Stage_2_-_Attribute_Analysis

October 25, 2016

1 Stage 2 - Attribute Analysis

1.1 Step 0: Import Required Packages

Below is a list of the python packages we used while preforming Stage 2 of the project.

```
In [1]: from bs4 import BeautifulSoup
        from urllib2 import urlopen
        import json
        import pandas as pd
        import re
        import numpy as np
        from datetime import datetime
        import matplotlib.pyplot as plt
        %matplotlib inline
```

1.2 Step 1: Load & Prepare Data

In this step we will **load** our data into the python notebook and **manipulate** the data so that it is in a format that is appropriate in order to analyze each attribute.

Step 1.1: Select Table to Analyze & Load Table from Github

```
In [2]: # Links to .CSV tables on Github
        table_spoj = "https://raw.githubusercontent.com/KaranTalreja\
        /CS638/master/spoj/json/problems.csv?token=AKuoLQ5TaJyvWHVY8M\
        6_6MbudhCVoTPrks5YFpVIwA%3D%3D"
        table_codechef = "https://raw.githubusercontent.com/KaranTalre\
        ja/CS638/master/codechef/data/codechef_problems.csv?token=AKuo\
        LShPnf70FONGdoBnqcJ48j9uYA8bks5YCnDKwA%3D%3D"

        # Choose table to analyze
        choose_table_A = table_spoj

        # Load table to Pandas dataframe
        table_A = pd.read_csv(urlopen(choose_table_A))
```

Step 1.2: Manipulate Table Format & Select 10 Attributes

```
In [3]: # Convert "TimeLimit" from string to float
        def str_to_float(df):
            times = str(df["time_limit"]).replace("s","").split("-")
            try:
                return pd.Series([times[0], times[1]])
            except:
                return pd.Series([times[0], times[0]])

        table_A[["lower_time_limit", "upper_time_limit"]] = \
        table_A.apply(str_to_float, axis=1)


        # "DateAdded" attribute as type datetime
        def str_to_datetime(df):
            try:
                return datetime.strptime(df["date_added"], "%Y-%m-%d")
            except:
                pass

        table_A["date_added"] = table_A.apply(str_to_datetime, axis=1)
```

Step 1.3: Select 10 Attributes

```
In [4]: table_A = table_A[["title", "added_by", "description", "input",
                          "output", "upper_time_limit", "accuracy",
                          "solved_by", "tags", "implementation_difficulty",
                          "concept_difficulty"]]

        def tags_missing(df):
            if df["tags"] == "0":
                return None
            else:
                return df["tags"]

        table_A["tags"] = table_A.apply(tags_missing, axis=1)

        table_A["difficulty"] = table_A["implementation_difficulty"] + \
        table_A["concept_difficulty"]

        ## Bin difficulty based on percentile (beginner, easy, medium,
        ## hard, challenge, N/A) Next stage...
        table_A = table_A.drop(["implementation_difficulty",
                                "concept_difficulty"], axis=1)
        table_A.head(3)
```

```
Out[4]:                                          title        added_by  \
        0  TEST - Life, the Universe, and Everything            mima
        1           CMEXPR - Complicated Expressions          adrian
```

```
2                  BABTWR - Tower of Babylon  Micha Czuczman

                                                description  \
0    Your program is to use the brute-force appro...
1    The most important activity of ACM is the GS...
2    Apart from the Hanging Gardens the Babylonia...

                                                   input  \
0                                                    NaN
1    There is asingle positive integer T on the f...
2    The number of types of blocks n is located i...

                                                  output upper_time_limit  \
0                                                    NaN               10
1    Print asingle line for every expression. The...                 5
2    For each test case your program should outpu...                 3

   accuracy  solved_by     tags  difficulty
0     32.93     100118  88,4,89         5.0
1     26.55        655     None        26.0
2     49.68       2087     None        36.0
```

1.3 Step 3: Begin Analyzing Attributes

1. Count Missing Values
2. Discuss Missing Values Fill
3. Classify Attribute as:
    1. Numeric
    2. Textual
        1. If textual, report the average, minimal and maximal lengths of its values (length is measured in the number of characters in the value).
    3. Categorical
    4. Boolean
4. Find and report possible outliers and anomalies among the attribute values
5. Search for possible synonyms
6. Are attribute values "sprinkled" over other attributes?
7. Note any other data quality issues

