Monary

Scientific analysis with MongoDB and Numpy

Imagine a world where...

- You are a data scientist
- You have taken a cab in New York

... and you want to analyze data

How can you do that?

- Need a tool to run analysis
- Need a place to store it

What to use for analysis?

To take an average...

- List of Python Dictionaries

  ~12 million numbers/sec

[{“a”: 1}, {“a”:2}, {“a”:3}]

What to use for analysis?

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What to use for analysis?

To take an average...

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- Python List

  110 million numbers/sec

[1,2,3]

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- numpy.ndarray

  500 million numbers/sec

[1,2,3]

What to use for analysis?

To take an average...

- List of Python Dictionaries

  ~12 million numbers/sec

- Python List

  110 million numbers/sec

- numpy.ndarray

  500 million numbers/sec

Numpy

Numerical **Py**thon:

Scientific computing with Python

- **ndarray:** n-dimensional array. High performance, C-style arrays
- extensive built-in math libraries

Storage

Where to store our data?

MongoDB

Open-source document database

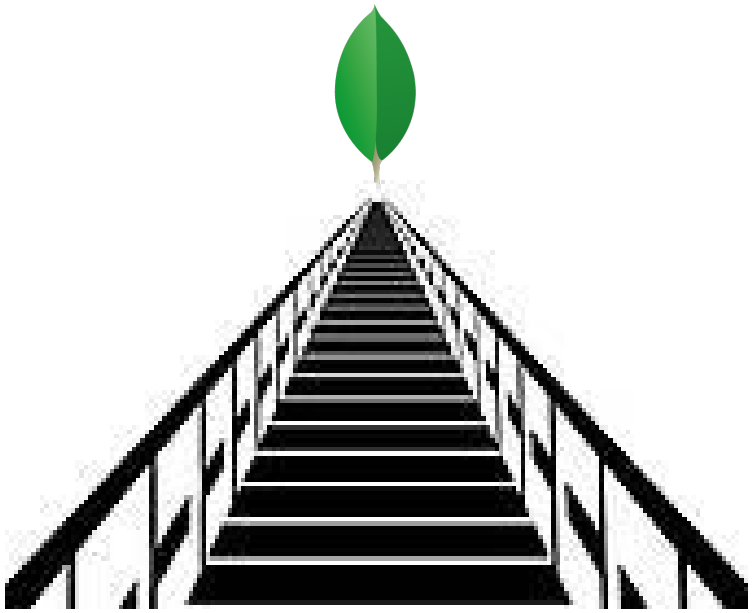
- data stored as BSON

```
{
    “name”: “anna”,
    “height”: 67,
}
```

Why MongoDB?

- **Easy to use!**
- Powerful query language
  - built-in geo queries
- Sophisticated aggregations

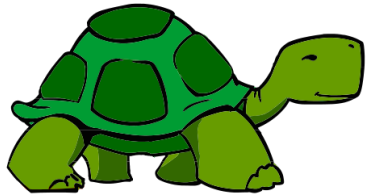
Now what?

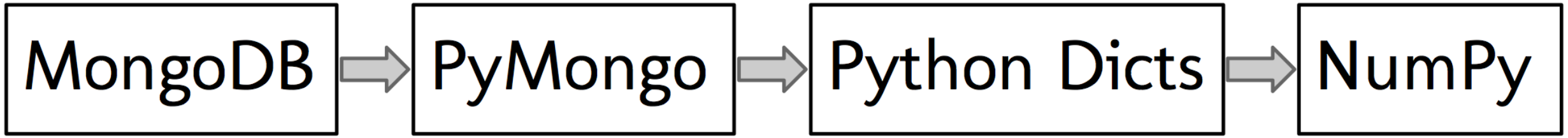


NumPy

PyMongo

Official MongoDB Python Driver





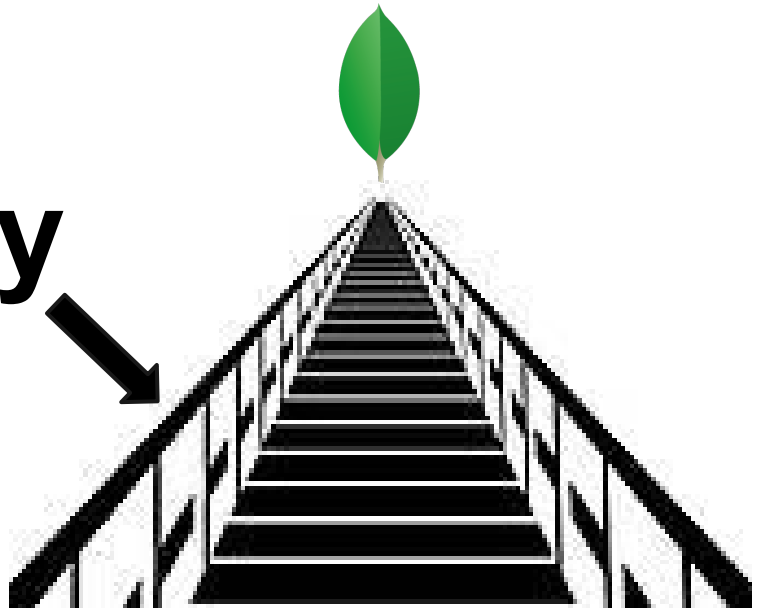
About 150,000 documents read per second

Can we do better?

Monary

Over ***1,700,000*** reads per second

Monary



NumPy

Monary Overview

- author: David J. C. Beach
- operations: CRUD
- dependencies: NumPy
- driver: MongoDB C Driver 1.0

Monary Features

- Insert
- Remove
- Queries
- Aggregation Framework

Monary Queries

Say you have a DB, “test”, with documents:

```
{“a”: 5,
 “b”: “hello!”,
 “c”: [1.2, 2.5, 3.1, 4.6, 5.7]}
```

...and you want to get a closer look at all documents for which *a* = *5*

Monary Queries

```
with Monary() as m:
  m.query("test",
```

Database

Monary Queries

```
with Monary() as m:
  m.query("test",
          "collection",
```

Database

Collection

Monary Queries

```
with Monary() as m:
  m.query("test",
          "collection",
          {"a":5},
```

Database

Collection

Query

Monary Queries

```
with Monary() as m:
  m.query("test",
          "collection",
          {"a":5},
          ["b"],
          ["string"])
```

Database

Collection

Query

Field Name

Return Type

Multiple Field Queries

```
with Monary() as m:
  m.query("test",
          "collection",
          {"a":5},
          ["b", "c"],
          ["string", "5float64"])
```

Database

Collection

Query

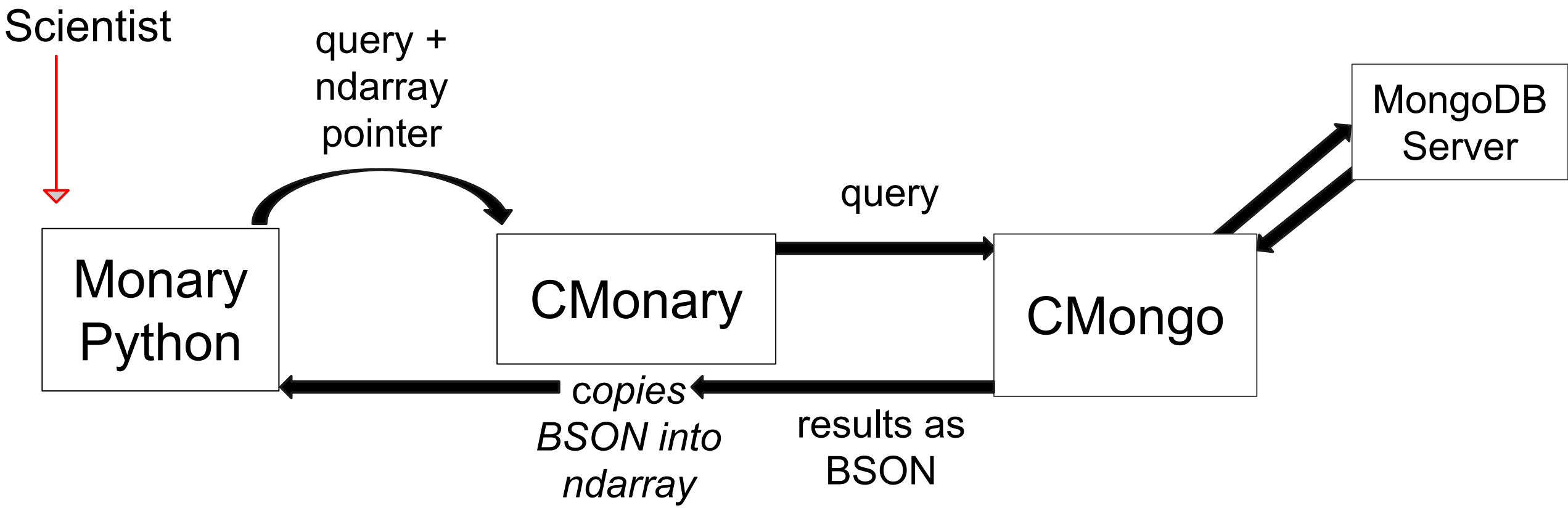
Field Name

Return Type

How Does Monary Work?

Python	C
● **numpy**: allocates ndarrays ● **Ctypes**: passes pointers to ndarrays into C ● *Passes user queries to CMongo and receives data back*	● **CMongo**: MongoDB C Driver ● **Libbson**: BSON Library ● *Populates arrays allocated by numpy with data retrieved from MongoDB*

How Does Monary Work?



