Analysis of H-1B Temporary Employment-Based in Data Science Occupation

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This project aims to analyze The H-1B temporary employment-based visa for Data Science related occupations in the United States. We are trying to answer the number of questions related to Data Science related jobs in America's workforce based on H-1B visa.

Keywords: Apach, Hadoop, H1B, Data Science

https://github.com/jardians/sp17-i524/blob/master/project/S17-IR-2002/report/report.pdf

INTRODUCTION

The H-1B non-immigrant classification is a vehicle through which a qualified alien may seek admission to the United States on a temporary basis to work in his or her field of expertise. An H-1B petition can be filed for an alien to perform services in a specialty occupation. Prior to employing an H-1B temporary worker, the U.S. employer must first file a Labor Condition Application (LCA) [1] with Department of Labor Certification [2] and then file an H-1B petition with United States Citizenship and Immigration Services(USCIS). The LCA specifies the job, salary, length, and geographic location of employment. The employer must agree to pay the alien the greater of the actual or prevailing wage for the position [3].

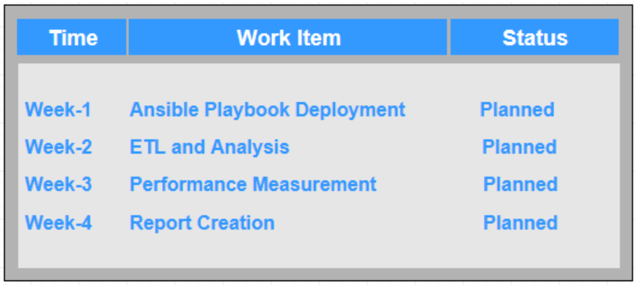
To qualify as a specialty occupation, the position must meet one of the following requirements: (1) a bachelor's or higher degree or its equivalent is normally the minimum entry requirement for the position; (2) the degree requirement is common to the industry in parallel positions among similar organizations or, in the alternative, the position is so complex or unique that it can be performed only by an individual with a degree; (3) the employer normally requires a degree or its equivalent for the position; or (4) the nature of the specific duties is so specialized and complex that the knowledge required to perform the duties is usually associated with attainment of a bachelor's or higher degree

In the past 6 years, tech industry executive bemoan the lack of data scientists—the people who theoretically know how to look at the data your company generates, and delve into it to derive the all-important insights we keep hearing about. It's no secret that there's a shortage of data scientists in America's workforce. Many companies look to hire overseas to help ease the domestic talent shortfall (in fact, one in three data scientists are born outside the U.S.) so understanding the ins and outs of visas is rapidly becoming a business necessity [4]. To accomplish the goals, I would like to answer question like the following:

- Is it the number of petitions with Data Engineer or Scientist jobs title increasing over time?
- Which part of the US has the most Data Engineer or Scientist jobs?
- what year petitions with Data Engineer or Scientist jobs granted the most between 2011 to 2016?
- Which employers file the most petitions with Data Engineer or Scientist jobs title each year?

PLAN

Following table gives a breakdown of tasks in order to complete the project. Assuming week1 starts after submission of the proposal. These work items are high level breakdown on the tasks and may changes if needed.



Time	Work Item	Status
Week-1	Ansible Playbook Deployment	Planned
Week-2	ETL and Analysis	Planned
Week-3	Performance Measurement	Planned
Week-4	Report Creation	Planned

Fig. 1. Planned Schedule

DESIGN

I break the high-level design of the technologies used into 3 main sections– storage, ingestion, processing and analyzing.

- Storage refers to decision around the storage system such as HDFS or HBase [5]

- Ingestion refers to getting data from source and loading it into Hadoop for processing.

- Analyzing refers to running various analytical queries on processed dataset to find answer and insight to the questions presented.

DATASET METADATA DESCRIPTION

The columns included in the dataset download from Kaggle [6] site are followed :

- CASE_STATUS: Status associated with the last significant event or decision.

- EMPLOYER_NAME: Name of employer submitting labor condition application.

- SOC_NAME: the occupational code associated with the job being requested for temporary labor condition, as classified by the Standard Occupational Classification (SOC) System.