1.3.1 Attribute Analysis - Helper Functions

```
In [5]: def missing_value_count(table, attribute):
            missing_values = 0
            for attr in table[attribute]:
                if pd.isnull(attr):
                    missing_values += 1
                else:
                    pass
```

```
    attr_length = len(table)
    percent_missing = float(missing_values)/float(attr_length)

    return "%s:%d missing values. (%.2f percent or %d/%d)" % \
(attribute, missing_values, percent_missing*100., missing_values, attr_leng

def len_nan(x):
    try:
        return len(x)
    except:
        return 0

def myround(x, base):
    return int(base * round(float(x)/base))

def textual_summary(table, attribute):
    char_len = table[attribute].apply(len_nan)
    return "%s: mean length = %.2f min length = %d max length = %d" % \
(attribute, char_len.mean(), char_len.min(), char_len.max())

def textual_histogram(table, attribute, range=[0,0], stdev=3, bins=20):
    char_len = table[attribute].apply(len_nan)
    if range == [0,0]:
        range = [0, myround(char_len.std()*stdev, 5)]
    plt.hist(char_len, bins=bins, range=range)
    plt.title("%s - Character Count Distribution (%d bins)" % \
              (attribute, bins))
    plt.show()
    summary_table = pd.DataFrame()
    summary_table["outliers"] = table[attribute][char_len[
            ((char_len - char_len.mean()) / char_len.std()).abs() > stdev
            ].index]
    summary_table["out_len"] = table[attribute][char_len[
            ((char_len - char_len.mean()) / char_len.std()).abs() > stdev
            ].index].apply(len_nan)
    print "There are %d outliers outside of %d standard \
    deviations of %s." % (len(summary_table), stdev, attribute)
    return summary_table.sort_values(by="out_len")

def numeric_histogram(table, attribute, range=[0,0], stdev=3, bins=20):
    values = table[attribute].astype(float)
    if range == [0,0]:
        range = [0, myround(values.std()*stdev, 5)]
    plt.hist(values, bins=bins, range=range)
    plt.title("%s - Histogram (%d bins)" % (attribute, bins))
    plt.show()
    summary_table = pd.DataFrame()
```

```
            summary_table["outliers"] = table[attribute][values[
                    ((values - values.mean()) / values.std()).abs() > stdev
                ].index].astype(float)
            print "There are %d outliers outside of %d standard \
            deviations of %s." % (len(summary_table), stdev, attribute)
            return summary_table.sort_values(by="outliers")
```

2 Step 1: Missing Values

```
In [6]: for attribute in table_A.columns.values:
            print missing_value_count(table_A, attribute)
```

```
title:0 missing values. (0.00 percent or 0/5166)
added_by:12 missing values. (0.23 percent or 12/5166)
description:0 missing values. (0.00 percent or 0/5166)
input:753 missing values. (14.58 percent or 753/5166)
output:876 missing values. (16.96 percent or 876/5166)
upper_time_limit:0 missing values. (0.00 percent or 0/5166)
accuracy:0 missing values. (0.00 percent or 0/5166)
solved_by:0 missing values. (0.00 percent or 0/5166)
tags:4173 missing values. (80.78 percent or 4173/5166)
difficulty:2984 missing values. (57.76 percent or 2984/5166)
```

3 Step 2: Fill Missing Values

- **title:** There are no missing values for this attribute.
- **added_by:** This attribute states the user account responsible for posting the problem, so there does not seem to be a good way to fill this value. Since there are only 12 missing values out of 5166, we will just leave the value as null.
- **description:** There are no missing values for this attribute.
- **input:** This value has 14.58% of the values missing but most of these missing values are sprinkled in the description so we will have to parse that variable to fill these missing values.
- **output:** This value has 16.96% of the values missing but most of these missing values are sprinkled in the description so we will have to parse that variable to fill these missing values.
- **upper_time_limit:** There are no missing values for this attribute.
- **accuracy:** There are no missing values for this attribute.
- **solved_by:** There are no missing values for this attribute.
- **tags:** For the instances without tags, we could look into pulling key words from the description and title. Both the title and description would contain the main ideas of the problem which is the point of this variable.
- **difficulty:** The difficulty has a large percentage of missing values (57.76%), so in order to fill some of these values, we could use a machine learning model to estimate the difficulty based on each instance's accuracy, upper_time_limit, and tags.

4 Step 3: Classify the Attribute

- **title:** textual
- **added_by:** categorical (there is a limited list of users who can submit problems so each problem can be categorized into one of the users)
- **description:** textual
- **input:** textual
- **output:** textual
- **upper_time_limit:** numeric
- **accuracy:** numeric
- **solved_by:** numeric
- **tags:** categorical (there is a list of keys that can be assigned to a problem)
- **difficulty:** numeric

5 Step 4: Textual Variables - Summary

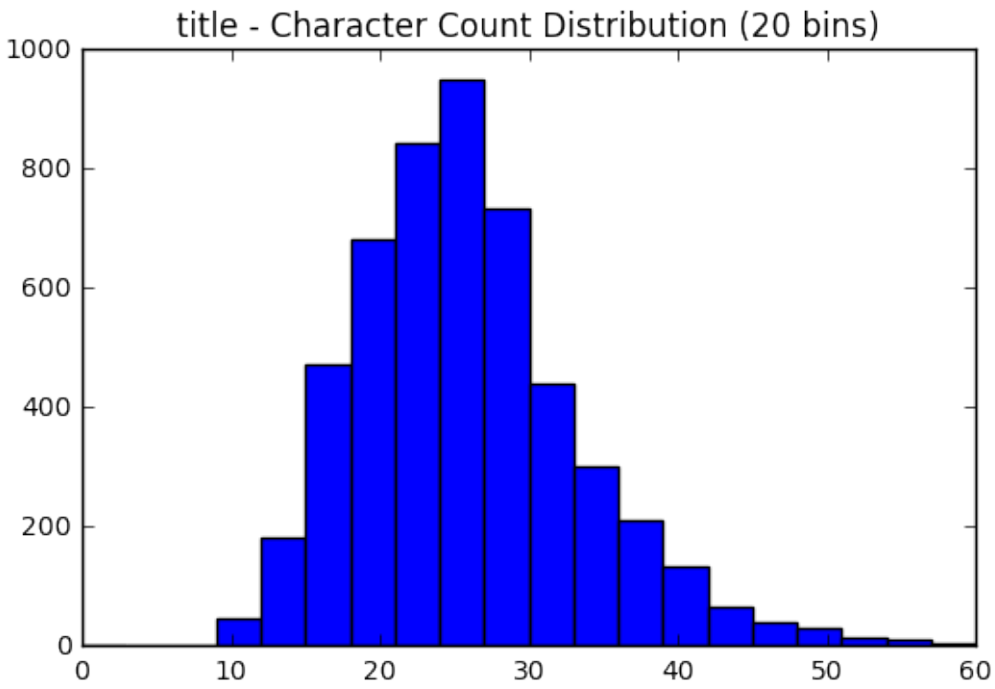
```
In [7]: for attribute in ["title", "description", "input", "output"]:
            print textual_summary(table_A, attribute)
```

```
title: mean length = 25.40 min length = 9 max length = 61
description: mean length = 1039.23 min length = 1 max length = 10969
input: mean length = 283.58 min length = 0 max length = 3411
output: mean length = 348.57 min length = 0 max length = 63965
```