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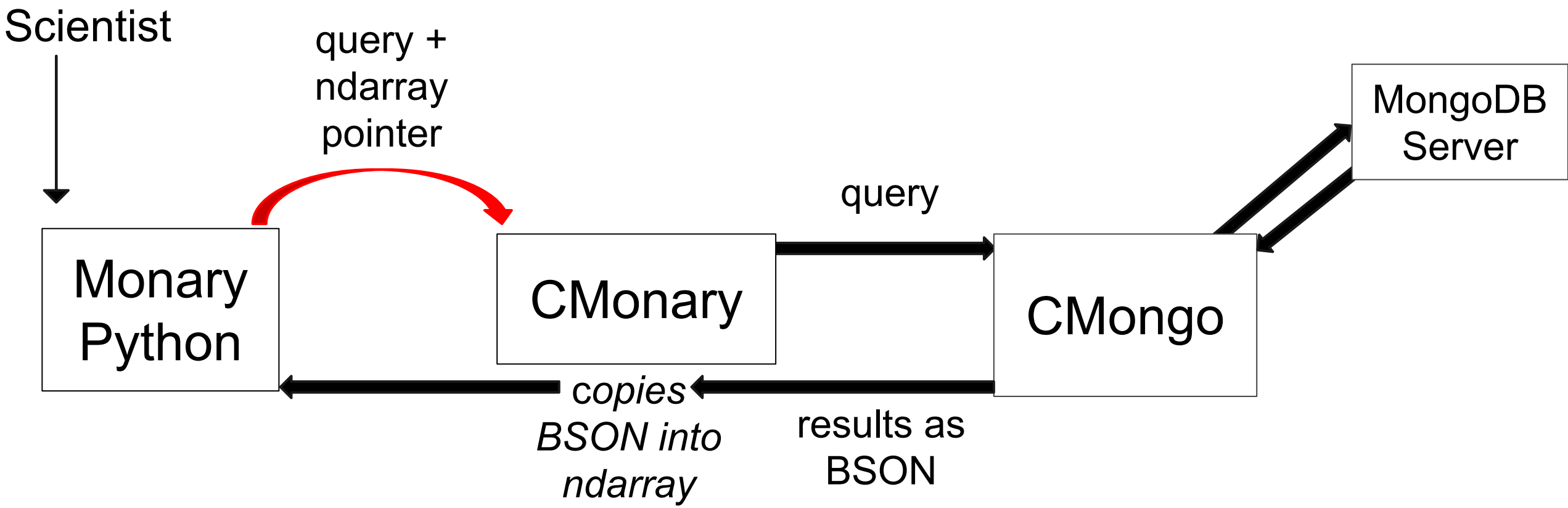

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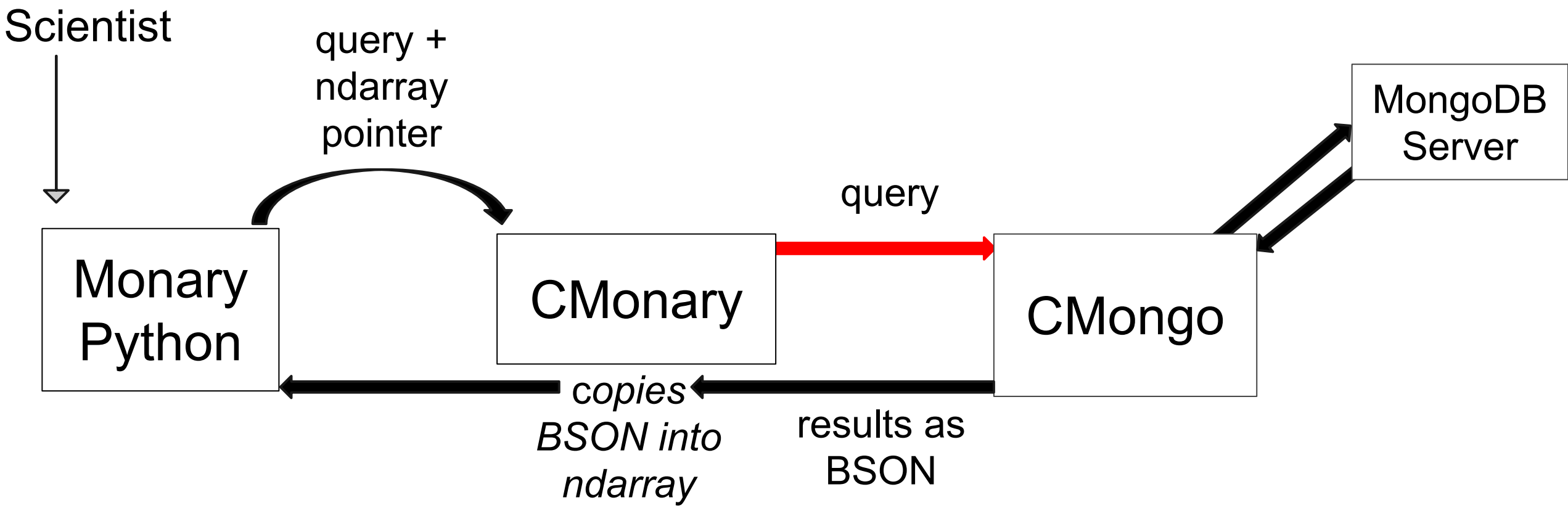

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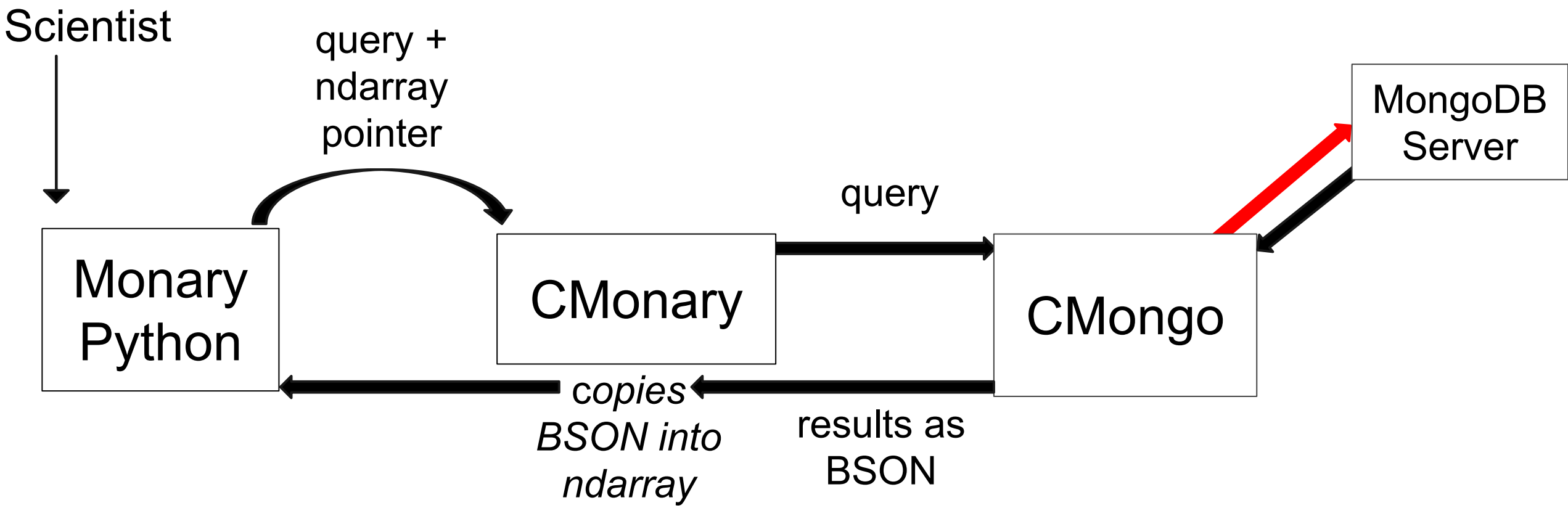

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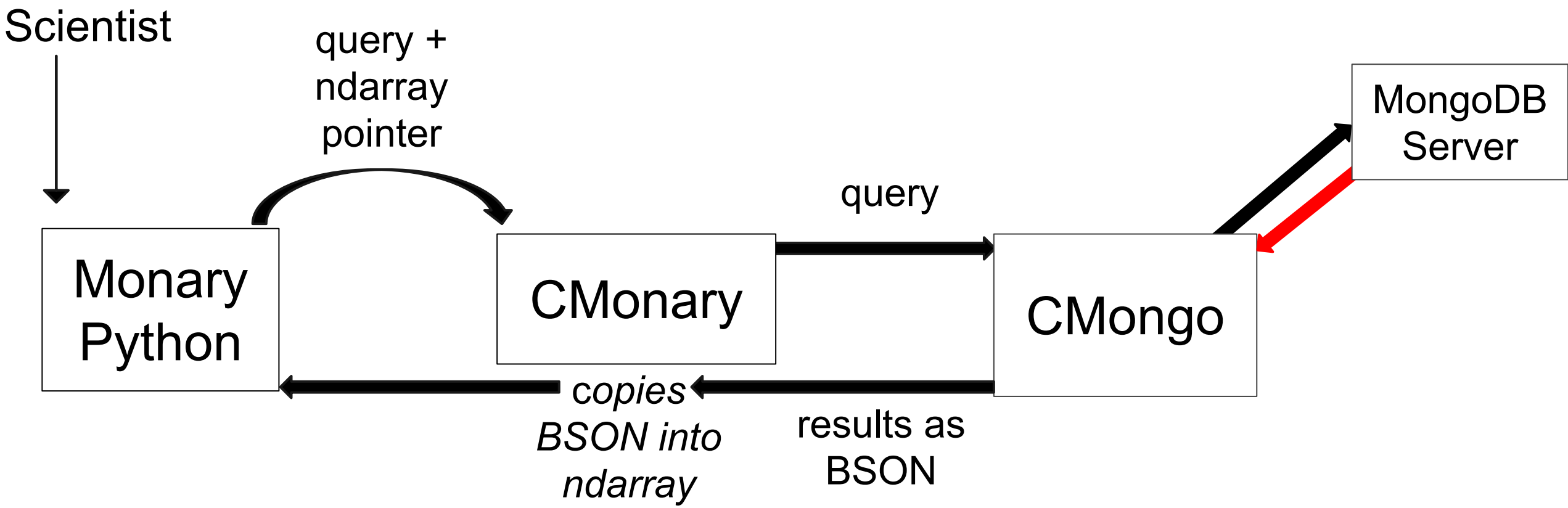