- JOB_TITLE: Title of the job

- FULL_TIME_POSITION: Y = Full Time Position; N = Part Time Position

- PREVAILING_WAGE: Prevailing Wage for the job being requested for temporary labor condition. The wage is listed at annual scale in USD. The prevailing wage for a job position is defined as the average wage paid to similarly employed workers in the requested occupation in the area of intended employment. The prevailing wage is based on the employer's minimum requirements for the position. YEAR: Year in which the H-1B visa petition was filed

- WORKSITE: City and State information of the foreign worker's intended area of employment

- LON: longitude of the Worksite

- LAT: latitude of the Worksite

DEPLOYMENT

Solution will be deployed using Ansible [7] ad-hoc commands and Linux commands. Driver script called `cc_main_driver.sh` should install all necessary software and project codes to the cluster nodes. The `cc_main_driver.sh` will copy both Python script called `cc_analyze_data.py` which analyzes and generates graphs/tables and shell script called `cc_etl_data.sh` into clusters. The `cc_main_driver.sh` will trigger `cc_etl_data.sh` to pull dataset from the web as well executes `cc_analyze_data.py` to analyze a dataset.

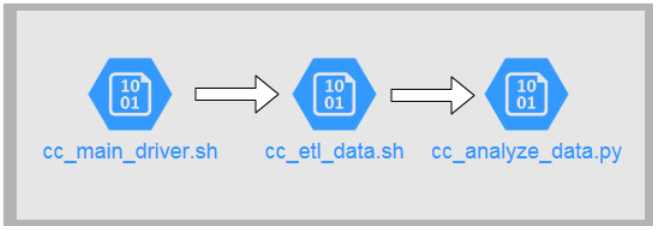


Fig. 2. Deployment Schema

BENCHMARKING

The original input dataset with approximately 3,000,000 rows (`h1b_3mRows`) split into two smaller datasets: 1,000,000 rows (`h1b_1mRows`) rows and 2,000,000 rows (`h1b_2mRows`). Then, I executed Python script with Linux time function (i.e: `time python ./cc_analyze_data.py`) against each of the input dataset mentioned above in order to measure both the storage size and elapsed time during the execution.

The benchmark testing on Chameleon Cloud environment revealed in the Figure-4 that elapsed processing time decreased when the number of rows in the dataset reduced. In the Figure-5, similar trend applied to disk space usage that it decreased linearly as the less number of rows need to be stored.

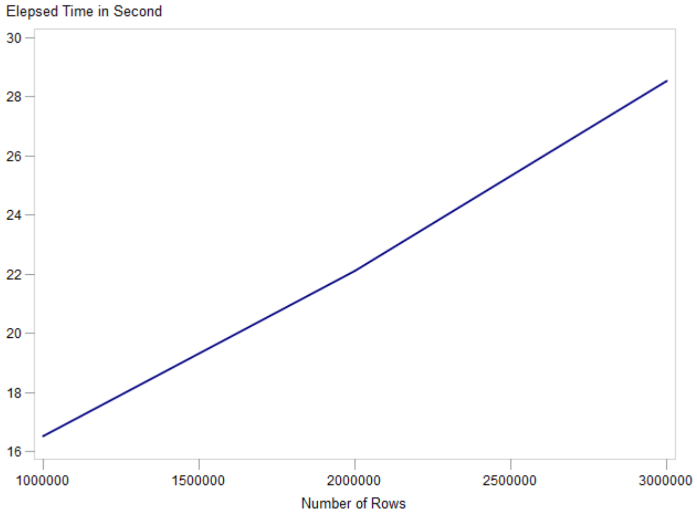
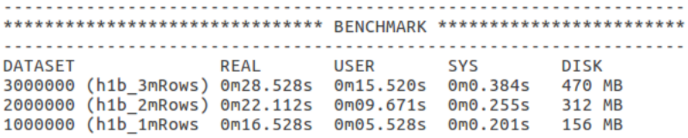