6 Step 5: Outliers & Anomalies

title: * The title attribute is approximately normally distributed with a long tail to the right. There are a 13 instances that have title character lengths longer than 4 times the standard deviation for this attribute.

```
In [8]: textual_histogram(table_A, "title", range=[0,60], stdev=4)
```



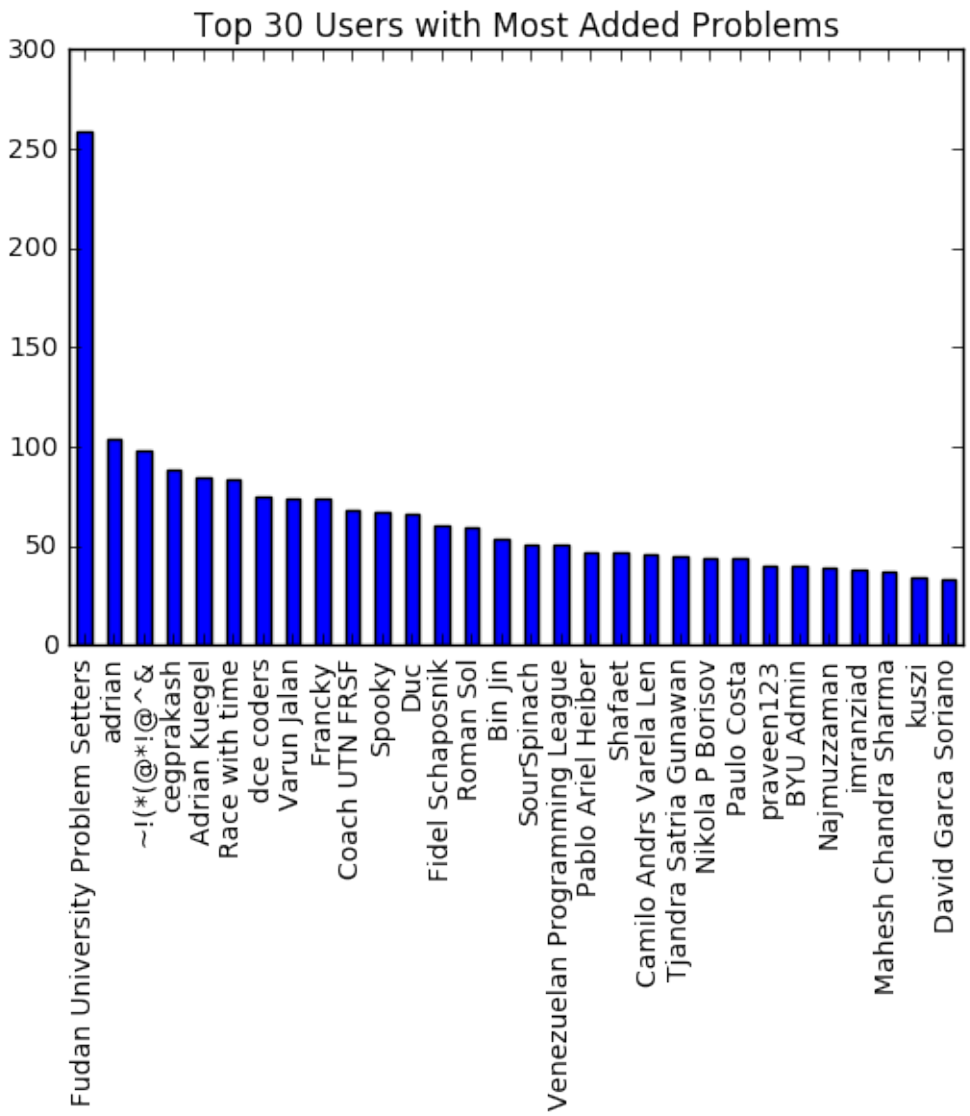

```
There are 13 outliers outside of 4 standard     deviations of title.
```

Out[8]:

	outliers	out_len
611	NITT1 - My Reaction when there is no internet ...	56
1229	BUGTEST - Tutorial for "Your Rank is Pure (EXT...	56
2736	EMAILGEN - Generador de direcciones de correo ...	56
2945	PES16SEQ - Search for an integer using sequent...	56
2968	PES16TSP - Solution for a Travelling Salespers...	56
1900	VAL_GAM4 - Happy Valentine Day (Valentine Adve...	57
3130	GUESSBDAY - Guess the birthday of author or th...	57
2975	PES16SO3 - Sort an array of student records by...	58
1025	IRECSQRT - Inverse of Recurrence Problem With ...	59
2592	PESADA08 - Position of all-distinct-digits num...	59
2967	PES16JT - Generate permutations by Johnson-Tro...	60
1249	BFK_AUTO - Automatic Brainf##k Code Generator ...	61
2954	PES16SO1 - Sort an array of integers using a O...	61