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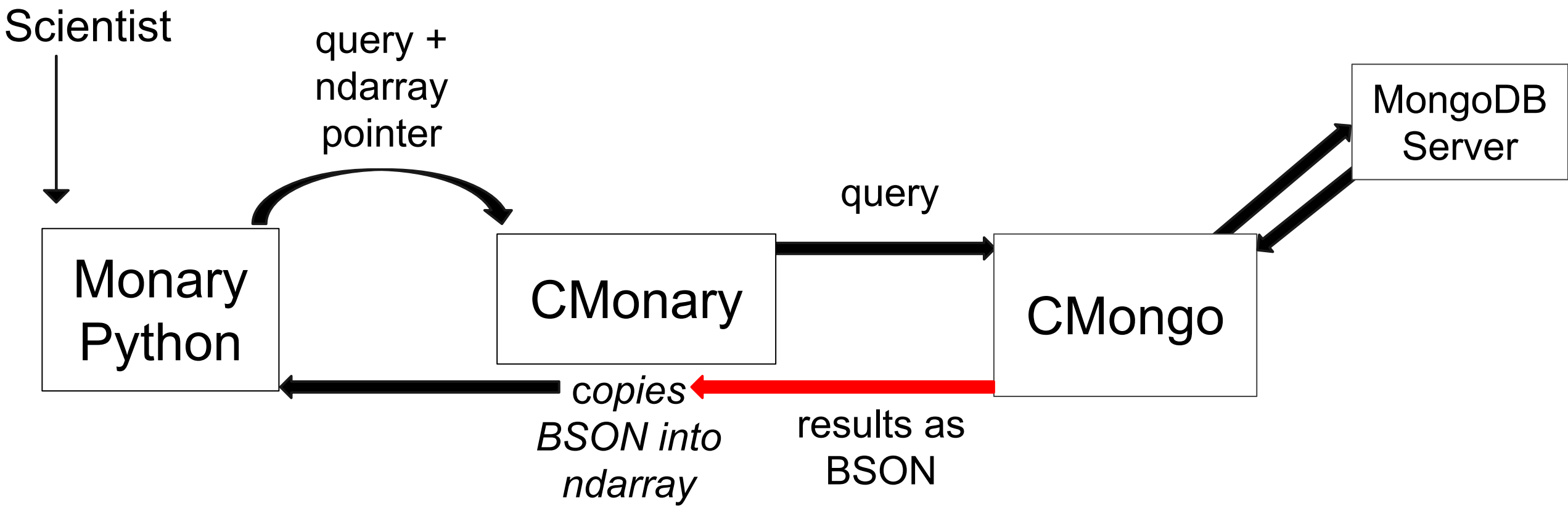

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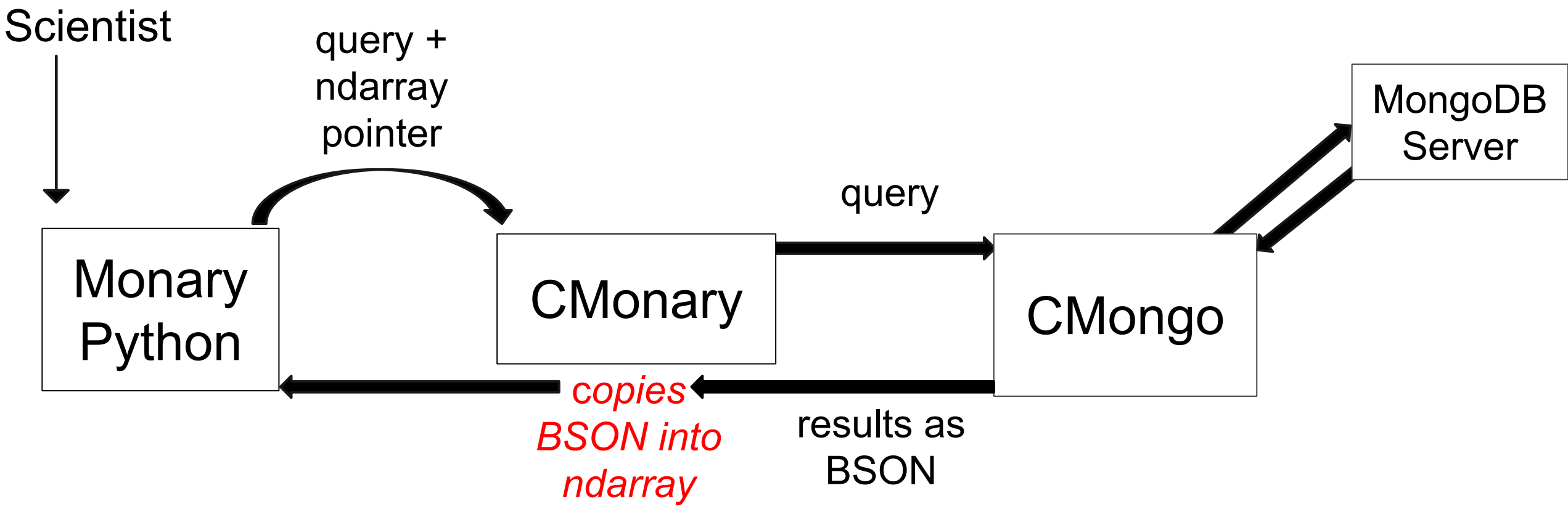

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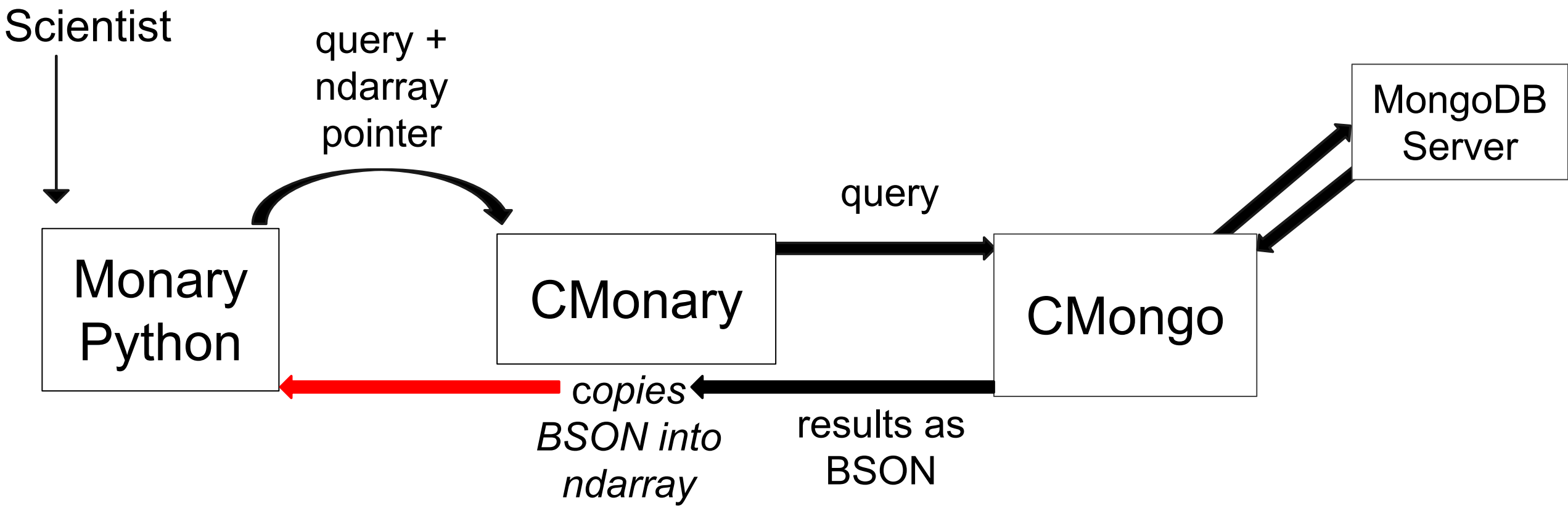


Monary Benefits

We can now combine the computational power of NumPy with the simplicity of MongoDB!

Demo

- NYC Taxi Data 2013 (Chris Whong)
- ~168 million rides
- What to do with it?