Fig. 3. Benchmark Testing - Number of Rows Vs. Elapsed Time



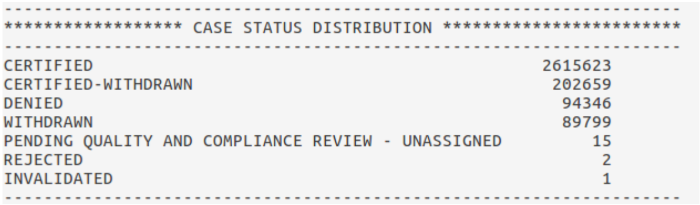
```
-----------------------------------------------------------------
****************************** BENCHMARK ***********************
-----------------------------------------------------------------
DATASET                  REAL       USER       SYS        DISK
3000000 (h1b_3mRows)     0m28.528s  0m15.520s  0m0.384s   470 MB
2000000 (h1b_2mRows)     0m22.112s  0m09.671s  0m0.255s   312 MB
1000000 (h1b_1mRows      0m16.528s  0m05.528s  0m0.201s   156 MB
```

Fig. 4. Benchmark Testing - Number of Rows Vs. Disk Storage

DATA REPORT

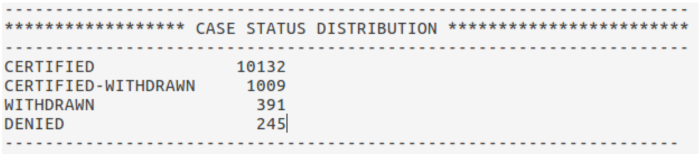
General petition distribution between Fiscal Year(FY) 2011 to FY 2016, United States Citizenship and Immigration Services (USCIS) approved 2,615,623 petitions submitted by the employer on behalf of alien workers as indicated in the Figure-5.

Of the petitions approved during FY 2011-2016, a total 10,132 petitions, or .38 % were Data Science related occupations (i.e: Data Scientist, Data Analytics, Data Science Engineer, Statistician and Data Modelling) as shows in the Figure-6.



```
-----------------------------------------------------------------------
****************** CASE STATUS DISTRIBUTION ************************
-----------------------------------------------------------------------
CERTIFIED                                                   2615623
CERTIFIED-WITHDRAWN                                          202659
DENIED                                                        94346
WITHDRAWN                                                     89799
PENDING QUALITY AND COMPLIANCE REVIEW - UNASSIGNED               15
REJECTED                                                          2
INVALIDATED                                                       1
-----------------------------------------------------------------------
```

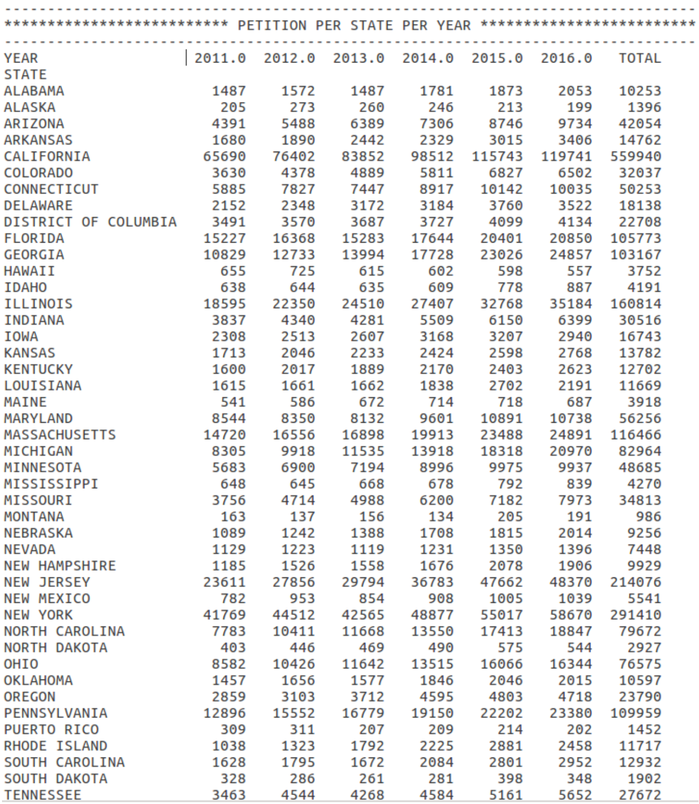
Fig. 5. General Distribution of Petition - All Jobs



```
-----------------------------------------------------------------------
****************** CASE STATUS DISTRIBUTION ************************
-----------------------------------------------------------------------
CERTIFIED              10132
CERTIFIED-WITHDRAWN     1009
WITHDRAWN                391
DENIED                   245
-----------------------------------------------------------------------
```

