PySpark of Warcraft

understanding video games better through data

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Who is this guy

- Vincent D. Warmerdam
- data guy @ GoDataDriven
- from amsterdam
- avid python, R and js user.
- give open sessions in R/Python
- minor user of scala, julia.
- hobbyist gamer. Blizzard fanboy.
- in **no way** affiliated with Blizzard.

Today

1. Description of the task and data
2. Description of the big technical problem
3. Explain why Spark is good solution
4. Explain how to set up a Spark cluster
5. Show some PySpark code
6. Share some conclusions of Warcraft
7. Conclusion + Questions
8. If time: demo!

TL;DR

Spark is a very worthwhile, open tool.

If you just know python, it's a preferable way to do big data in the cloud. It performs, scales and plays well with the current python data science stack, although the api is a bit limited.

This project has gained enormous traction, so you can expect more in the future.

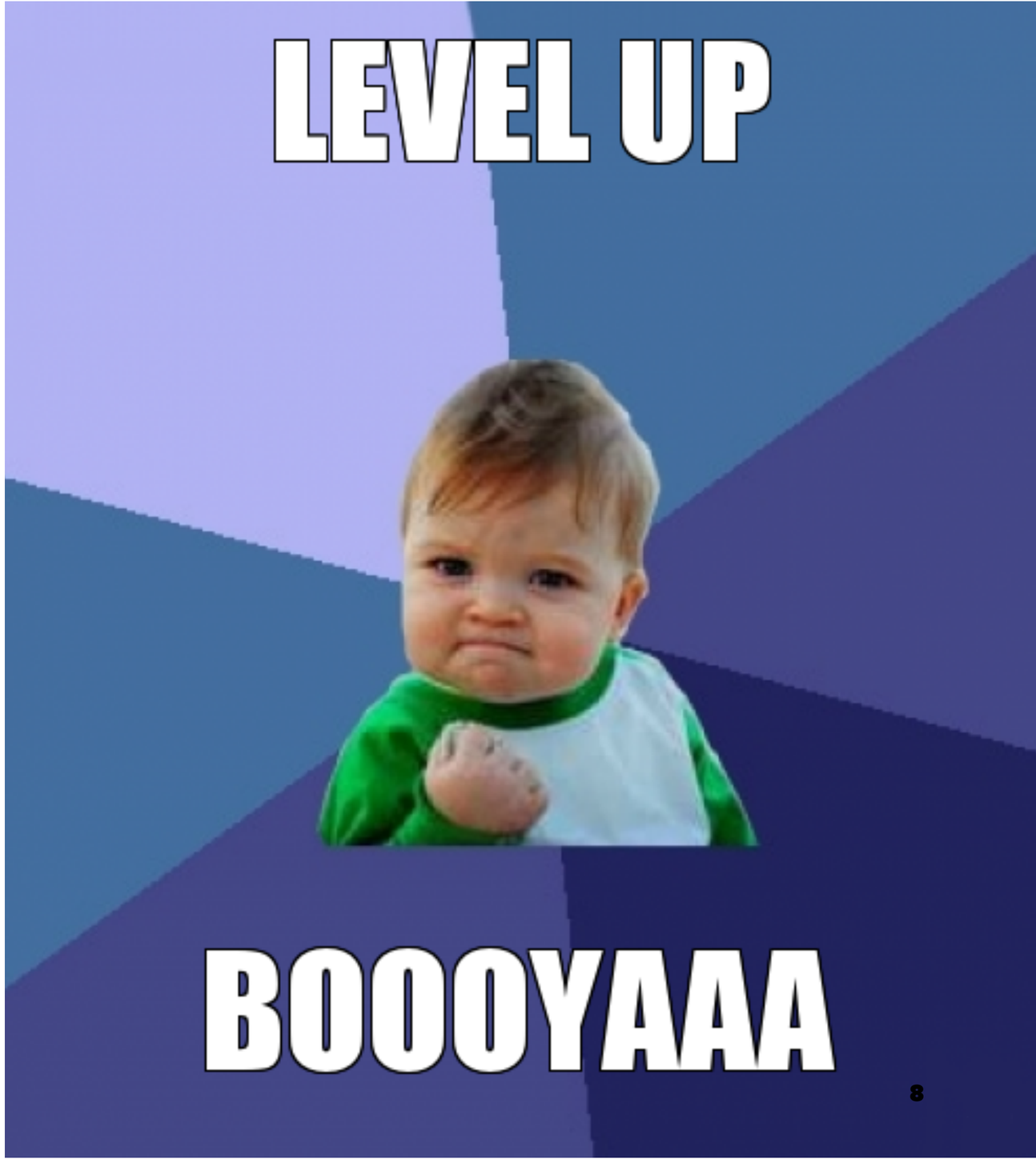
1. The task and data

For those that haven't heard about it yet


WORLD OF WARCRAFT™

The Game of Warcraft

- you keep getting stronger
- fight stronger monsters
- get stronger equipment
- fight stonger monsters
- you keep getting stronger
- repeat ...



Items of Warcraft

Items/gear are an important part of the game. You can collect raw materials and make gear from it. Another alternative is to sell it.

- you can collect virtual goods
- you trade with virtual gold
- to buy cooler virtual swag
- to get better, faster, stronger
- collect better virtual goods

World of Warcraft Auction House

WoW data is cool!

- now about 10 million of players
- 100+ identical wow instances (servers)
- real world economic assumptions still hold
- perfect measurement that you don't have in real life
- each server is an identical
- these worlds are independant of eachother

WoW Auction House Data

For every auction we have:

- the product id (which is tracable to actual product)
- the current bid/buyout price
- the amount of the product
- the owner of the product
- the server of the product

See api description.