Noel Y. C. @ http://nyclovesnyc.blogspot.com/

Collections

- “**pickups**”: set of trips that start in Times Square
- “**drops**”: set of trips that end in Times Square
- “**both**”: set of trips that start and end in the 5-block radius around times square (yes, there were 140,829)

Example: Query

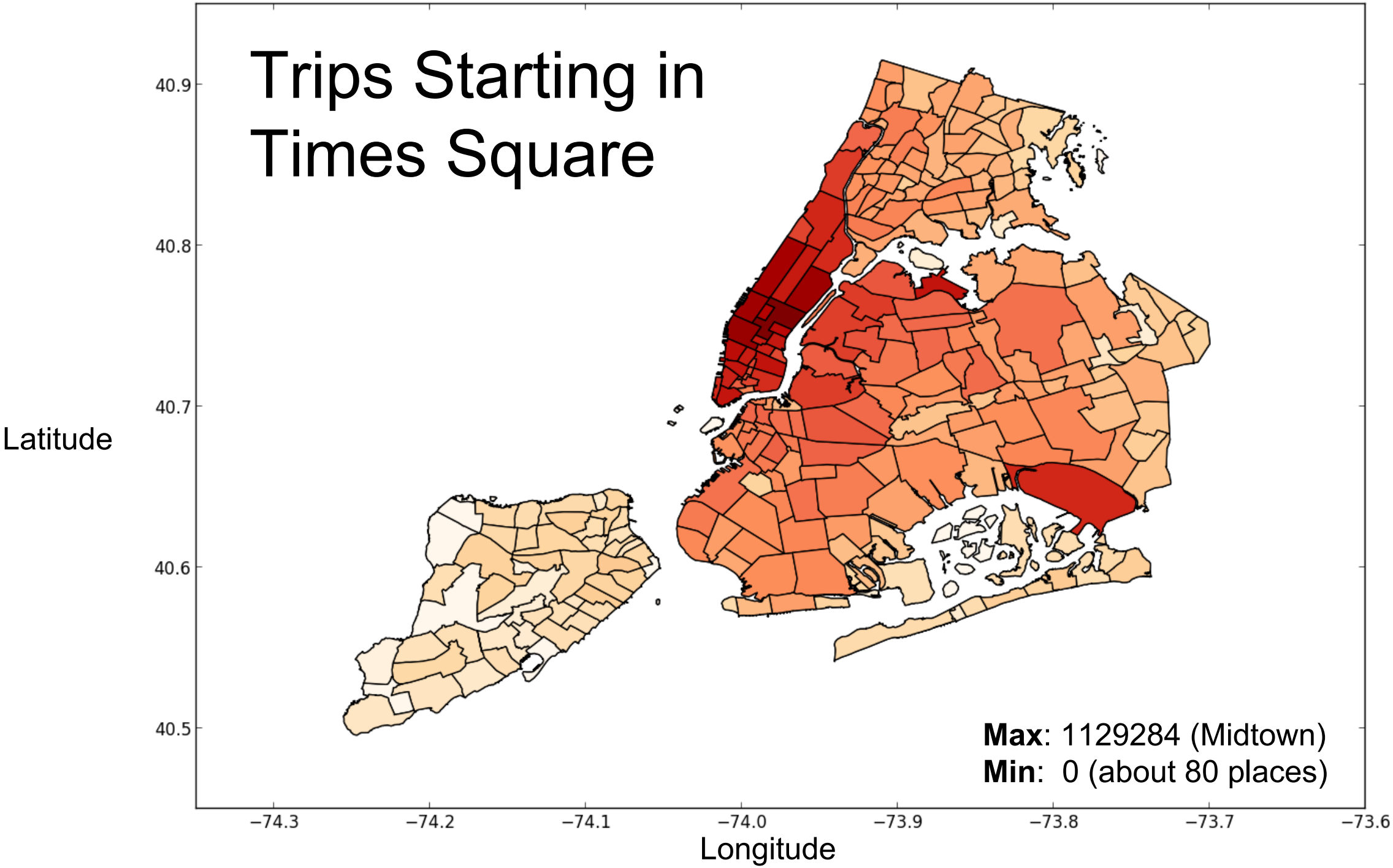
Filtering by Neighborhood

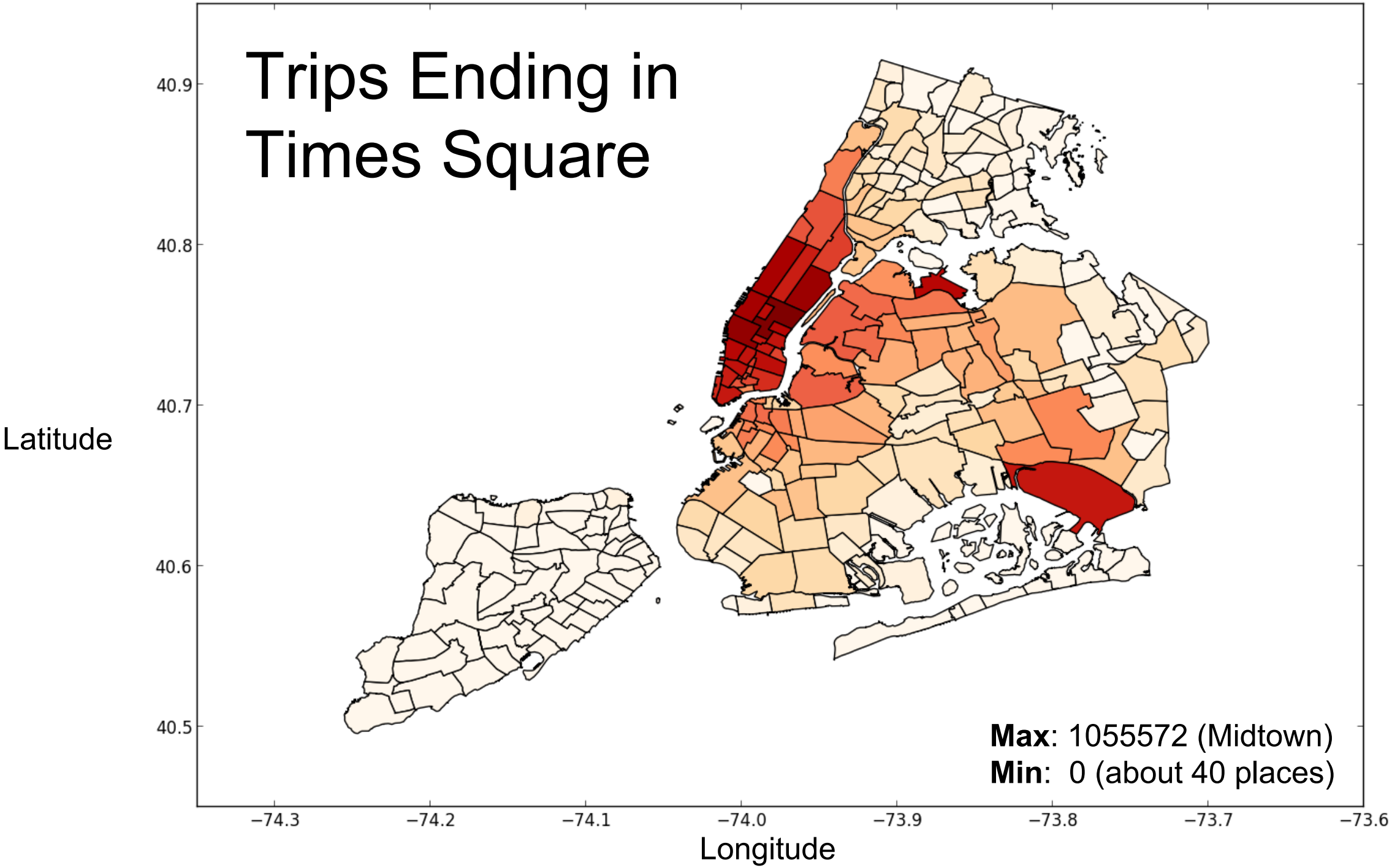
- How can I further simplify the data?
  - Primarily interested in location points
- PediaCities' NYC neighborhoods GeoJSON

  http://nyc.pediacities.com/nycpedia
- MongoDB's Geo Queries

My Query

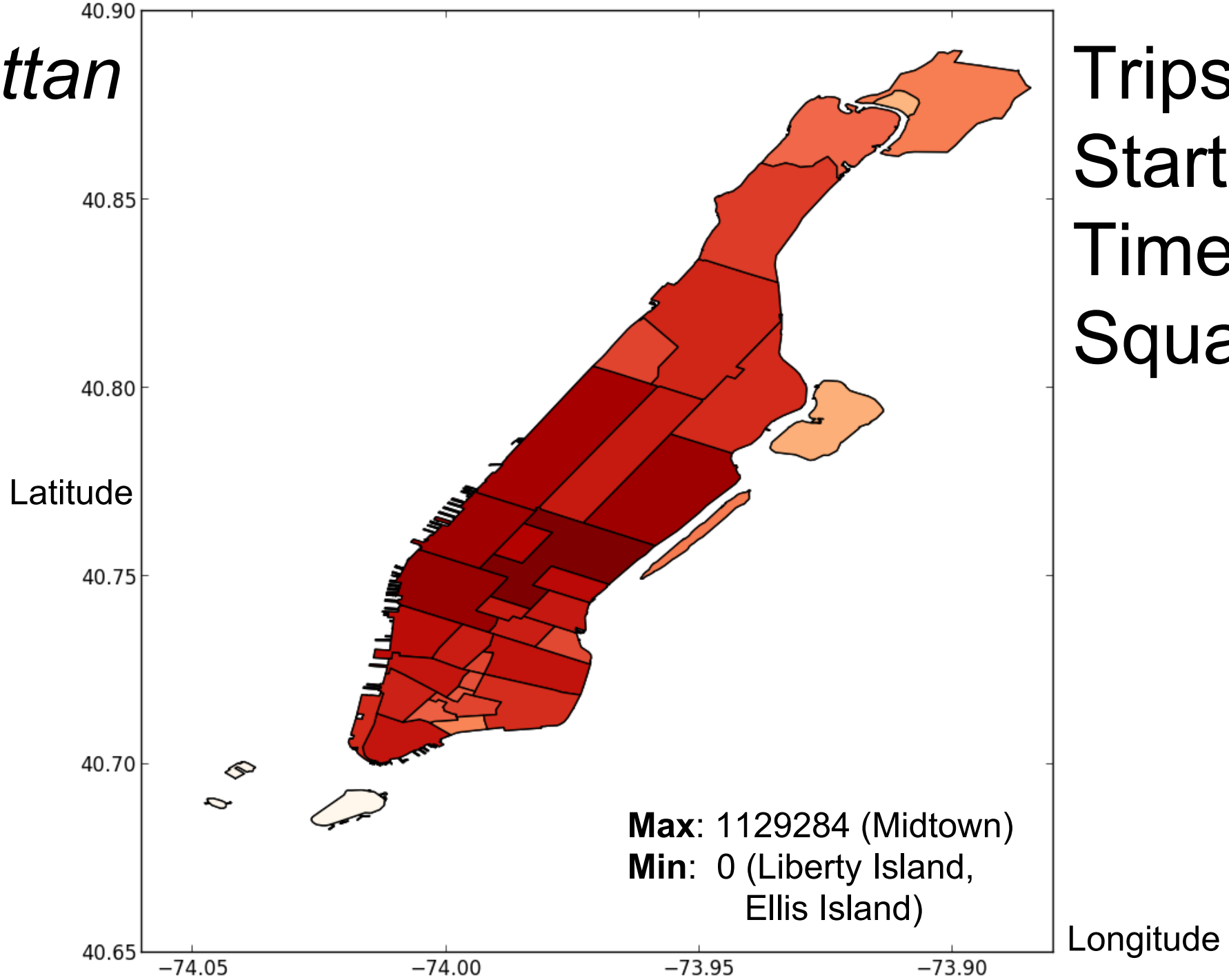
```
with Monary() as m:
  m.count("taxi",
            "drop",
            {pickup_loc:
               $geoWithin: {
                   neighborhoods["soho"]
              }
           })
```