Fig. 6. General Distribution of Petition - Data Science Related Occupations

As Figure-7 indicated, petitions submitted regardless of the CASE_STATUS and all JOB_TITLE increased approximately 5 to 7 percent. For Data Science related petitions also increased especially in metropolitan areas such as San Francisco, New York and Menlo Park . The highest number of petition related to Data Science petitions to acquire H1-B visa was in the Fiscal Year 2016 as shown on the Figure-8.



```
--------------------------------------------------------------------------------
************************* PETITION PER STATE PER YEAR *************************
--------------------------------------------------------------------------------
YEAR                 | 2011.0  2012.0  2013.0  2014.0  2015.0  2016.0   TOTAL
STATE
ALABAMA                 1487    1572    1487    1781    1873    2053   10253
ALASKA                   205     273     260     246     213     199    1396
ARIZONA                 4391    5488    6389    7306    8746    9734   42054
ARKANSAS                1680    1890    2442    2329    3015    3406   14762
CALIFORNIA             65690   76402   83852   98512  115743  119741  559940
COLORADO                3630    4378    4889    5811    6827    6502   32037
CONNECTICUT             5885    7827    7447    8917   10142   10035   50253
DELAWARE                2152    2348    3172    3184    3760    3522   18138
DISTRICT OF COLUMBIA    3491    3570    3687    3727    4099    4134   22708
FLORIDA                15227   16368   15283   17644   20401   20850  105773
GEORGIA                10829   12733   13994   17728   23026   24857  103167
HAWAII                   655     725     615     602     598     557    3752
IDAHO                    638     644     635     609     778     887    4191
ILLINOIS               18595   22350   24510   27407   32768   35184  160814
INDIANA                 3837    4340    4281    5509    6150    6399   30516
IOWA                    2308    2513    2607    3168    3207    2940   16743
KANSAS                  1713    2046    2233    2424    2598    2768   13782
KENTUCKY                1600    2017    1889    2170    2403    2623   12702
LOUISIANA               1615    1661    1662    1838    2702    2191   11669
MAINE                    541     586     672     714     718     687    3918
MARYLAND                8544    8350    8132    9601   10891   10738   56256
MASSACHUSETTS          14720   16556   16898   19913   23488   24891  116466
MICHIGAN                8305    9918   11535   13918   18318   20970   82964
MINNESOTA               5683    6900    7194    8996    9975    9937   48685
MISSISSIPPI              648     645     668     678     792     839    4270
MISSOURI                3756    4714    4988    6200    7182    7973   34813
MONTANA                  163     137     156     134     205     191     986
NEBRASKA                1089    1242    1388    1708    1815    2014    9256
NEVADA                  1129    1223    1119    1231    1350    1396    7448
NEW HAMPSHIRE           1185    1526    1558    1676    2078    1906    9929
NEW JERSEY             23611   27856   29794   36783   47662   48370  214076
NEW MEXICO               782     953     854     908    1005    1039    5541
NEW YORK               41769   44512   42565   48877   55017   58670  291410