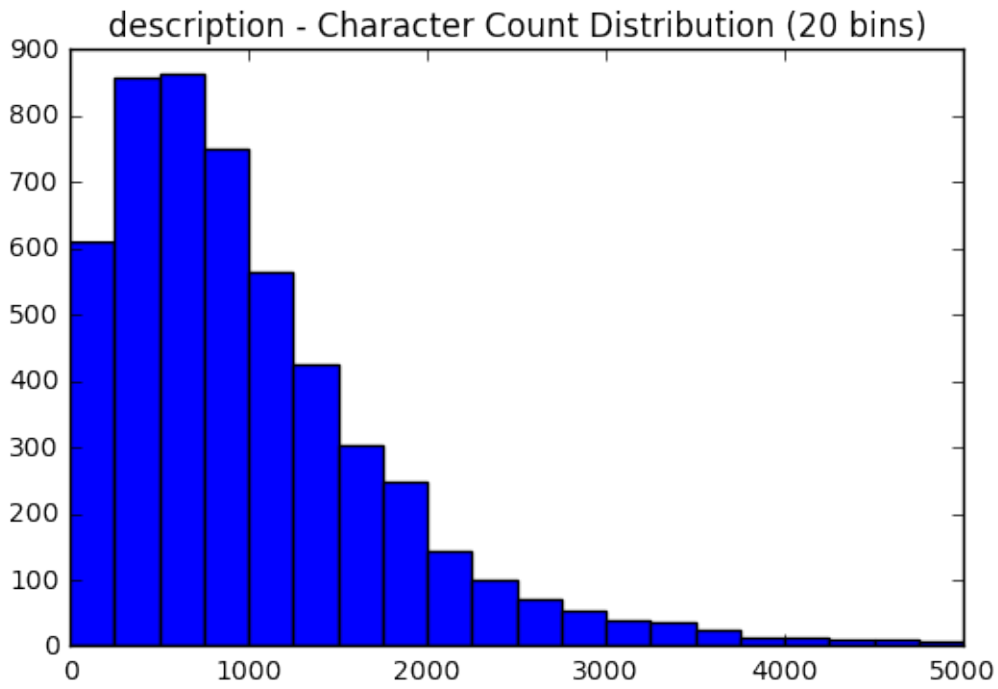
added_by: * The number of posts by user seem to decline at a regular rate with the exception of "Fudan University Problem Setters". This seems to be the only outlier for this attribute.

```
In [9]: table_A['added_by'].value_counts()[:30].plot(kind='bar')
        plt.title("Top 30 Users with Most Added Problems")
        plt.show()
```



description: * The description attribute seems to follow a log normal distribution. There are a 40 instances that have title character lengths longer than 4 times the standard deviation for this attribute.

```
In [10]: textual_histogram(table_A, "description",
                           range=[0,5000], stdev=4)
```



There are 40 outliers outside of 4 standard deviations of description.

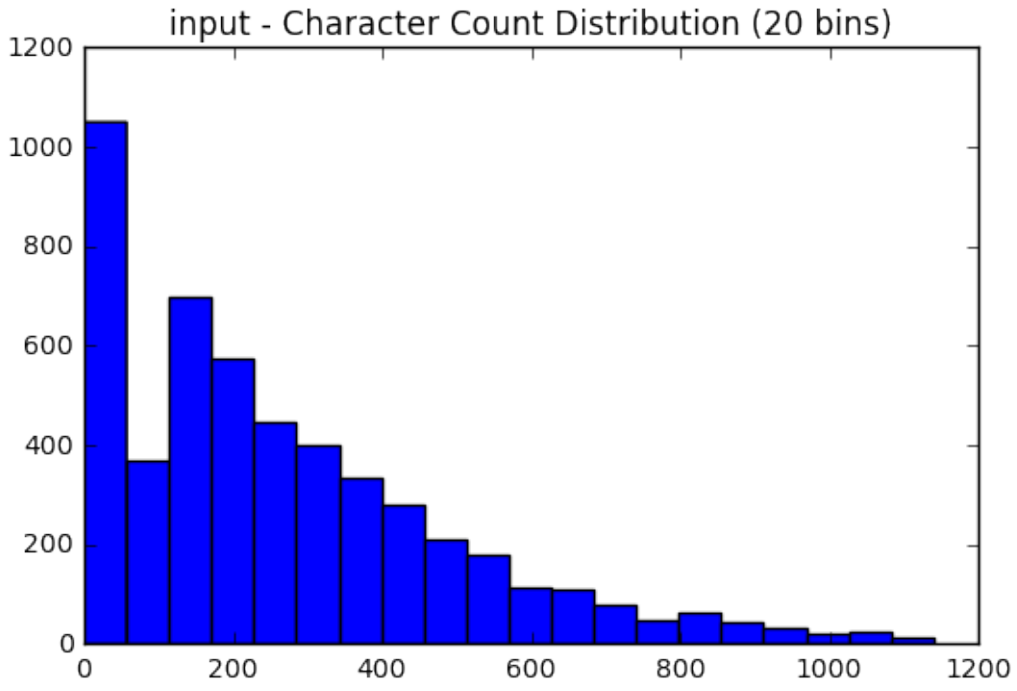
Out[10]:

	outliers	out_len
5164	For years, a group of Regional Contest Dir...	4593
142	People in Nloglnia are very addicted to vide...	4603
764	'"For I am Saruman the Wise, Saruman Ring-...	4619
1821	With growing popularity of Robert in Harvard...	4642
4908	Most nonfiction and reference books have an ...	4677
1763	Charlie and the Chocolate Factory Charlie...	4714
4814	Deoxyribonucleic acid (DNA) is composed of a...	4734
67	Harry's friend Charlie Weasley has partner...	4796
768	Wormtongue looked from face to face. In hi...	4867
2298	All of us are familiar with the reign of t...	4889
3910	The nefarious Mysterio an expertise in ill...	4904
3289	[Due to SPOJ restrictions, this problem has ...	4940
2240	In the woods of Lill-Jansskogen, there is ...	4965
767	Hoo, ho! Good morning, Merry and Pippin!' ...	4995
1844	You are studying a takeover war between tw...	5019
4919	HQ9+ is an esoteric programming language spe...	5025
763	'Strange are the ways of Men, Legolas! Her...	5077
758	'Hush!' said Frodo. 'I think I hear hoofs ...	5089
2347	David has a problem. He wants to transfer a ...	5097
5156	This year, Egypt has been going through an e...	5113
1462	PROBLEM CODE:Enigma Treasure Hunt Kaushi...	5163

```
2276    [Due to SPOJ restrictions, this problem has ...     5215
2861    [Due to SPOJ restrictions, this problem has ...     5256
1698    Tropical Garden  Botanist Somhed regularly t...     5270
2042      NOTE: You can skip to BRIEF if you do not ...     5356
68        The wizards and witches of Hogwarts School...     5373
14      A colony of alien bacteria has recently been...     5630
173       Nlogonian people is very excited about the...     5637
1396      An application to assist in the analysis o...     6318
766       'I think that the enemy brought his own en...     6357
3445    Slitherlink is a puzzle published by Nikoli,...     6565
2485    One of the most famous German card games (al...     6621
2197    Combinational logic circuits are part of all...     6735
4906    The Dotty Software Company makes software th...     6816
759       'We fought far under the living earth, whe...     6909
3294    [Due to SPOJ restrictions, this problem has ...     7864
2451        English version  Wersja polska      The ...     7939
2857    [Due to SPOJ restrictions, this problem has ...     9761
762       'Though the Stewards deemed that it was a ...    10202
1291    Imagine you are a Human Being .. So you have...    10969
```

input: * The input attribute seems to follow an exponential distribution. There are a 36 instances that have title character lengths longer than 4 times the standard deviation for this attribute.

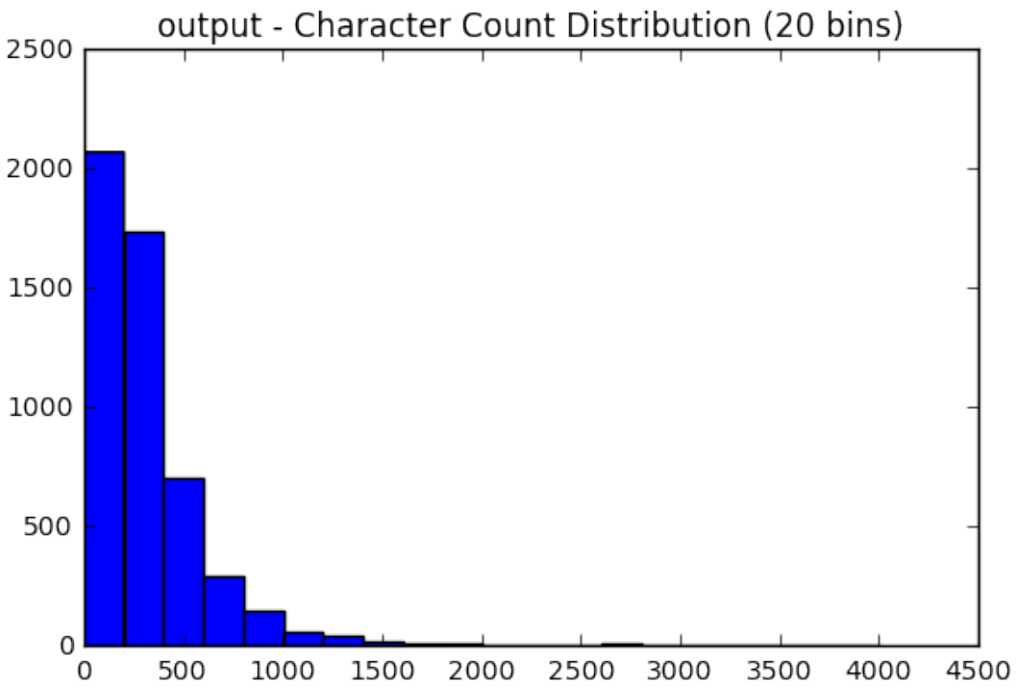
```
In [11]: textual_histogram(table_A, "input", stdev=4)
```



```
There are 36 outliers outside of 4 standard     deviations of input.


Out[11]:                                                    outliers  out_len
         1780    The number of equations t is in the first li...     1426
         489     The input consists of multiple datasets, eac...     1426
         3845    The first line of the standard input contain...     1432
         3748    The first line of the input contains a singl...     1436
         868     The first line of the input contains a numbe...     1445
         3119    The first line of input contains two integer...     1446
         128     The first line contains a number T ( T  100)...     1458
         3696    The input consists of multiple datasets, eac...     1488
         2555    The input file contains one or more test cas...     1495
         4956    The graph to be read comes in several lines:...     1498
         3448    The input will consist of one to sixteen dat...     1502
         1354    The first line of each test case contains tw...     1506
         3121    Multiple test cases. Please process until EO...     1534
         3693    The input consists of a number of datasets, ...     1544
         2547    A Program which has the following format:  <...     1618
         1097    A Program which has the following format:  <...     1625
         2692    The input starts with a line containing a si...     1642
         533     There is asingle positive integer T on the f...     1673
         497     Input is a standard input which contains 3 p...     1683
         4331    There is asingle positive integer T on the f...     1723
         2994    First line, you have n<100, the number of cu...     1729
         3515    The input contains several test cases. The f...     1774
         1224    The first line contains integers m , n , k (...     1887
         2111    Computer networking requires that the comput...     1932
         5079    The input consists of many dialogues.  There...     1933
         3423    The input consists of a set of cities for wh...     1977
         2493    Input starts with a positive integer t<100, ...     2222
         1653    The input consists of multiple datasets, eac...     2236
         628     Each test case is described using several li...     2348
         2492    Input starts with a positive integer t<1000,...     2381
         3922    Your program will be tested on one or more d...     2537
         4904    There is asingle positive integer T on the f...     2651
         2380      There will be several test cases in the in...     2780
         296     The first line of the input contains an inte...     3209
         2184    The input contains several pictures. Each pi...     3251
         749     There is asingle positive integer T on the f...     3411
```

