activations
2023-01-16 02:10:14,648 [INFO] invokers.py:208 -- ExecutorID cc0069-1 | JobID M000 - View execution logs at /tmp/lithops/logs/cc0069-1-M000.log
2023-01-16 02:10:14,970 [INFO] wait.py:97 -- ExecutorID cc0069-1 - Getting results from 1979 function activations

100% 1979/1979

2023-01-16 02:11:22,127 [INFO] executors.py:609 -- ExecutorID cc0069-1 - Cleaning temporary data
```

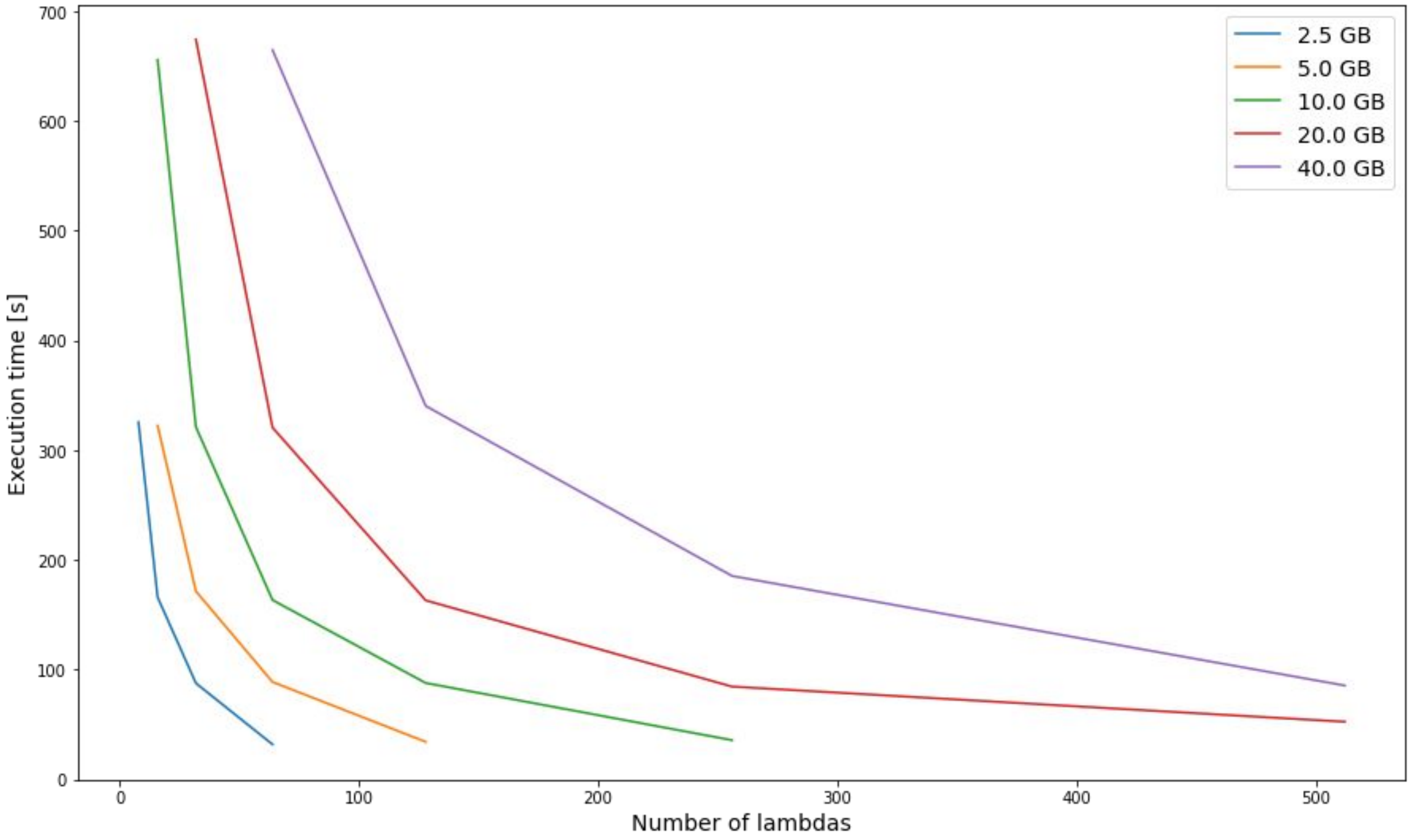
Measurements

Compute backend: AWS Lambda

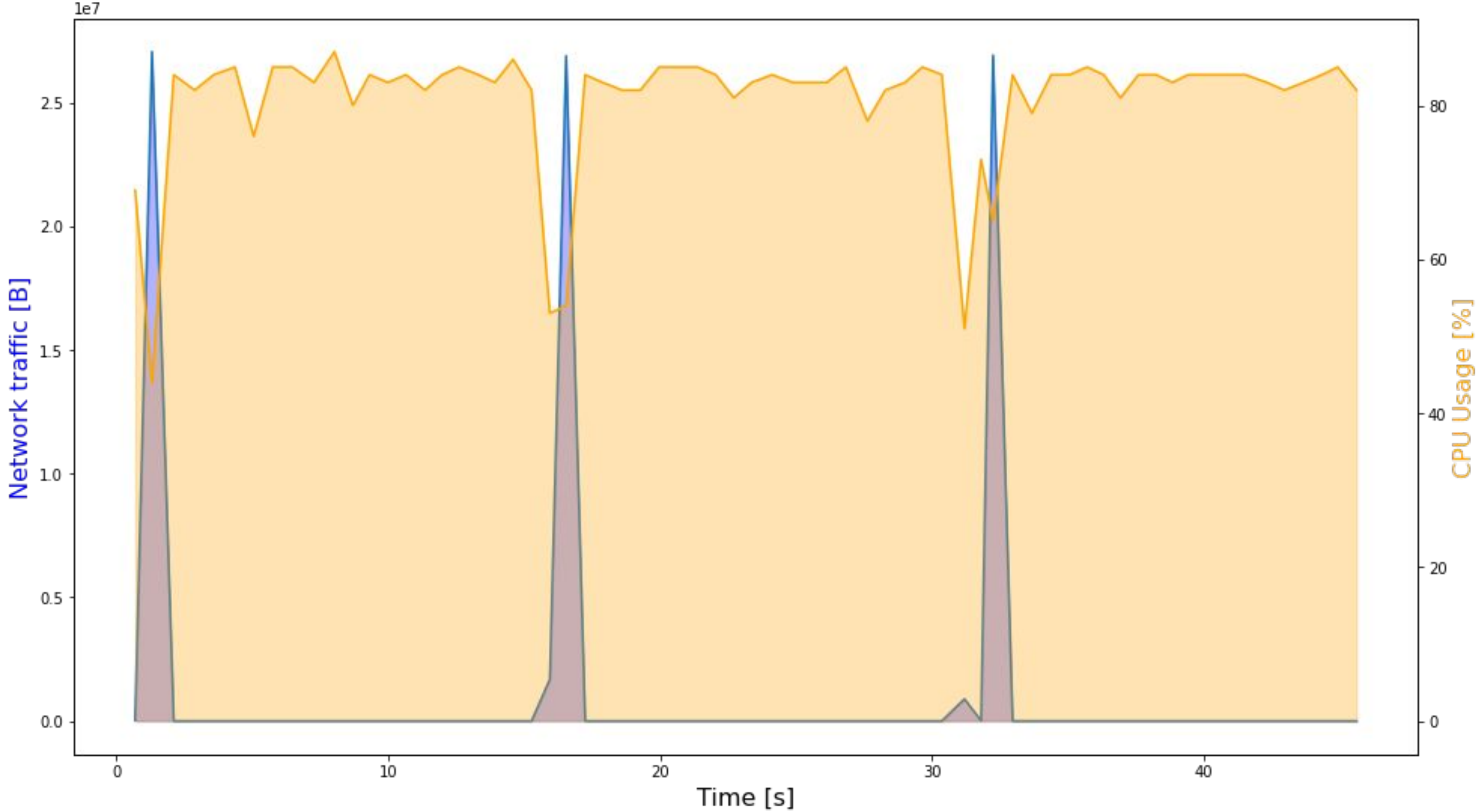
- 2048 MB memory
- cpu: `Intel(R) Xeon(R) Processor @ 2.50GHz model 63`
- timeout: 900s

Storage: S3

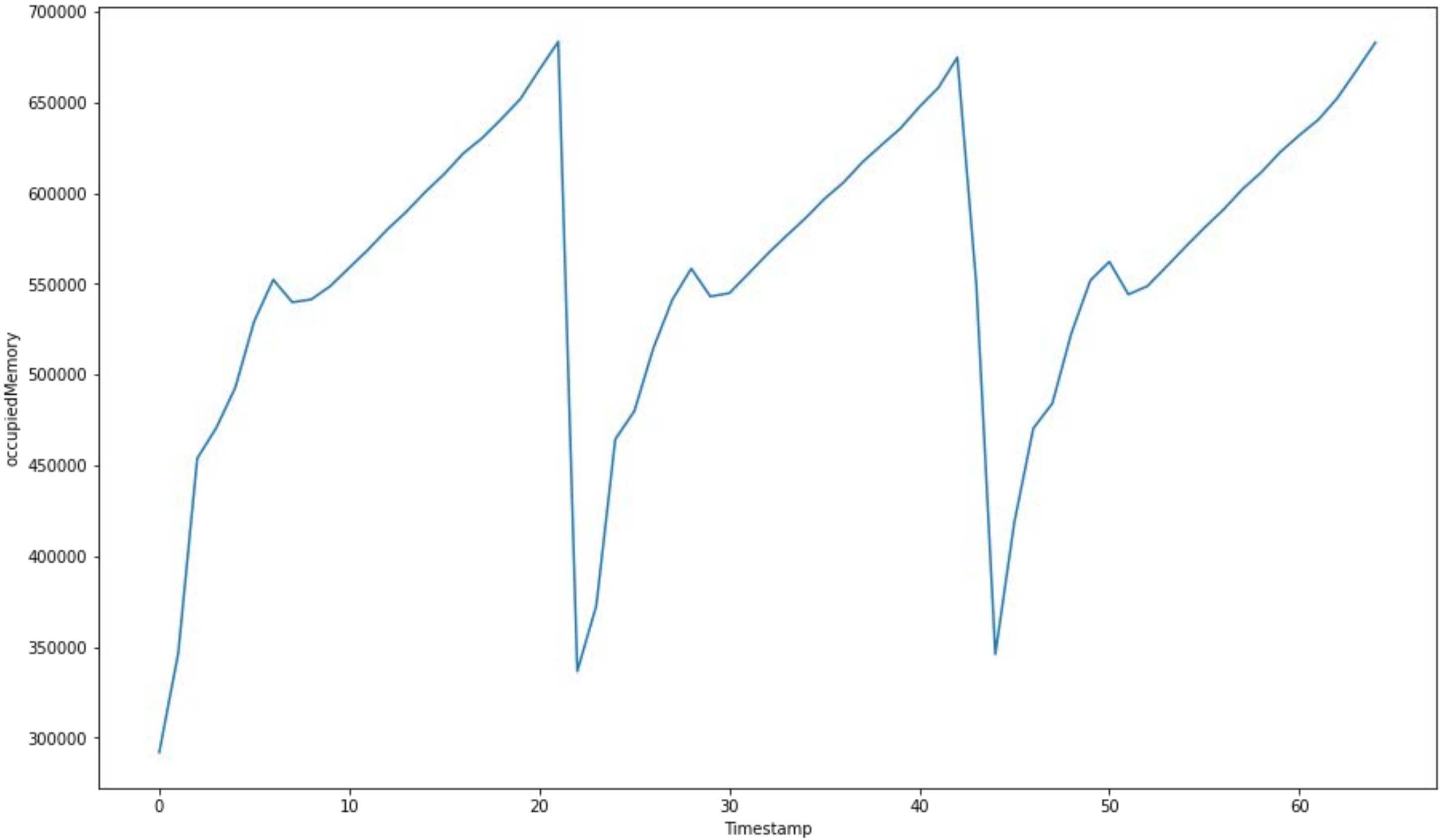
Scalability



CPU and network usage



Occupied memory



Sources

- J. Sampe, M. Sanchez-Artigas, G. Vernik, I. Yehekzel and P. Garcia-Lopez, "Outsourcing Data Processing Jobs with Lithops," in IEEE Transactions on Cloud Computing, doi: 10.1109/TCC.2021.3129000

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[AWS] Added session token as optional #1026

Edit | Code