NORTH CAROLINA          7783   10411   11668   13550   17413   18847   79672
NORTH DAKOTA             403     446     469     490     575     544    2927
OHIO                    8582   10426   11642   13515   16066   16344   76575
OKLAHOMA                1457    1656    1577    1846    2046    2015   10597
OREGON                  2859    3103    3712    4595    4803    4718   23790
PENNSYLVANIA           12896   15552   16779   19150   22202   23380  109959
PUERTO RICO              309     311     207     209     214     202    1452
RHODE ISLAND            1038    1323    1792    2225    2881    2458   11717
SOUTH CAROLINA          1628    1795    1672    2084    2801    2952   12932
SOUTH DAKOTA             328     286     261     281     398     348    1902
TENNESSEE               3463    4544    4268    4584    5161    5652   27672
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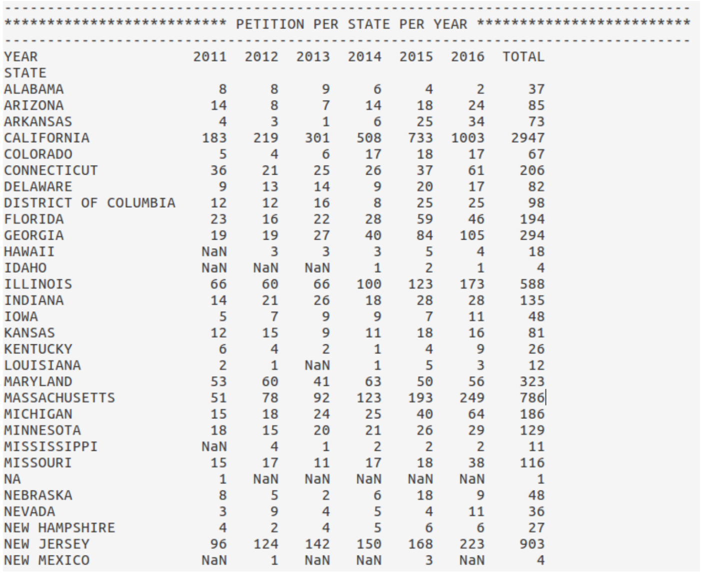
Fig. 7. H1-B Petition Per Year Per State - All Jobs



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--------------------------------------------------------------------------------
************************* PETITION PER STATE PER YEAR *************************
--------------------------------------------------------------------------------
YEAR                  2011  2012  2013  2014  2015  2016  TOTAL
STATE
ALABAMA                  8     8     9     6     4     2     37
ARIZONA                 14     8     7    14    18    24     85
ARKANSAS                 4     3     1     6    25    34     73
CALIFORNIA             183   219   301   508   733  1003   2947
COLORADO                 5     4     6    17    18    17     67
CONNECTICUT             36    21    25    26    37    61    206
DELAWARE                 9    13    14     9    20    17     82
DISTRICT OF COLUMBIA    12    12    16     8    25    25     98
FLORIDA                 23    16    22    28    59    46    194
GEORGIA                 19    19    27    40    84   105    294
HAWAII                 NaN     3     3     3     5     4     18
IDAHO                  NaN   NaN   NaN     1     2     1      4
ILLINOIS                66    60    66   100   123   173    588
INDIANA                 14    21    26    18    28    28    135
IOWA                     5     7     9     9     7    11     48
KANSAS                  12    15     9    11    18    16     81
KENTUCKY                 6     4     2     1     4     9     26
LOUISIANA                2     1   NaN     1     5     3     12
MARYLAND                53    60    41    63    50    56    323
MASSACHUSETTS           51    78    92   123   193   249    786
MICHIGAN                15    18    24    25    40    64    186
MINNESOTA               18    15    20    21    26    29    129
MISSISSIPPI            NaN     4     1     2     2     2     11
MISSOURI                15    17    11    17    18    38    116
NA                       1   NaN   NaN   NaN   NaN   NaN      1
NEBRASKA                 8     5     2     6    18     9     48
NEVADA                   3     9     4     5     4    11     36
NEW HAMPSHIRE            4     2     4     5     6     6     27
NEW JERSEY              96   124   142   150   168   223    903
NEW MEXICO             NaN     1   NaN   NaN     3   NaN      4
```
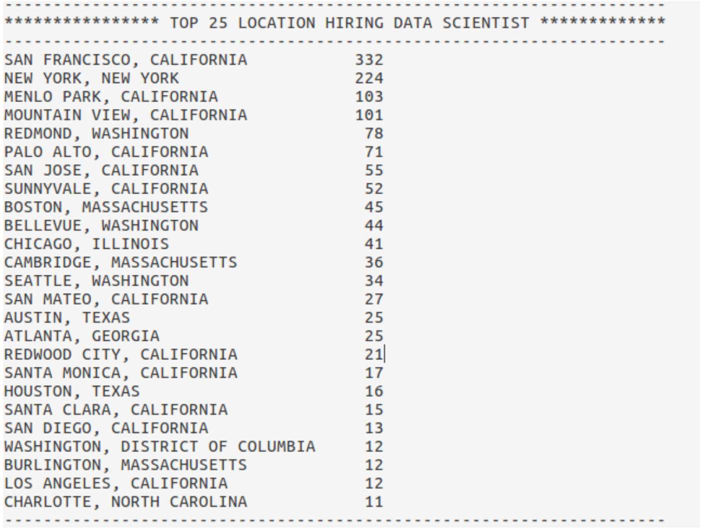