output: * The output attribute seems to follow an exponential distribution. There are a 13 instances that have title character lengths longer than 4 times the standard deviation for this attribute.

```
In [12]: textual_histogram(table_A, "output", stdev=4)
```



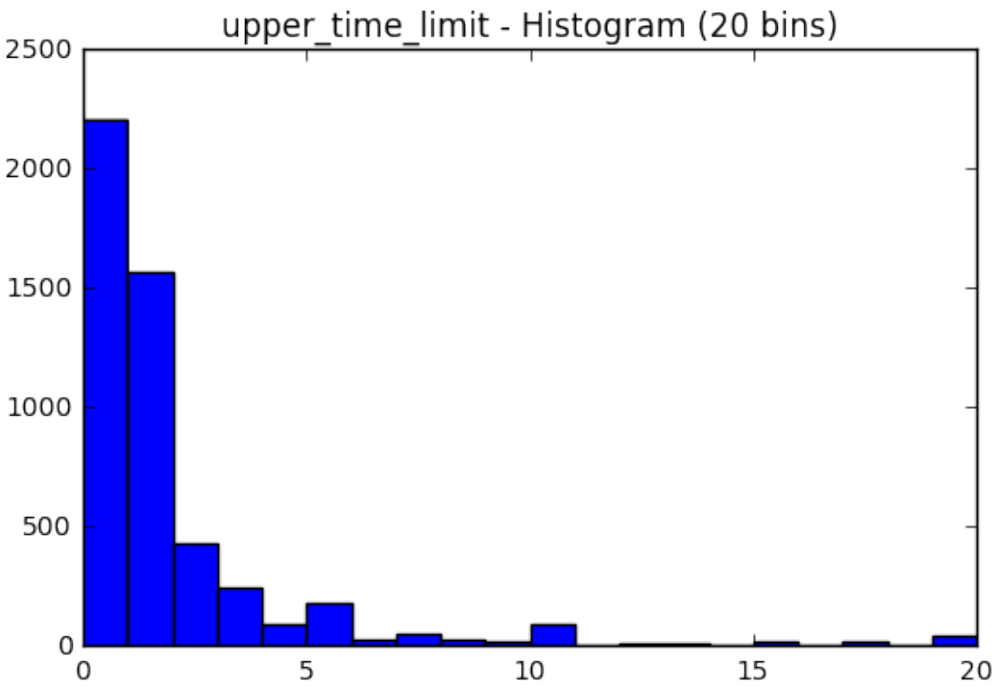

```
There are 13 outliers outside of 4 standard     deviations of output.
```

Out[12]:

		outliers	out_len
749	For each dialogue, your program must output ...		4778
668	For each input case you must print "Scenario...		4887
1973	Your output should describe the strategy you...		5117
2485	For each game you have to print the sequence...		5291
2493	For every testcase you have to generate a co...		5453
1051	For each test case you must output a picture...		5833
1638	For each of the test cases output the reques...		6801
1642	For each of the test cases output the reques...		6801
1643	For each of the test cases output the reques...		6801
3024	Output the value of F(x) E...		8232
2538	Output a single integer, the largest total a...		8565
726	Print a number which is the number of ways i...		9039
2978	For each test output the recognized word in ...		63965

upper_time_limit: * The upper_time_limit attribute seems to (sort of) follow an exponential distribution. There are a 45 instances that have title character lengths longer than 4 times the standard deviation for this attribute.

```
In [13]: numeric_histogram(table_A, "upper_time_limit",
                           range=[0,20], stdev=4)
```



There are 45 outliers outside of 4 standard deviations of upper_time_limit.