Sort of questions you can answer?

- Do basic economic laws make sense?
- Is there such a thing as an equilibrium price?
- Is there a relationship between production and price?

This is very interesting because...

- It is very hard to do something like this in real life.

How much data is it?

The Blizzard API gives you snapshots every two hours of the current auction house status.

One such snapshot is a 2 GB blob op json data.

After a few days the dataset does not fit in memory.

What to do?

It is not trivial to explore this dataset.

This dataset is too big to just throw in excel.

Even pandas will have trouble with it.

Possible approach

Often you can solve a problem by avoiding it.

- use a better fileformat (csv instead of json)
- hdf5 where applicable

This might help, but this approach does not scale.

The scale of this problem seems too big.

2. The technical problem

This problem occurs more often

This is a BIG DATA problem

What is a big data problem?

'Whenever your data is too big to analyze on a single computer.'

- Ian Wrigley, Cloudera

What do you do when you want to blow up a building?

Use a bomb.

What do you do when you want to blow up a building?

Use a bomb.

What do you do when you want to blow up a bigger building?

Use a bigger, way more expensive, bomb

What do you do when you want to blow up a building?

Use a bomb.

What do you do when you want to blow up a bigger building?

~~Use a bigger, way more expensive, bomb~~

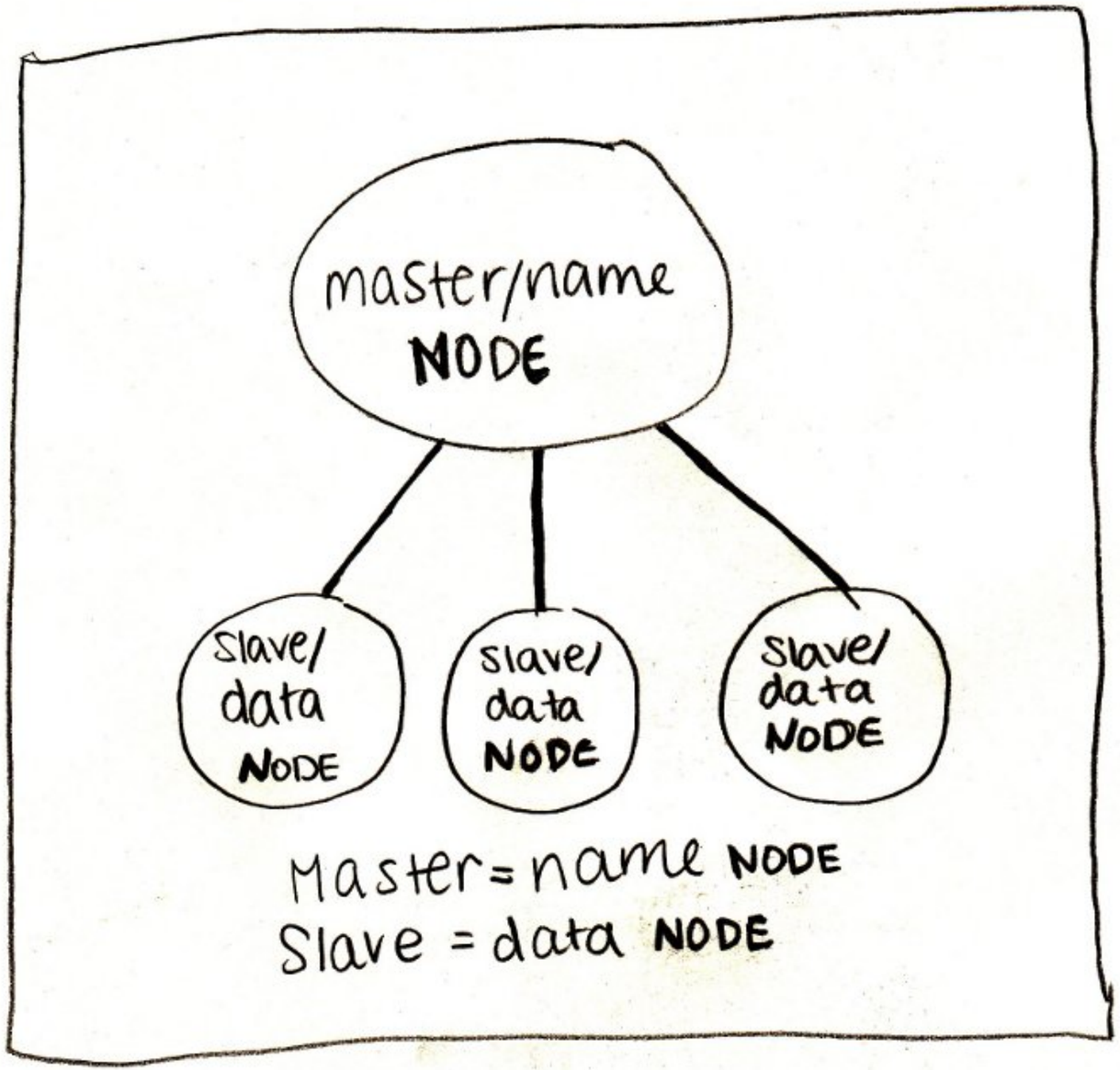
Use many small ones.