Fig. 8. H1-B Petition Per Year Per State - Data Science Related Occupations

As revealed in Figure-9, New Jersey, California, Massachusetts and Illinois are top locations that hires Data Science talents. Almost all technology based companies are now aware that data-driven decision making is critical if they want to succeed. As showed in the Figure-10, some of the biggest and well-known technology companies are the biggest driving force in hiring talent pool with Data Science skills.



```
-----------------------------------------------------------------------
**************** TOP 25 LOCATION HIRING DATA SCIENTIST *************
-----------------------------------------------------------------------
SAN FRANCISCO, CALIFORNIA             332
NEW YORK, NEW YORK                    224
MENLO PARK, CALIFORNIA                103
MOUNTAIN VIEW, CALIFORNIA             101
REDMOND, WASHINGTON                    78
PALO ALTO, CALIFORNIA                  71
SAN JOSE, CALIFORNIA                   55
SUNNYVALE, CALIFORNIA                  52
BOSTON, MASSACHUSETTS                  45
BELLEVUE, WASHINGTON                   44
CHICAGO, ILLINOIS                      41
CAMBRIDGE, MASSACHUSETTS               36
SEATTLE, WASHINGTON                    34
SAN MATEO, CALIFORNIA                  27
AUSTIN, TEXAS                          25
ATLANTA, GEORGIA                       25
REDWOOD CITY, CALIFORNIA               21
SANTA MONICA, CALIFORNIA               17
HOUSTON, TEXAS                         16
SANTA CLARA, CALIFORNIA                15
SAN DIEGO, CALIFORNIA                  13
WASHINGTON, DISTRICT OF COLUMBIA       12
BURLINGTON, MASSACHUSETTS              12
LOS ANGELES, CALIFORNIA                12
CHARLOTTE, NORTH CAROLINA              11
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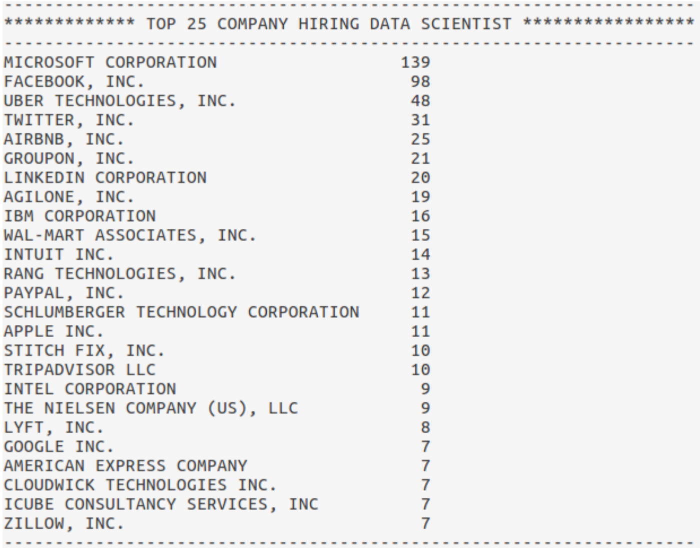
Fig. 9. Top 25 Location Hiring Data Scientist



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************* TOP 25 COMPANY HIRING DATA SCIENTIST *****************
--------------------------------------------------------------------------
MICROSOFT CORPORATION                    139
FACEBOOK, INC.                            98
UBER TECHNOLOGIES, INC.                   48
TWITTER, INC.                             31
AIRBNB, INC.                              25
GROUPON, INC.                             21
LINKEDIN CORPORATION                      20
AGILONE, INC.                             19
IBM CORPORATION                           16
WAL-MART ASSOCIATES, INC.                 15
INTUIT INC.                               14
RANG TECHNOLOGIES, INC.                   13
PAYPAL, INC.                              12
SCHLUMBERGER TECHNOLOGY CORPORATION       11
APPLE INC.                                11
STITCH FIX, INC.                          10
TRIPADVISOR LLC                           10
INTEL CORPORATION                          9
THE NIELSEN COMPANY (US), LLC              9
LYFT, INC.                                 8
GOOGLE INC.                                7
AMERICAN EXPRESS COMPANY                   7
CLOUDWICK TECHNOLOGIES INC.                7
ICUBE CONSULTANCY SERVICES, INC            7
ZILLOW, INC.                               7
--------------------------------------------------------------------------
```