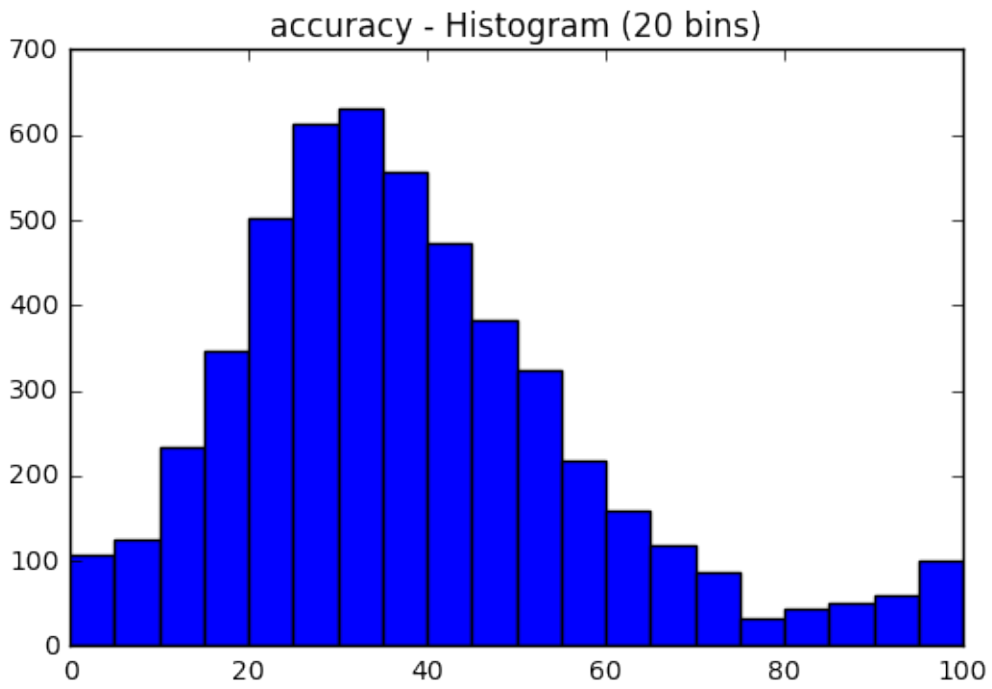
Out[13]:

	outliers
3200	32.00
3575	32.00
4082	32.12
35	34.61
2852	35.00
1494	36.00
4385	37.47
637	40.00
3586	40.00
721	44.00
1934	45.00
1691	50.00
2197	50.00
1788	50.00
641	50.00
1590	50.00
3585	50.00
1317	50.00
3604	50.00
4394	51.85
1508	60.00

```
1923     60.00
3725     60.00
1970     60.00
2000     60.00
1113     60.00
2281     60.00
2824     60.00
3802     60.00
2994     60.00
3115     60.00
707      60.00
1965     75.00
4387     85.17
4395     89.26
3120     90.00
1272     90.00
3121     90.00
1789     99.00
1290    100.00
1243    100.00
998     100.00
818     100.00
171     100.00
1555    120.00
```

accuracy: * The accuracy attribute does not strictly follow any distributions but there seems to be a normal distribution around 30 with an additional increase as the values approach 100. There are no major outliers in this set.

```
In [14]: numeric_histogram(table_A, "accuracy",
                           range=[0,100], stdev=4)
```

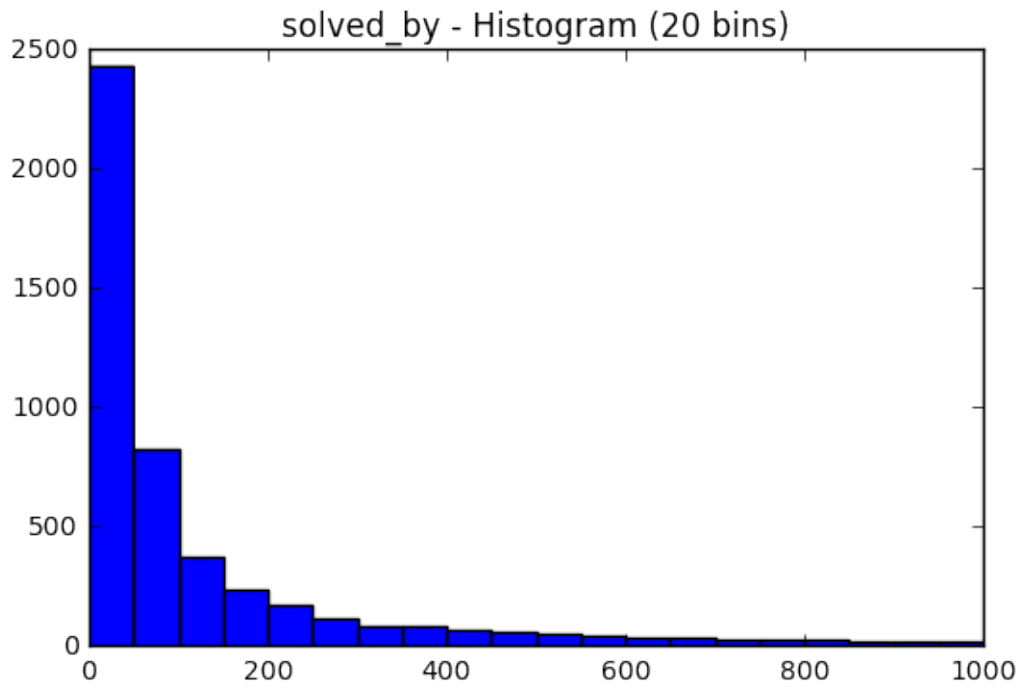



```
There are 0 outliers outside of 4 standard     deviations of accuracy.
```

```
Out[14]: Empty DataFrame
         Columns: [outliers]
         Index: []
```

solved_by: * The solved_by attribute seems to follow an exponential distribution. There are a 30 instances that have title character lengths longer than 4 times the standard deviation for this attribute.

```
In [15]: numeric_histogram(table_A, "solved_by", range=[0, 1000], stdev=4)
```




```
There are 30 outliers outside of 4 standard     deviations of solved_by.
```