3. The technical problem

Take the many small bombs approach

Distributed disk (Hadoop/Hdfs)

- connect machines
- store the data on multiple disks
- compute map-reduce jobs in parallel
- bring code to data
- not the other way around
- old school: write map reduce jobs

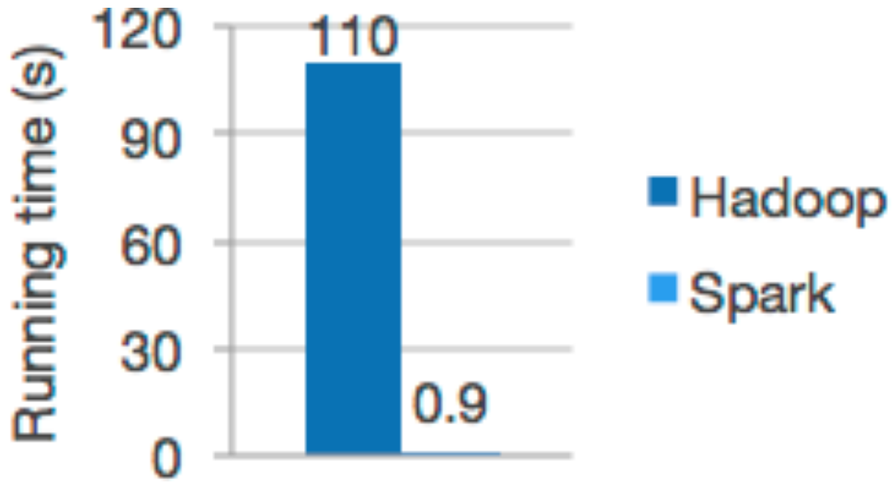


Why Spark?

"It's like Hadoop but it tries to do computation in memory."

Why Spark?

"Run programs up to 100x faster than Hadoop MapReduce in memory, or 10x faster on disk."



It does performance optimization for you.

Spark is parallel

Even locally

```
Processes: 228 total, 3 running, 3 stuck, 222 sleeping, 1345 threads                 21:04:
Load Avg: 3.24, 2.29, 1.87  CPU usage: 96.94% user, 2.76% sys, 0.29% idle
SharedLibs: 90M resident, 0B data, 14M linkedit.
MemRegions: 83992 total, 7019M resident, 76M private, 13G shared.
PhysMem: 13G used (2546M wired), 632M unused.
VM: 608G vsize, 1312M framework vsize, 3013284(0) swapins, 3316559(0) swapouts.
Networks: packets: 29603472/34G in, 11073080/2276M out.
Disks: 3185216/85G read, 3042468/109G written.

PID    COMMAND      %CPU      TIME      #TH    #WQ  #PORT #MREGS MEM    RPRVT  PURG   CMPRS
48026  java         775.5     11:21.01 95/8    0    236-  2339   941M-  947M-  0B     138M
36104  top          18.9      42:47.01 1/1     0    45    56     7904K  7748K  0B     172K
118    WindowServer 2.4       02:45:02 4       0    732   6561-  581M-  120M-  29M    242M
```

Spark API

The api just makes functional sense.

Word count:

```
text_file = spark.textFile("hdfs://...")

text_file.flatMap(lambda line: line.split())
    .map(lambda word: (word, 1))
    .reduceByKey(lambda a, b: a+b)
```

Nice Spark features

- super fast because distributed memory (not disk)
- it scales linearly, like hadoop
- good python bindings
- support for SQL/Dataframes
- plays well with others (mesos, hadoop, s3, cassandra)

More Spark features!

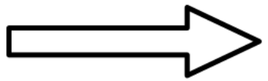
- has parallel machine learning libs
- has micro batching for streaming purposes
- can work on top of Hadoop
- optimizes workflow through DAG operations
- provisioning on aws is pretty automatic
- multilanguage support (R, scala, python)

4. How to set up a Spark cluster

Don't fear the one-liner

Spark Provisioning

You could go for Databricks, or you could set up your own.



bagel	[SPARK-7801] [BUILD] Updating versions to SPARK 1.5.0	a month ago
bin	[SPARK-7733] [CORE] [BUILD] Update build, code to use Java 7 for 1.5.0+	a month ago
build	[SPARK-8316] Upgrade to Maven 3.3.3	28 days ago
conf	[SPARK-3071] Increase default driver memory	11 days ago
core	[SPARK-8880] Fix confusing Stage.attemptId member variable	10 hours ago
data/mllib	[SPARK-8758] [MLLIB] Add Python user guide for PowerIterationClustering	11 days ago
dev	[SPARK-7977] [BUILD] Disallowing println	3 days ago
docker	[SPARK-2691] [MESOS] Support for Mesos DockerInfo	2 months ago
docs	[SPARK-8598] [MLLIB] Implementation of 1-sample, two-sided, Kolmogoro…	2 days ago
ec2	[SPARK-8863] [EC2] Check aws access key from aws credentials if there…	4 days ago
examples	[SPARK-7977] [BUILD] Disallowing println	3 days ago
external	[SPARK-7977] [BUILD] Disallowing println	3 days ago

You can clone with HTTPS, SSH, or Subversion.

Clone in Desktop

Download ZIP

Spark Provisioning

Starting is a one-liner.

```
./spark-ec2 \
--key-pair=pems \
--identity-file=/path/pems.pem \
--region=eu-west-1 \
-s 8 \
--instance-type c3.xlarge \
launch my-spark-cluster
```

This starts up the whole cluster, takes about 10 mins.

Spark Provisioning

If you want to turn it off.

```
./spark-ec2 \
--key-pair=pems \
--identity-file=/path/pems.pem \
--region=eu-west-1 \
 destroy my-spark-cluster
```

This brings it all back down, warning: deletes data.

Spark Provisioning

If you want to log into your machine.

```
./spark-ec2 \
--key-pair=pems \
--identity-file=/path/pems.pem \
--region=eu-west-1 \
 login my-spark-cluster
```

It does the ssh for you.

