

# Modern Data Science with **vaex:** A new approach to DataFrames and pipelines

Maarten Breddels & Jovan Veljanoski  
[vaex.io](https://vaex.io)

# VAEX.IO: WHO ARE WE?

# VAEX.IO: WHO ARE WE?



## **Maarten Breddels**

Former astrophysicist

Freelancer / consultant / data scientist

Core Jupyter-Widgets developer

QuantStack partner

Founder of [vaex.io](https://vaex.io)

Principal author of vaex

✉ [maartenbreddels@gmail.com](mailto:maartenbreddels@gmail.com)

🌐 [www.maartenbreddels.com](http://www.maartenbreddels.com)

🐦 [@maartenbreddels](https://twitter.com/maartenbreddels)

🐙 [github.com/maartenbreddels](https://github.com/maartenbreddels)

# VAEX.IO: WHO ARE WE?



## **Maarten Breddels**

Former astrophysicist

Freelancer / consultant / data scientist

Core Jupyter-Widgets developer

QuantStack partner

Founder of [vaex.io](https://vaex.io)

Principal author of vaex

✉ [maartenbreddels@gmail.com](mailto:maartenbreddels@gmail.com)

[www.maartenbreddels.com](https://www.maartenbreddels.com)

🐦 [@maartenbreddels](https://twitter.com/maartenbreddels)

🐙 [github.com/maartenbreddels](https://github.com/maartenbreddels)



## **Jovan Veljanoski**

Former astrophysicist

Sr. Data Scientist @ XebiaLabs

Co-founder of [vaex.io](https://vaex.io)

✉ [jovan.veljanoski@gmail.com](mailto:jovan.veljanoski@gmail.com)

🌐 <https://www.linkedin.com/in/jovanvel/>

# VAEX.IO: WHO ARE WE?



## **Maarten Breddels**

Former astrophysicist  
Freelancer / consultant / data scientist  
Core Jupyter-Widgets developer  
QuantStack partner  
Founder of [vaex.io](https://vaex.io)  
Principal author of vaex  
✉ [maartenbreddels@gmail.com](mailto:maartenbreddels@gmail.com)  
🌐 [www.maartenbreddels.com](https://www.maartenbreddels.com)  
🐦 [@maartenbreddels](https://twitter.com/maartenbreddels)  
🐙 [github.com/maartenbreddels](https://github.com/maartenbreddels)



## **Jovan Veljanoski**

Former astrophysicist  
Sr. Data Scientist @ XebiaLabs  
Co-founder of [vaex.io](https://vaex.io)  
✉ [jovan.veljanoski@gmail.com](mailto:jovan.veljanoski@gmail.com)  
🌐 <https://www.linkedin.com/in/jovanvel/>



## **Yonatan Alexander**

Head of Data Science at BuiltOn  
✉ [jonathan@xdss.io](mailto:jonathan@xdss.io)  
🌐 <https://www.linkedin.com/in/xdssio/>