Trips Starting in Times Square
Max: 1129284 (Midtown)
Min: 0 (about 80 places)
Latitude
40.9
40.8
40.7
40.6
40.5
Longitude
−74.3
−74.2
−74.1
−74.0
−73.9
−73.8
−73.7
−73.6


Trips Ending in Times Square
Max: 1055572 (Midtown)
Min: 0 (about 40 places)
40.9
40.8
40.7
40.6
40.5
Latitude
−74.3
−74.2
−74.1
−74.0
−73.9
−73.8
−73.7
−73.6
Longitude

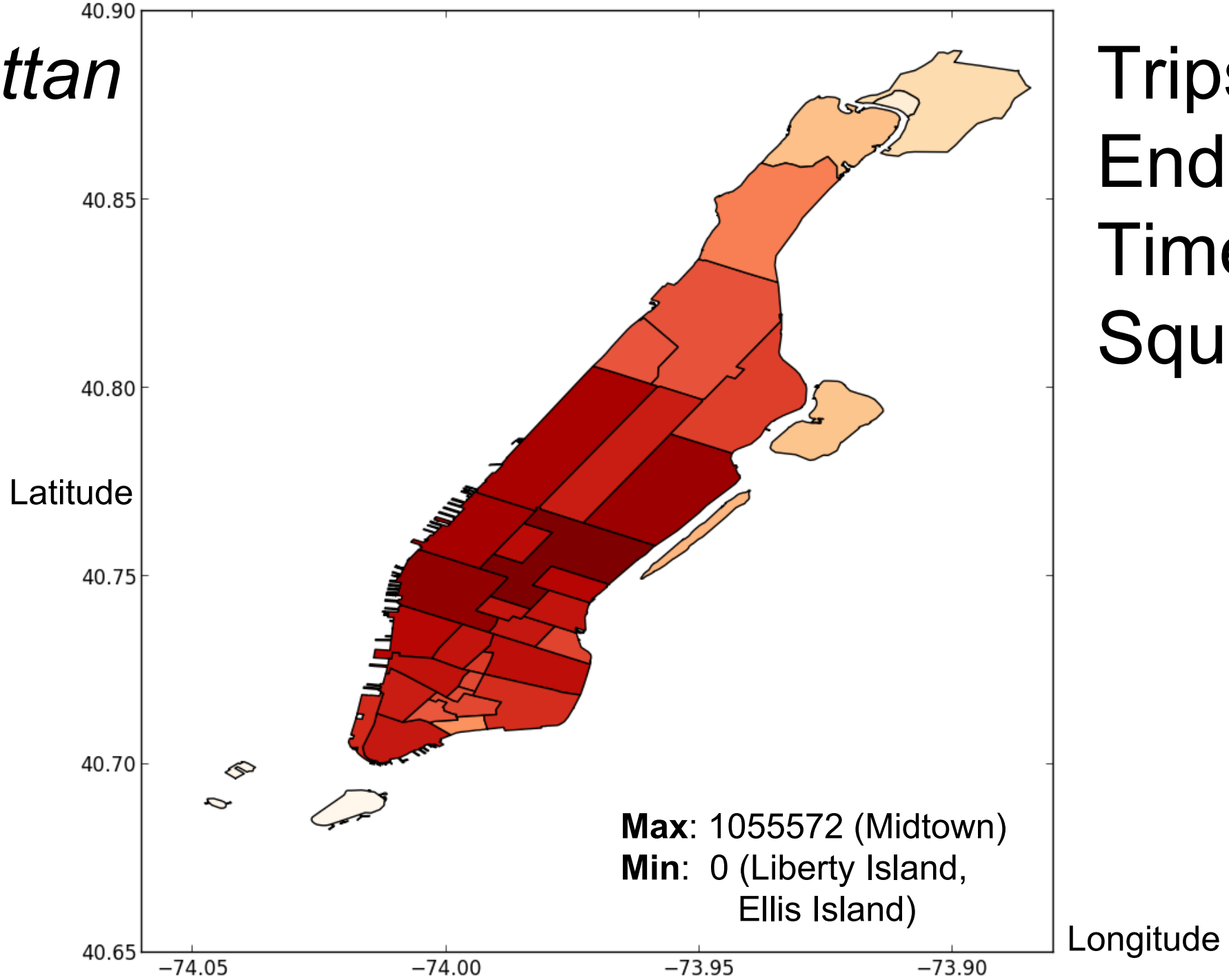
Manhattan