Startup from notebook

```
from pyspark import SparkContext
from pyspark.sql import SQLContext, Row

CLUSTER_URL = "spark://<master_ip>:7077"
sc = SparkContext(CLUSTER_URL, 'ipython-notebook')
sqlContext = SQLContext(sc)
```

Reading from S3

Reading in .json file from amazon.

```
filepath = "s3n://<aws_key>:<aws_secret>@wow-dump/total.json"

data = sc\
    .textFile(filepath, 30)\
    .cache()
```

Reading from S3

```
filepath = "s3n://<aws_key>:<aws_secret>@wow-dump/total.json"

data = sc\
    .textFile(filepath, 30)\
    .cache()

data.count() # 4.0 mins
data.count() # 1.5 mins
```

The `persist` method causes caching. Note the speed increase.

Reading from S3

```
data = sc\
    .textFile("s3n://<aws_key>:<aws_secret>@wow-dump/total.json", 200)\
    .cache()

data.count() # 4.0 mins
data.count() # 1.5 mins
```

Note that code doesn't get run until the `.count()` command is run.

More better: textfile to DataFrame!

```
df_rdd = data\
    .map(lambda x : dict(eval(x)))\
    .map(lambda x : Row(realm=x['realm'], side=x['side'],
         buyout=x['buyout'], item=x['item']))
df = sqlContext.inferSchema(df_rdd).cache()
```

This dataframe is distributed!

5. Simple PySpark queries

It's similar to Pandas

Basic queries

The next few slides contain questions, queries, output , loading times to give an impression of performance.

All these commands are run on a simple AWS cluster with 8 slave nodes with 7.5 RAM each.

Total `.json` file that we query is 20 GB. All queries ran in a time that is acceptable for exploritory purposes. It feels like pandas, but has a different api.

DF queries

economy size per server

```
df\
   .groupBy("realm")\
   .agg({"buyout":"sum"})\
   .toPandas()
```

You can cast to pandas for plotting

DF queries

offset price vs. market production

```
df.filter("item = 21877")\
    .groupBy("realm")\
    .agg({"buyout":"mean", "*":"count"})\
    .show(10)
```

DF queries

chaining of queries

```
import pyspark.sql.functions as func

items_ddf = ddf.groupBy('ownerRealm', 'item')\
    .agg(func.sum('quantity').alias('market'),
        func.mean('buyout').alias('m_buyout'),
        func.count('auc').alias('n'))\
    .filter('n > 1')

# now to cause data crunching
items_ddf.head(5)
```

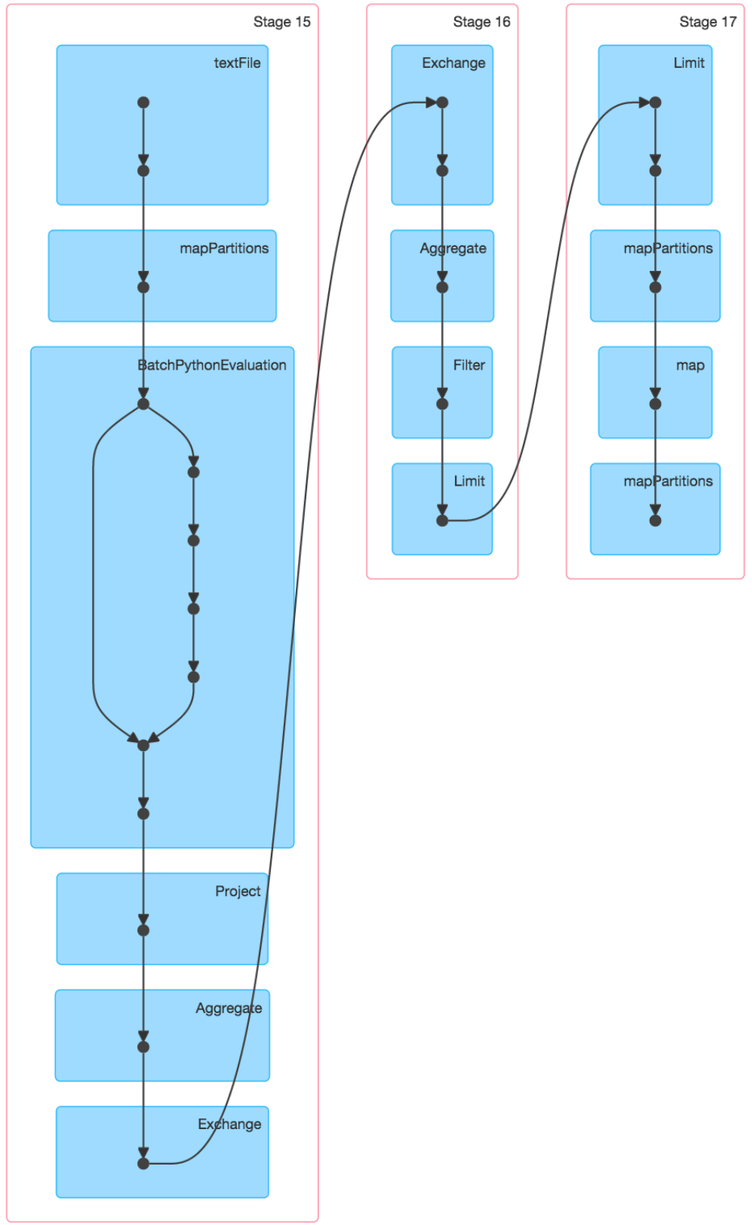
DF queries

visualisation of the DAG

You can view the DAG in Spark UI.