## **Mario Buikhuizen**

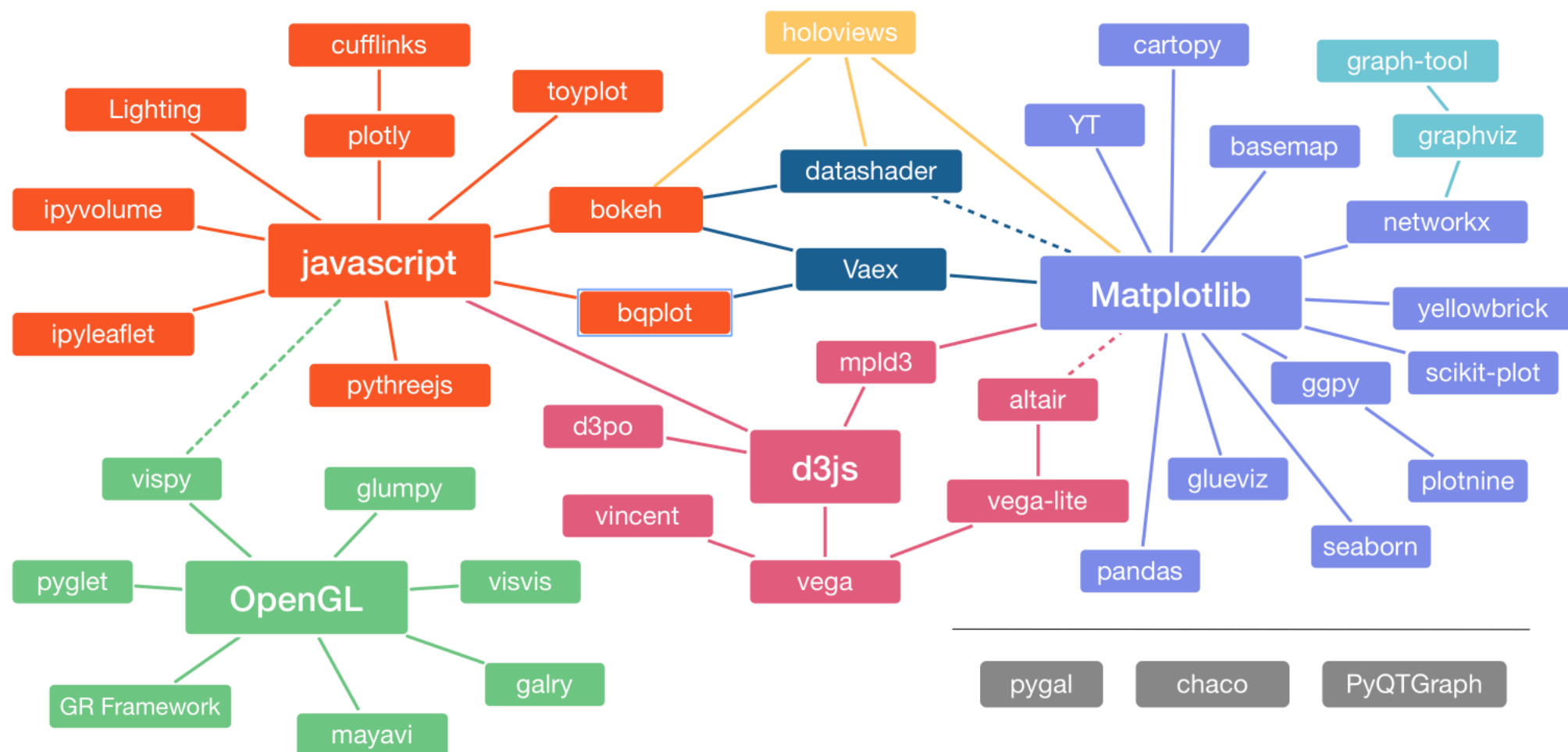
Freelancer / consultant  
Front-end / dashboards / widgets specialist  
✉ [mbuikhuizen@gmail.com](mailto:mbuikhuizen@gmail.com)

# Outline

- What is vaex?
- Why does vaex exist?
- What makes vaex unique?
  - DataFrame: Data + state
  - Expression system
- Live demo from notebook
- Misc
  - AWS s3 support, CUDA, remote data frames, xarray

# PyViz landscape

- unorganized or choice



# DataFrames



# DataFrames

- Pandas

# DataFrames

- Pandas
  - `dask.dataframe`

# DataFrames

- Pandas
  - `dask.dataframe`
  - Modin (using Ray)

# DataFrames

- Pandas
  - `dask.dataframe`
  - Modin (using Ray)
- SFrame (turi/Apple)

# DataFrames

- Pandas
  - `dask.dataframe`
  - Modin (using Ray)
- SFrame (turi/Apple)
- cudf (nVidia/rapids)

# DataFrames

- Pandas
  - `dask.dataframe`
  - Modin (using Ray)
- SFrame (turi/Apple)
- cudf (nVidia/rapids)
- Kaolas (databricks)

# DataFrames

- Pandas
  - `dask.dataframe`
  - Modin (using Ray)
- SFrame (turi/Apple)
- cudf (nVidia/rapids)
- Kaolas (databricks)
- Vaex ([vaex.io](https://vaex.io))

# DataFrames

- Pandas
  - `dask.dataframe`
  - Modin (using Ray)
- SFrame (turi/Apple)
- cudf (nVidia/rapids)
- Kaolas (databricks)
- Vaex (vaex.io)
- Data format?