Fig. 10. Top 25 Companies Hiring Data Scientist

As shown in Figure-11, for occupations in Data Science field, the median annual compensation reported by employers of H-1B workers between FY 2011 to FY 2016 was ranged from a low of $40,000 to a high $110,000 which depends on geological location.

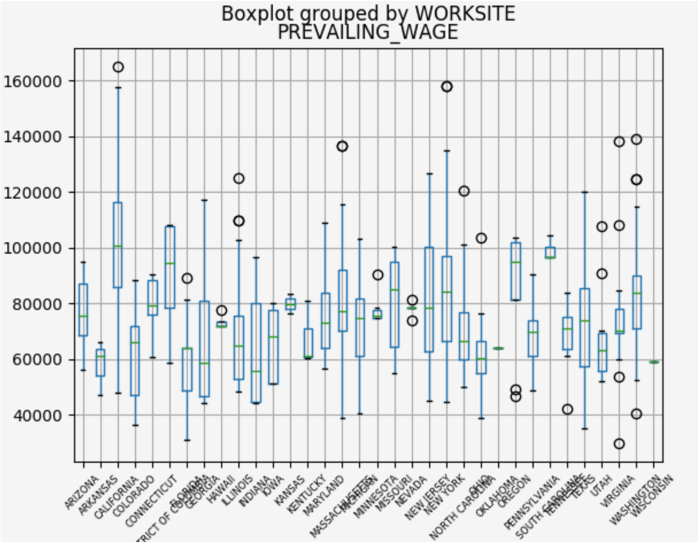

Fig. 11. Data Scientist Wage Across States

CONCLUSION

Overall, there is compelling evidence that the H-1B visa program is helping to alleviate acute shortages in Data Science occupations since the number of petitions submitted increased linearly from FY 2011 to FY 2016. Armed with such information, as well as indicators presented above, Data Science occupation mostly concentrated in large metropolitan areas. Well-known technology companies has indicated hired professional with Data Science skill sets.

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REFERENCES

[1] Wikipedia, “Labor condition application,” Web Page, Apr. 2017, accessed: 2017-04-20. [Online]. Available: https://en.wikipedia.org/wiki/Labor_Condition_Application

[2] USCIS, “Labor certification,” Web Page, Apr. 2017, accessed: 2017-04-20. [Online]. Available: https://www.uscis.gov/tools/glossary/labor-certification

[3] Wikipedia, “H-1b visa,” Web Page, Apr. 2017, accessed: 2017-04-20. [Online]. Available: https://en.wikipedia.org/wiki/H-1B_visa

[4] M. Li, M. J. Wildes, and A. W. Moses, “Hiring data scientists from outside the u.s.: A primer on visas,” Web Page, Mar. 2017, accessed: 2017-03-20. [Online]. Available: https://hbr.org/2016/09/hiring-data-scientists-from-outside-the-us-a-primer-on-visas

[5] Wikipedia, “Apache hadoop,” Web Page, Mar. 2017, accessed: 2017-03-20. [Online]. Available: https://en.wikipedia.org/wiki/Apache_Hadoop

[6] S. Naribole, “H-1b visa petitions 2011-2016,” Web Page, Mar. 2017, accessed: 2017-03-20. [Online]. Available: https://www.kaggle.com/nsharan/h-1b-visa

[7] Wikipedia, “Ansible,” Web Page, Mar. 2017, accessed: 2017-03-20. [Online]. Available: https://en.wikipedia.org/wiki/Ansible