The job on the right describes the previous task.

You can find this at `master-ip:4040`.



DF queries

new column via user defined functions

```
# add new column with UDF
to_gold = UserDefinedFunction(lambda x: x/10000, DoubleType())

ddf = ddf.withColumn('buyout_gold', to_gold()('buyout'))
```

OK

But clusters cost more, correct?

Cheap = Profit

Isn't Big Data super expensive?

Cheap = Profit

Isn't Big Data super expensive?

Actually, no

Cheap = Profit

Isn't Big Data super expensive?

Actually, no

S3 transfers within same region = free.
40 GB x $0.03 per month = $1.2

`$0.239 x hours x num_machines`

If I use this cluster for a day.

`$0.239 x 6 x 9 = $12.90`

6. Results of Warcraft

Data, for the horde!

Most popular items

item	count	name
82800	2428044	pet-cage
21877	950374	netherweave-cloth
72092	871572	ghost-iron-ore
72988	830234	windwool-cloth
72238	648028	golden-lotus
4338	642963	mageweave-cloth
21841	638943	netherweave-bag
74249	631318	spirit-dust
72120	583234	exotic-leather
72096	578362	ghost-iron-bar
33470	563214	frostweave-cloth
14047	534130	runecloth
72095	462012	trillium-bar
72234	447406	green-tea-leaf
53010	443120	embersilk-cloth

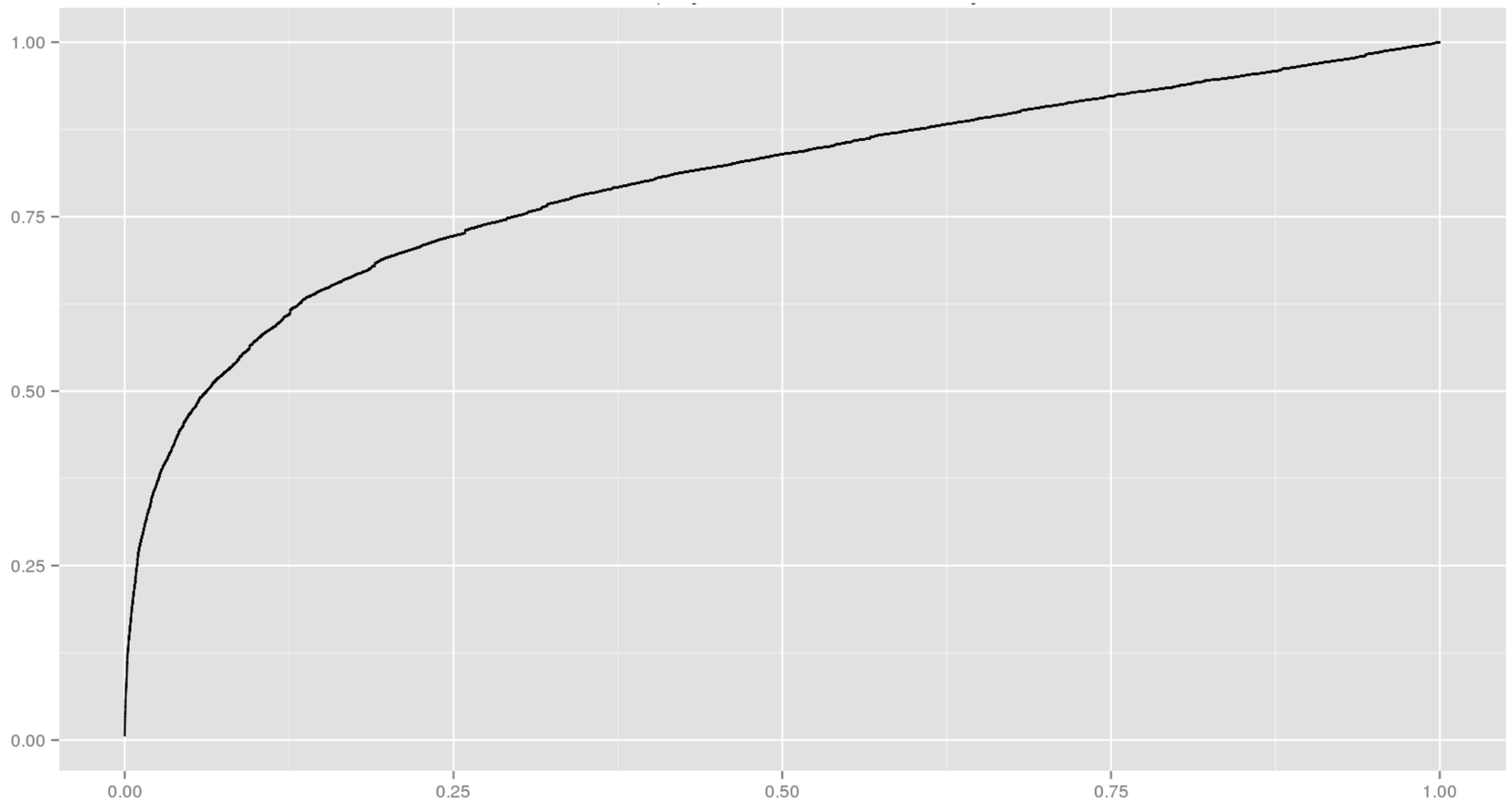
what profession?