# DataFrames

- Pandas
  - `dask.dataframe`
  - Modin (using Ray)
- SFrame (turi/Apple)
- cudf (nVidia/rapids)
- Kaolas (databricks)
- Vaex (vaex.io)
- Data format?
  - Apache Arrow

# What is *vaex*

# What is vaex

- DataFrame library (vaex-core) ala Pandas

# What is vaex

- DataFrame library (vaex-core) ala Pandas
- Many (domain specific) libraries
  - vaex-hdf5 — hdf5 file support
  - vaex-arrow — Apache Arrow support
  - vaex-viz — (matplotlib) based plotting
  - vaex-server — serves remote data frames
  - vaex-ml — ML integration (sklearn, annoy, xgboost, lightgbm, catboost) + automatic pipelines
  - ...

# What is vaex

- DataFrame library (vaex-core) ala Pandas
- Many (domain specific) libraries
  - vaex-hdf5 — hdf5 file support
  - vaex-arrow — Apache Arrow support
  - vaex-viz — (matplotlib) based plotting
  - vaex-server — serves remote data frames
  - vaex-ml — ML integration (sklearn, annoy, xgboost, lightgbm, catboost) + automatic pipelines
  - ...
- `pip install vaex==2` / `conda install -c conda-forge vaex`

# What is vaex

- DataFrame library (vaex-core) ala Pandas
- Many (domain specific) libraries
  - vaex-hdf5 — hdf5 file support
  - vaex-arrow — Apache Arrow support
  - vaex-viz — (matplotlib) based plotting
  - vaex-server — serves remote data frames
  - vaex-ml — ML integration (sklearn, annoy, xgboost, lightgbm, catboost) + automatic pipelines
  - ...
- `pip install vaex==2` / `conda install -c conda-forge vaex`
- Without the kitchen sink:
  - `pip install vaex-core vaex-hdf5 vaex-viz vaex-ml`

# Why does *vaex* exist?

# Why does *vaex* exist?

- Very memory efficient due to expression system



# Why does vaex exist?

- Very memory efficient due to expression system
  - +free pipelines

# Why does vaex exist?

- Very memory efficient due to expression system
  - +free pipelines
  - +free jitting to numba/pythran/CUDA

# Why does vaex exist?

- Very memory efficient due to expression system
  - +free pipelines
  - +free jitting to numba/pythran/CUDA
- Hdf5 + arrow spec (columnar storage) + memory mapping

# Why does vaex exist?

- Very memory efficient due to expression system
  - +free pipelines
  - +free jitting to numba/pythran/CUDA
- Hdf5 + arrow spec (columnar storage) + memory mapping
  - Open a 1.2TB file on your laptop instantly

# Why does vaex exist?

- Very memory efficient due to expression system
  - +free pipelines
  - +free jitting to numba/pythran/CUDA
- Hdf5 + arrow spec (columnar storage) + memory mapping
  - Open a 1.2TB file on your laptop instantly
- No cluster needed

# Why does vaex exist?

- Very memory efficient due to expression system
  - +free pipelines
  - +free jitting to numba/pythran/CUDA
- Hdf5 + arrow spec (columnar storage) + memory mapping
  - Open a 1.2TB file on your laptop instantly
- No cluster needed
  - Handle over 1 billion rows on your laptop

# Why does vaex exist?

- Very memory efficient due to expression system
  - +free pipelines
  - +free jitting to numba/pythran/CUDA
- Hdf5 + arrow spec (columnar storage) + memory mapping
  - Open a 1.2TB file on your laptop instantly
- No cluster needed
  - Handle over 1 billion rows on your laptop
  - 10-1000x string processing speedup (wrt Pandas)

# Why does vaex exist?

- Very memory efficient due to expression system
  - +free pipelines
  - +free jitting to numba/pythran/CUDA
- Hdf5 + arrow spec (columnar storage) + memory mapping
  - Open a 1.2TB file on your laptop instantly
- No cluster needed
  - Handle over 1 billion rows on your laptop
  - 10-1000x string processing speedup (wrt Pandas)
  - Saves time/money/energy