Trips Starting in Times Square



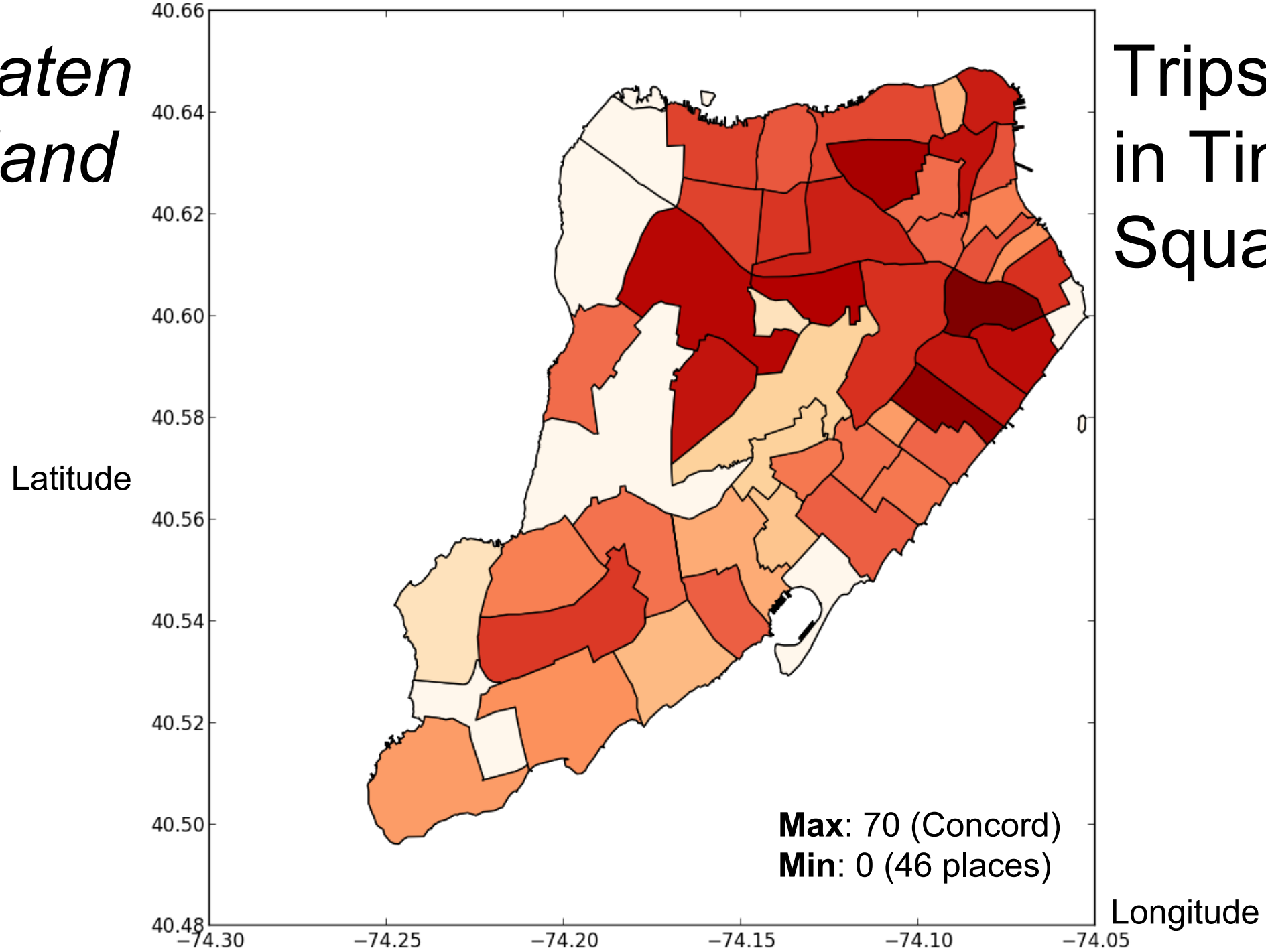
Manhattan

Trips Ending in Times Square



Staten Island

Trips Starting in Times Square



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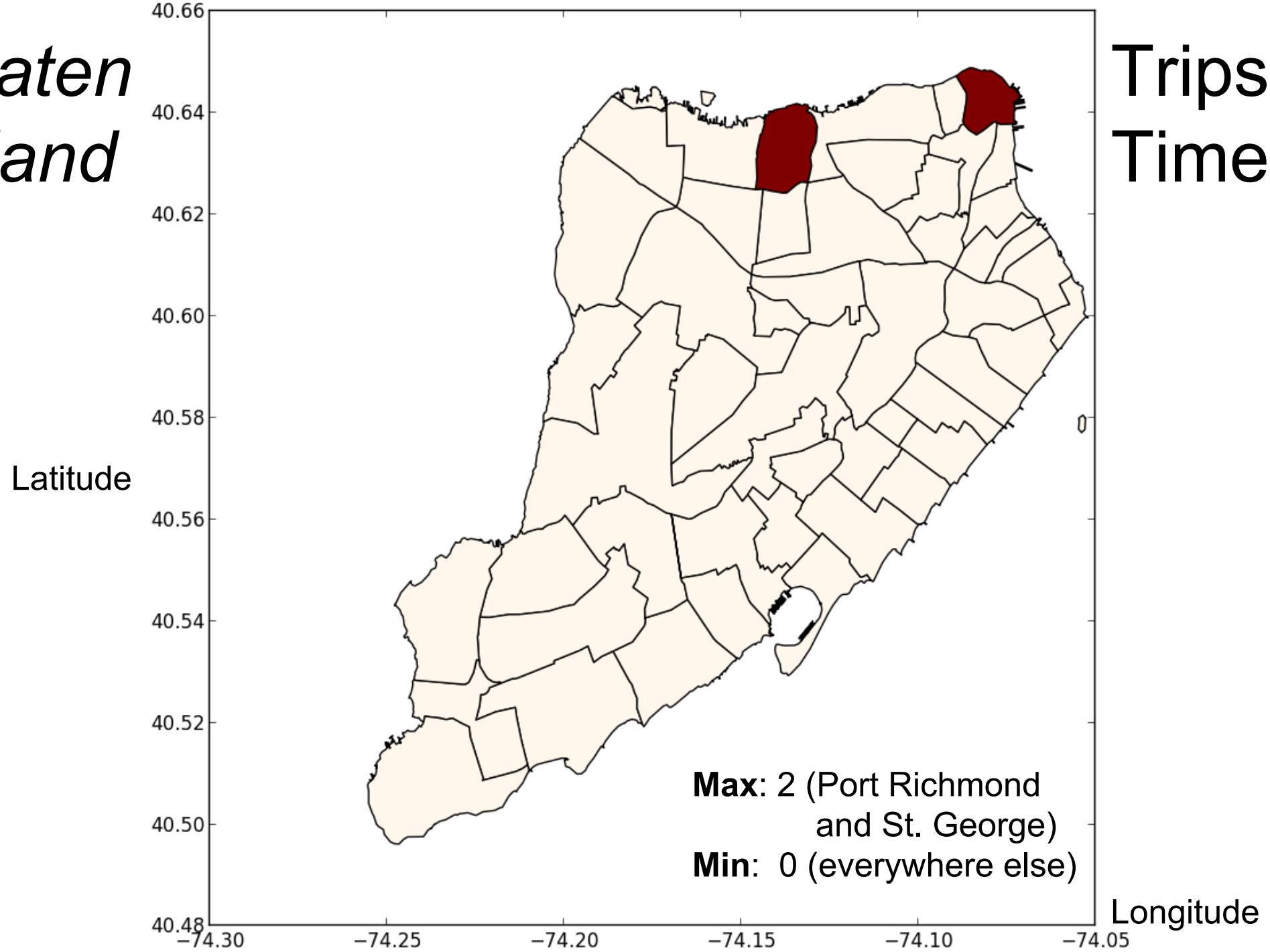

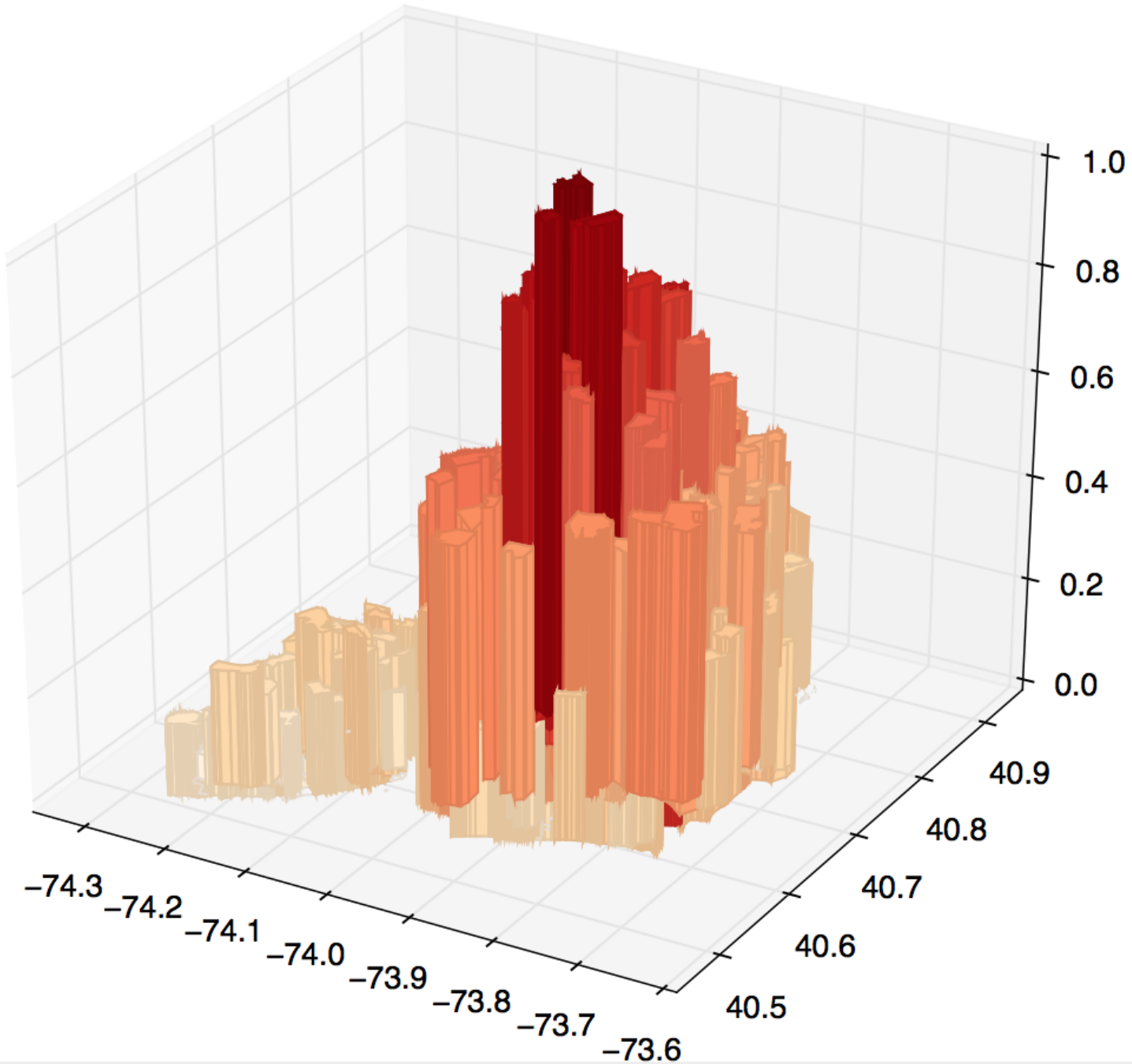

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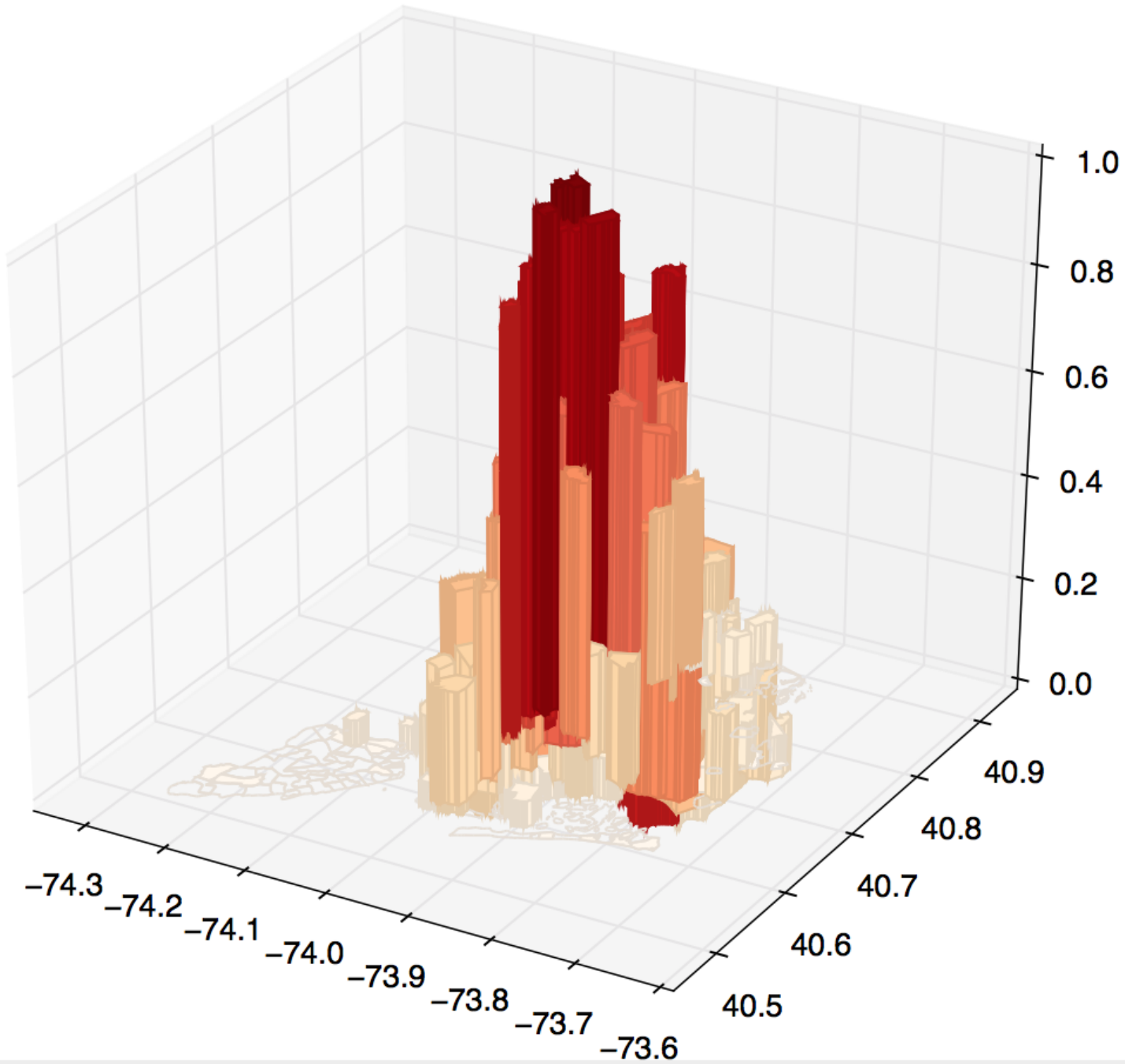