based on level 10-20 items

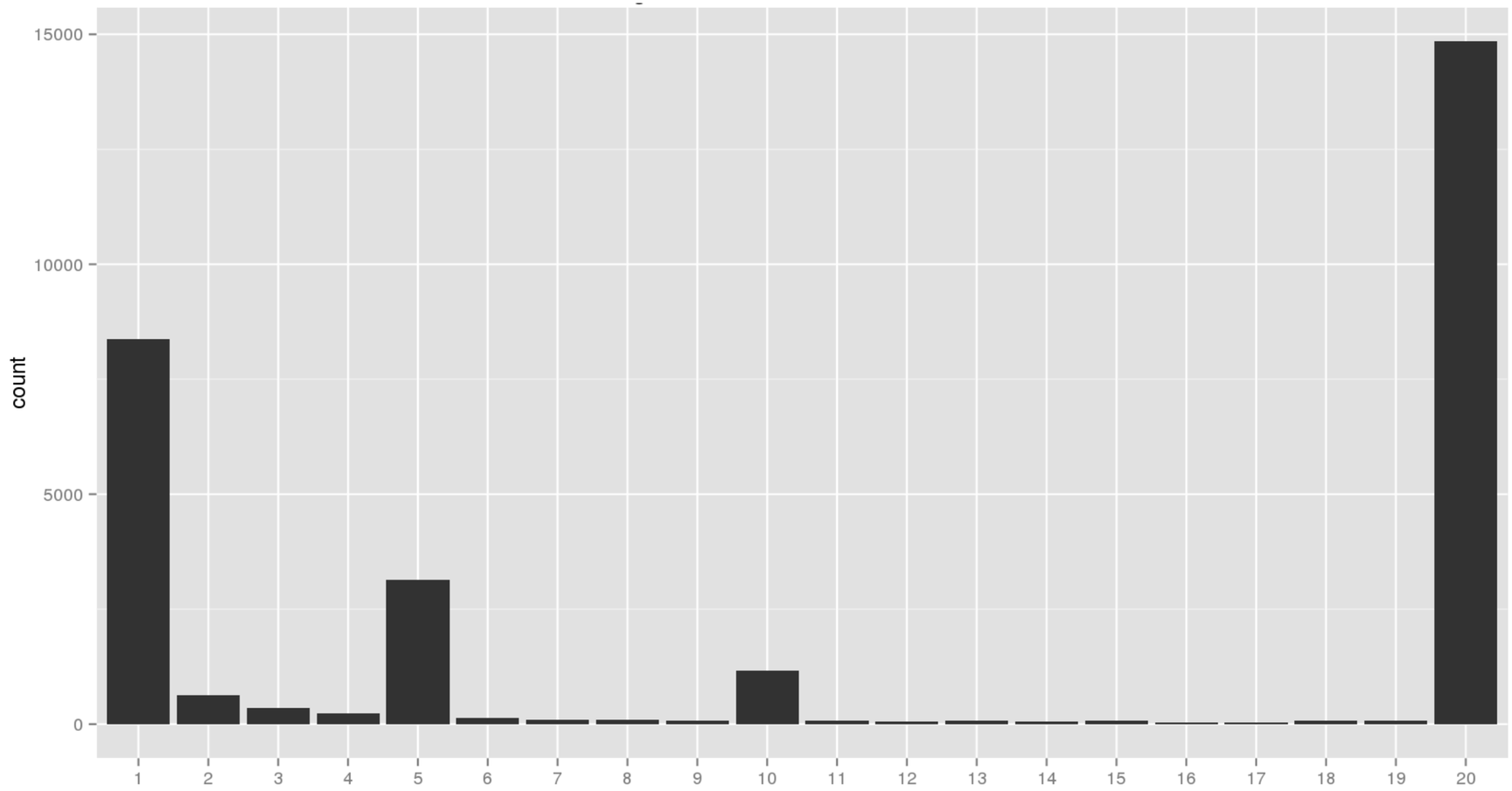
```
       type   m_gold
1  skinning 2.640968
2 herbalism 2.316380
3    mining 1.586510
```

Seems like in the beginning skinning makes the most money. Note these values are aggregates, this number can also be calculated per server for end game items for relevance.