Merged JosepSampe merged 1 commit into `lithops-cloud:master` from `Kamilbur:aws-session-token` yesterday

Conversation 1 | Commits 1 | Checks 0 | Files changed 17 +47 −3

Kamilbur commented 2 days ago Contributor

I've added an option to pass a session token from AWS credentials. Session tokens are included f.e. in credentials for student accounts.

Tested it with `lithops test` with credentials from my AWS Academy account.

Also included info about those changes in docs.

Developer's Certificate of Origin 1.1

```
By making a contribution to this project, I certify that:

(a) The contribution was created in whole or in part by me and I
    have the right to submit it under the Apache License 2.0; or

(b) The contribution is based upon previous work that, to the best
    of my knowledge, is covered under an appropriate open source
    license and I have the right under that license to submit that
    work with modifications, whether created in whole or in part
    by me, under the same open source license (unless I am
    permitted to submit under a different license), as indicated
    in the file; or

(c) The contribution was provided directly to me by some other
    person who certified (a), (b) or (c) and I have not modified
    it.

(d) I understand and agree that this project and the contribution
    are public and that a record of the contribution (including all
    personal information I submit with it, including my sign-off) is
    maintained indefinitely and may be redistributed consistent with
    this project or the open source license(s) involved.
```

[AWS] Added session token as optional ... 36e5a17

JosepSampe reviewed yesterday View changes

JosepSampe left a comment Member

Cool! Thanks @Kamilbur

Reviewers
JosepSampe

Assignees
No one assigned

Labels
None yet

Projects
None yet

Milestone
No milestone

Development
Successfully merging this pull request may close these issues.
None yet

Notifications Customize
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2 participants

Allow edits by maintainers