Trips Ending in Times Square

Example: Aggregation

Aggregating Data by Date

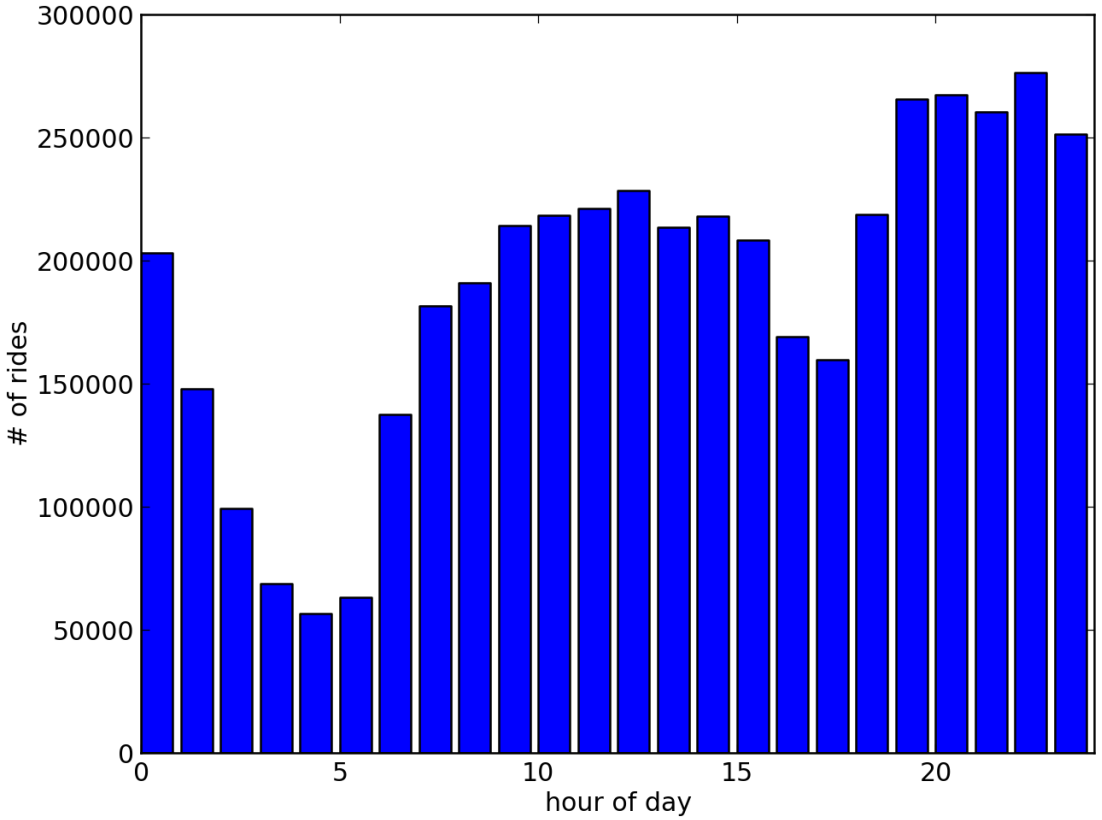
- MongoDB aggregation pipeline sets up various filters to run the data through
- $group, $count, $sort
- Date Operators: $hour, $dayOfWeek, $dayOfMonth, $dayOfYear

Aggregation

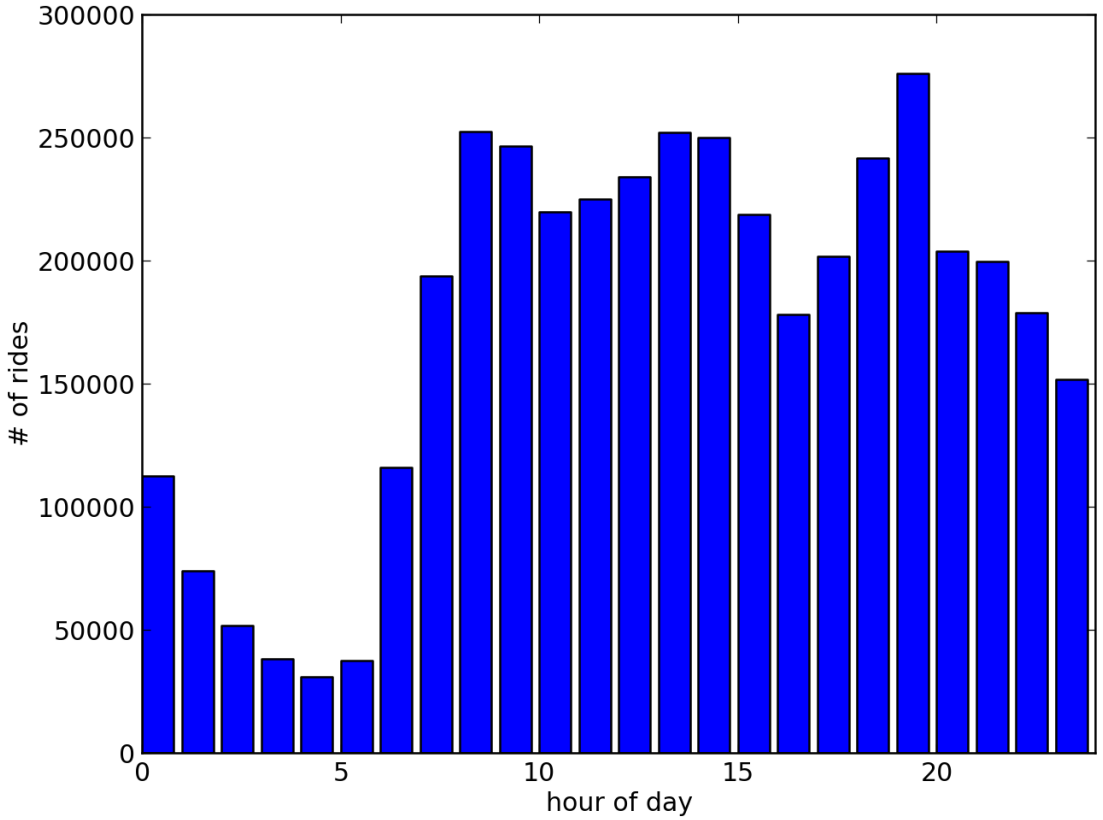
```
db.both.aggregate(
  [{$group: { _id:
                { hourOfRide:
                  {$hour: "$pickup_time}},
               count: {$sum: 1}
               }}])
```