the one percent



effect of stack size, spirit dust



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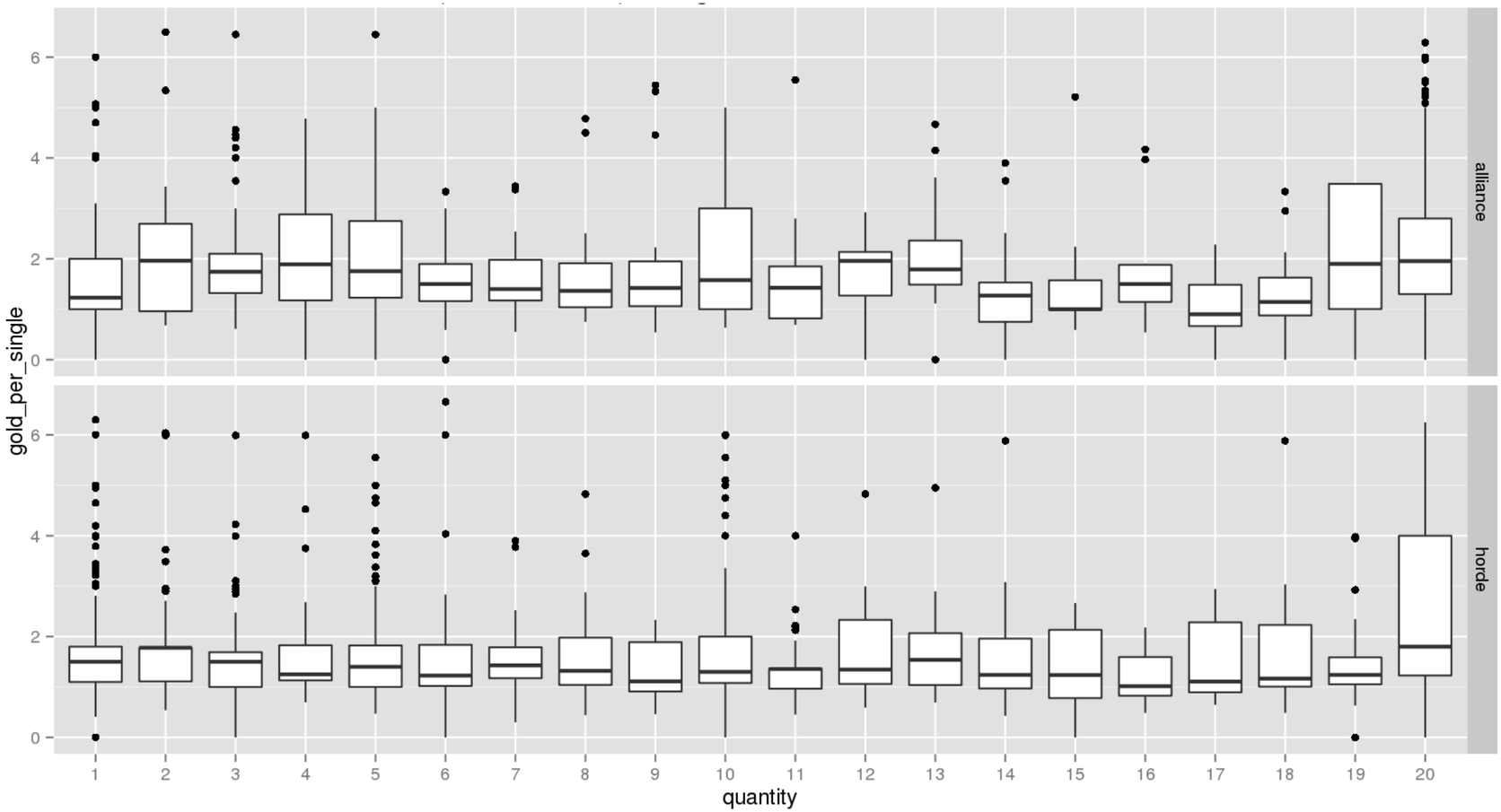
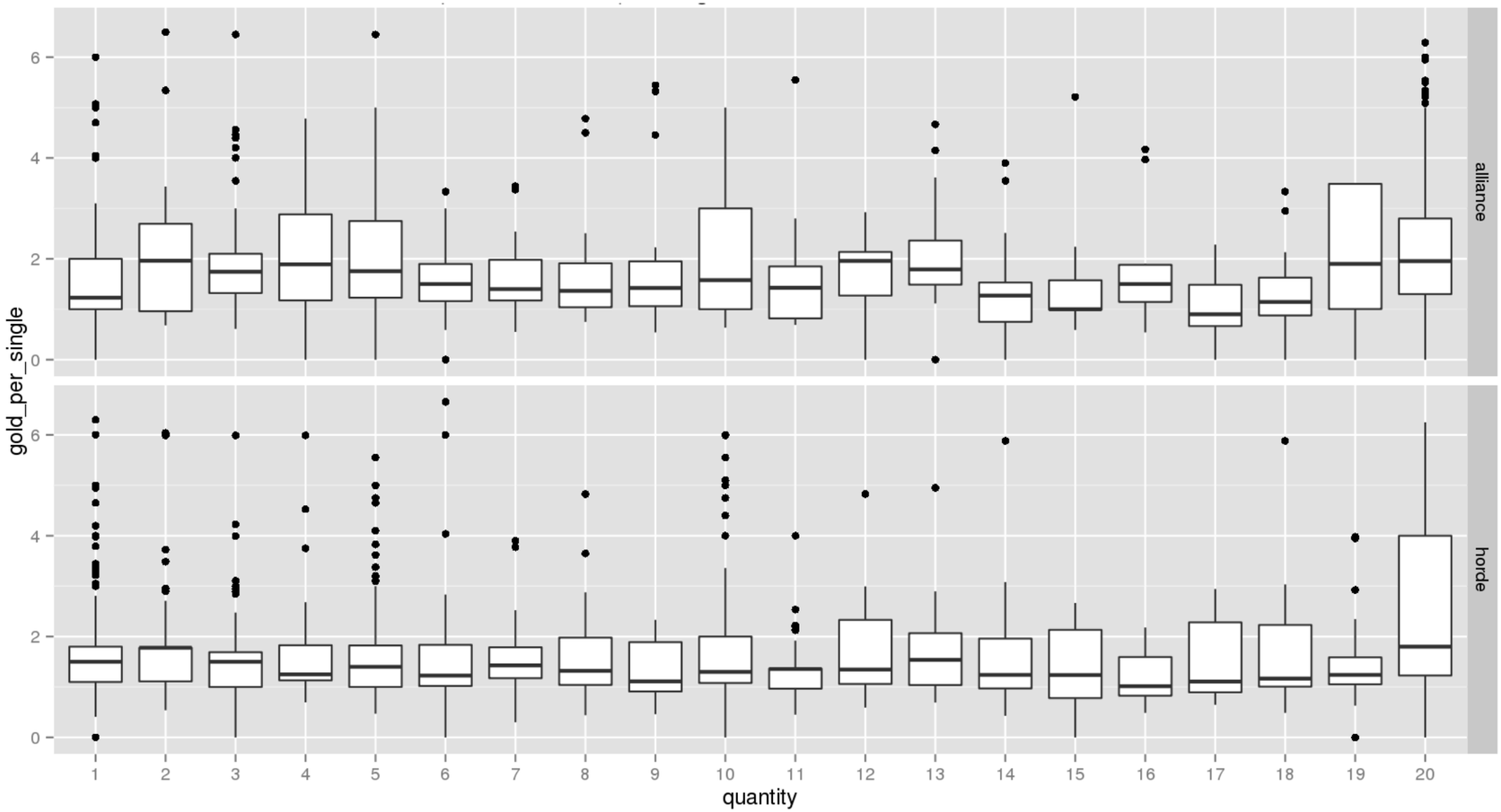
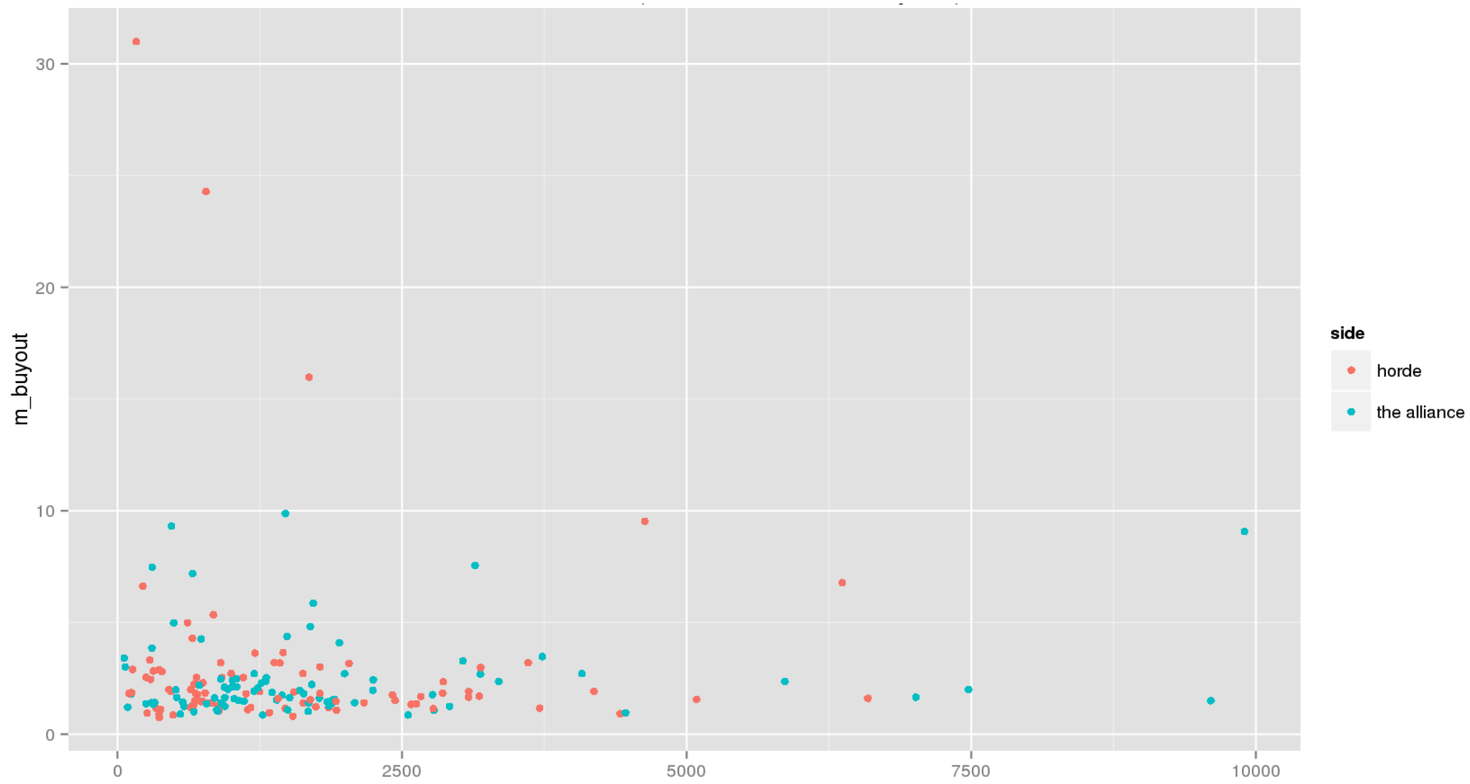


effect of stack size, spirit dust



market size vs price[1]



[1] for spirit dust we check for every server that the market quantity is and the mean buyout

market size vs price

We repeat for every product by calculating it's β_1 regression coefficient:

$$\beta_1 = \frac{Cov(x, y)}{Var(x)}$$

where x is market size and y is price. If $\beta_1 < 0$ then we may have found a product that is sensitive to market production.

slightly shocking find

Turns out that most of these products have $\beta_1 \approx 0$.

What does this mean? Are our economical laws flawed?

Conclusion

Spark is worthwhile tool.

There's way more things supported:

- machine learning
- graph analysis tools
- real time tools

Conclusion

Spark is worthwhile tool.

Final hints:

- don't forget to turn machines off
- this setup is not meant for multi users
- only bother if your dataset is too big, scikit/pandas has more flexible api

Questions?

The images

Some images from my presentation are from the nounproject.

Credit where credit is due;

- video game controller by Ryan Beck
- inspection by Creative Stall
- Shirt Size XL by José Manuel de Laá

Other content online:

- epic orc/human fight image

/r/pokemon/

/r/pokemon/

Feedback:

- pokemon fans did **not** agree that my model was correct
- pokemon fans did agree that my models output made sense

Why this matters:

- pokemon is relatively complicated