# Vaex: data + state

```
df = {  
    'data': {  
        'x': np.arange(4),  
        'y': np.array([0, np.nan, 5, 1, 1e10])  
    },  
    'state': {}  
}
```

# Vaex: data + state

```
df = {  
    'data': {  
        'x': np.arange(4),  
        'y': np.array([0, np.nan, 5, 1, 1e10])  
    },  
    'state': {}  
}  
  
df2 = df[df.y<10]
```

# Vaex: data + state

```
df = {  
    'data': {  
        'x': np.arange(4),  
        'y': np.array([0, np.nan, 5, 1, 1e10])  
    },  
    'state': {}  
}
```

```
df2 = df[df.y<10]
```

```
df2 = {  
    'data': same_data,  
    'state': {  
        'filter': 'y < 10'  
    }  
}
```

# Vaex: data + state

```
df = {  
    'data': {  
        'x': np.arange(4),  
        'y': np.array([0, np.nan, 5, 1, 1e10])  
    },  
    'state': {}  
}
```

```
df2 = df[df.y<10]
```

```
df2 = {  
    'data': same_data,  
    'state': {  
        'filter': 'y < 10'  
    }  
}
```

```
df2['z'] = df.x + df.y*10
```

# Vaex: data + state

```
df = {  
    'data': {  
        'x': np.arange(4),  
        'y': np.array([0, np.nan, 5, 1, 1e10])  
    },  
    'state': {}  
}
```

```
df2 = df[df.y<10]
```

```
df2 = {  
    'data': same_data,  
    'state': {  
        'filter': 'y < 10'  
    }  
}
```

```
df2['z'] = df.x + df.y*10
```

```
df2 = {  
    'data': same_data  
    'state': {  
        'filter': 'y < 10'  
        'virtual_columns': {  
            'z': 'x + y*10'  
        }  
    }  
}
```

***“Never do a live demo”***

**-Many people**

# Conclusions

# Conclusions

- Vaex: A very fast and memory efficient Dataframe library



# Conclusions

- Vaex: A very fast and memory efficient Dataframe library
  - 1 billion rows - 1TB data on a laptop

# Conclusions

- Vaex: A very fast and memory efficient Dataframe library
  - 1 billion rows - 1TB data on a laptop
- Concept of data + state (virtual columns, filters)

# Conclusions

- Vaex: A very fast and memory efficient Dataframe library
  - 1 billion rows - 1TB data on a laptop
- Concept of data + state (virtual columns, filters)
- Expression system allows jitting (numba, pythran, CUDA)

# Conclusions

- Vaex: A very fast and memory efficient Dataframe library
  - 1 billion rows - 1TB data on a laptop
- Concept of data + state (virtual columns, filters)
- Expression system allows jitting (numba, pythran, CUDA)
- State 'remembers' the 'pipeline', it's an artifact you get for free. Easy deployment.

# Conclusions

- Vaex: A very fast and memory efficient Dataframe library
  - 1 billion rows - 1TB data on a laptop
- Concept of data + state (virtual columns, filters)
- Expression system allows jitting (numba, pythran, CUDA)
- State 'remembers' the 'pipeline', it's an artifact you get for free. Easy deployment.
- S3 support, remote dataframes.

# Resources

- Contact:
  - [contact@vaex.io](mailto:contact@vaex.io)
  - [maartenbreddels@gmail.com](mailto:maartenbreddels@gmail.com)
  - [jovan.veljanoski@gmail.com](mailto:jovan.veljanoski@gmail.com)
  - Twitter: @maartenbreddels / @vaex\_io
- [vaex.io](http://vaex.io) / [docs.vaex.io](http://docs.vaex.io)
- [github.com/vaexio/vaex/](https://github.com/vaexio/vaex/)
- [github.com/vaexio/vaex-talks/](https://github.com/vaexio/vaex-talks/)
- Medium
  - Vaex: Out of Core Dataframes for Python and Fast Visualization
  - Vaex: A DataFrame with super strings