$hour

Starting in Times Square

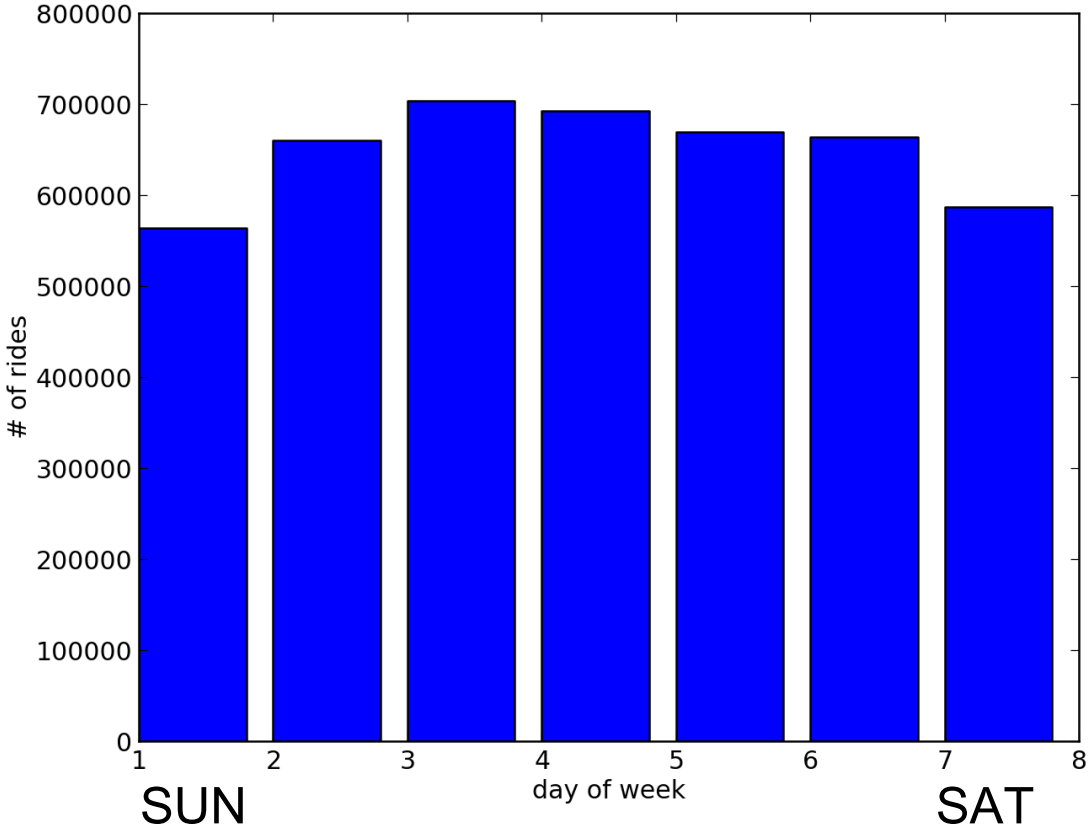


Ending in Times Square

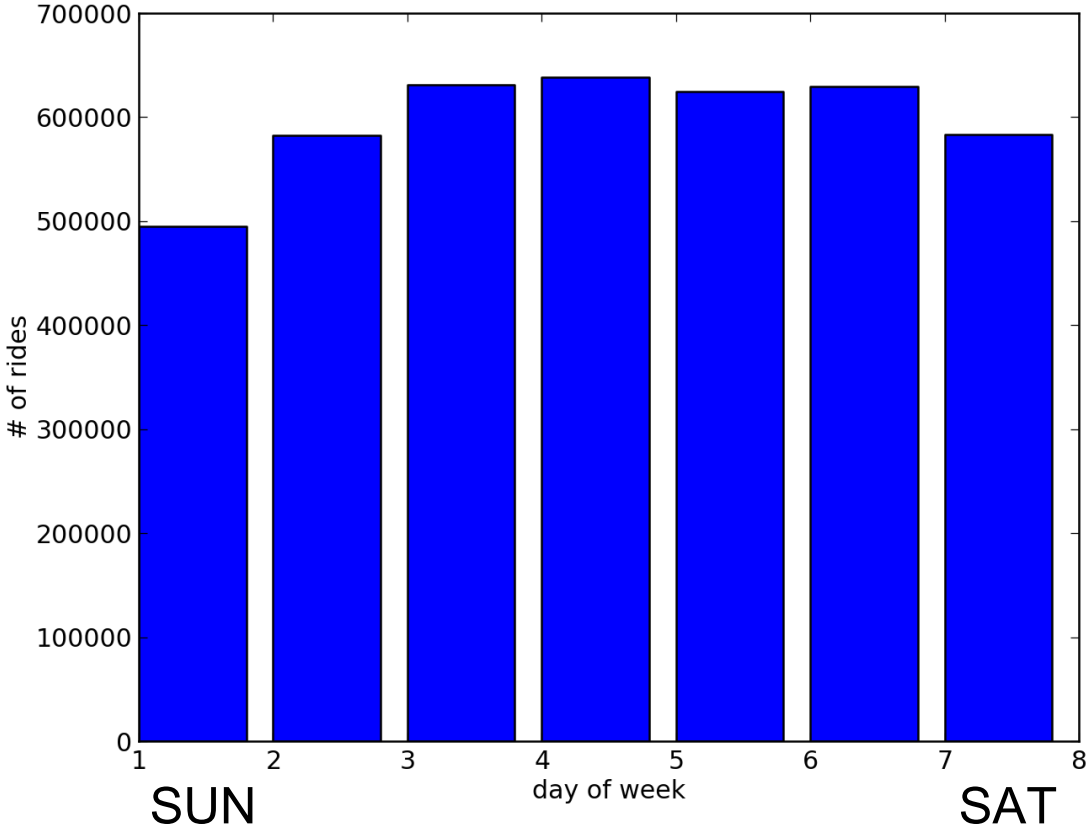


$dayOfWeek

Starting in Times Square

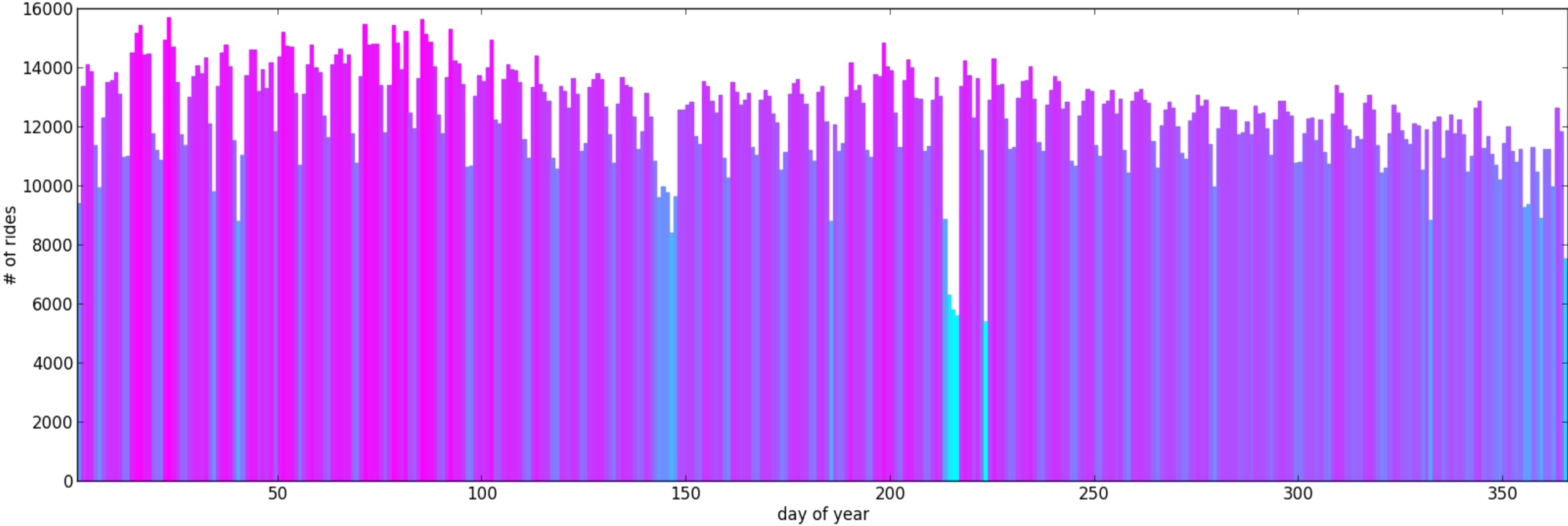


Ending in Times Square



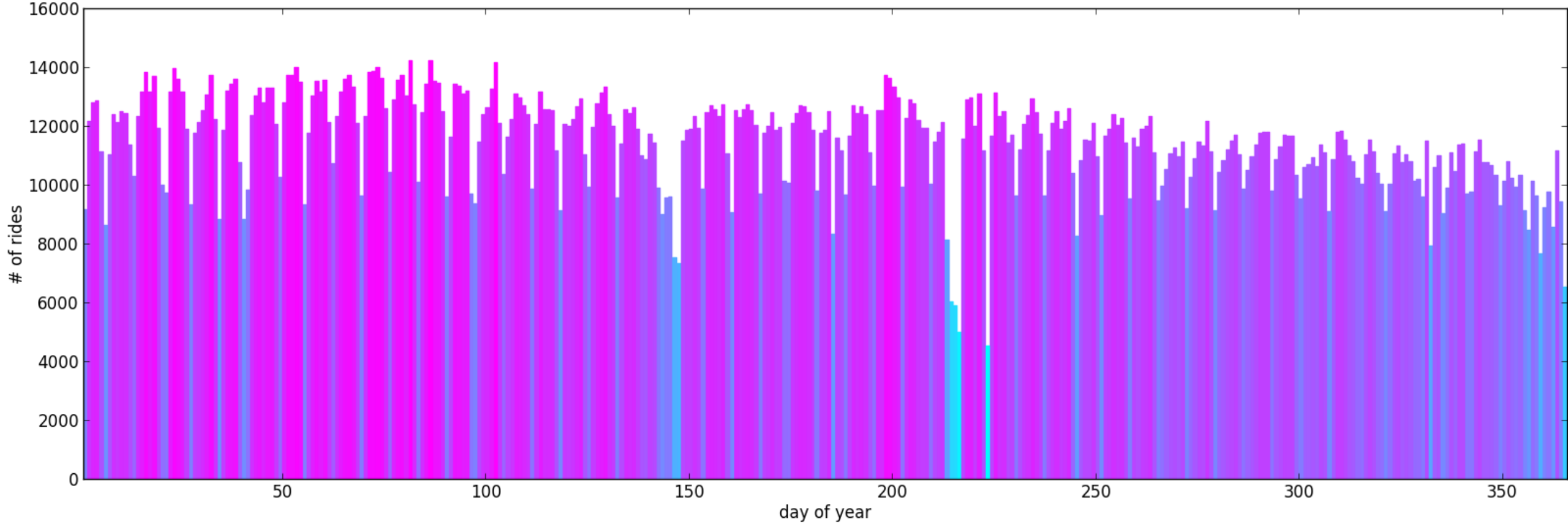
$dayOfYear

Starting in Times Square



$dayOfYear

Ending in Times Square



Future of Monary

Very exciting time for Monary!

- Matt and Kyle: inserts, aggregation, PyPI integration
- Me: SSL, error handling, multidimensional array extraction
- TBD: Optimized search, logging, upserts, new C bindings, type-safe mode, and more!

Future Monary Integration

- Currently, a lot of projects that use MongoDB connect with Pymongo
  - Blaze!
- There are a lot of projects that could use a connection with MongoDB
  - Pandas!
- Endless other use cases!

HUGE Thanks

- My mentors at MongoDB
  - A. Jesse Jiryu Davis
  - Jason Carey
- Summer Interns
  - Matt Cotter
  - Kyle Suarez
- David Beach


Thank you
PyData!
Foot Locker
Noel Y. C. @ http://nyclovesnyc.blogspot.com/

Contact

anna.herlihy@mongodb.com

Source: https://bitbucket.org/djcbeach/monary

PyPI: pypi.python.org/pypi/monary

Documentation: tinyurl.com/monary-docs

This Talk: github.com/aherlihy/monary-talk