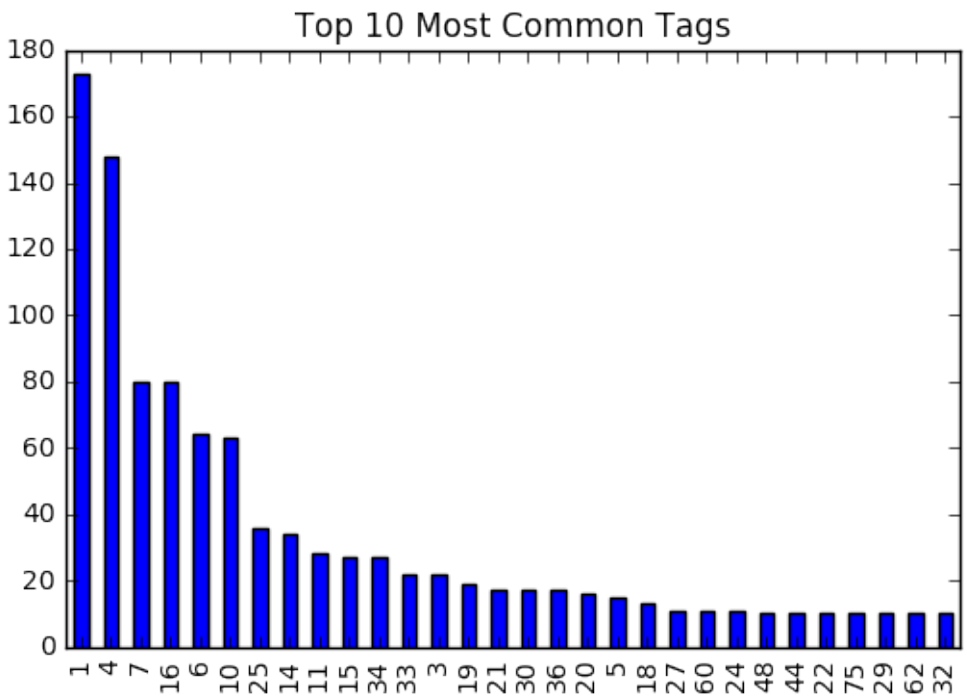
Out[15]:

	outliers
3159	8340.0
3619	8472.0
3392	8751.0
3487	8797.0
5148	9103.0
3618	9144.0
2363	9164.0
4441	10047.0
3694	10101.0
4910	10274.0
3994	10324.0
542	10527.0
88	10717.0
2337	11839.0
3530	12338.0
4077	12675.0
3839	13058.0
3523	13227.0
74	14462.0
3729	14603.0
2285	15001.0

```
4602   16073.0
3511   17680.0
308    17870.0
3727   20560.0
2691   24072.0
279    29322.0
2123   31347.0
3811   35277.0
0     100118.0
```

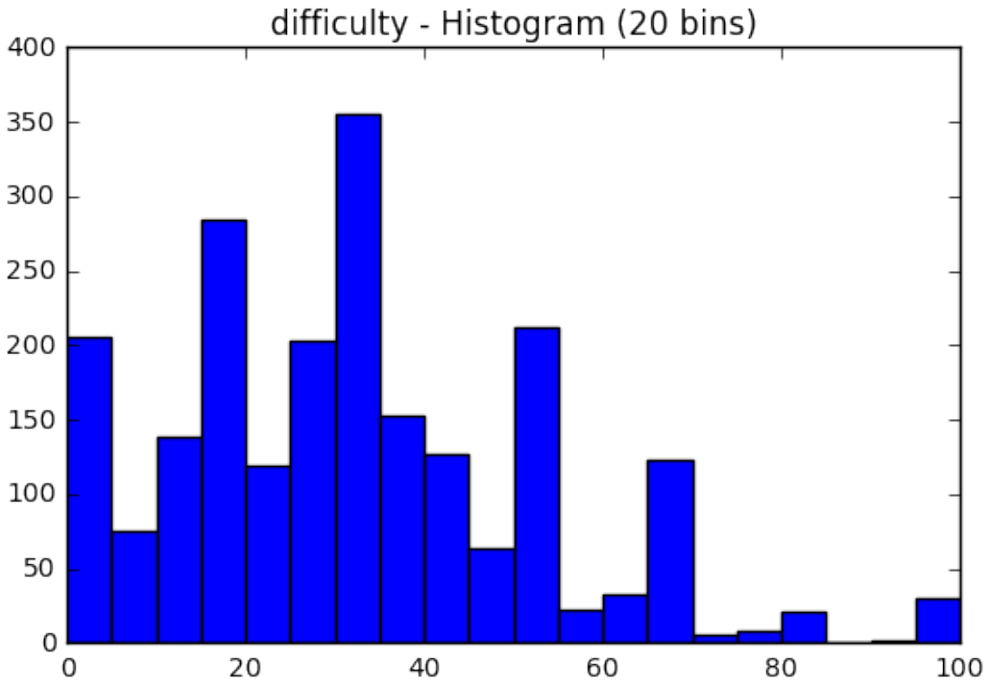
tags: * For the tags attribute, tags 1, 4, 7, 16, 6, & 10 appear to be relative outliers as they are tagged in the most problems with a drop off of at least 20 between each of these and the next most common tag.

```
In [16]: def all_tag_counts(table):
             try:
                 return table["tags"].split(",")
             except:
                 pass

         tag_list = []

         for instance in table_A.apply(all_tag_counts, axis=1):
             if instance != None:
                 for tag in instance:
                     tag_list.append(tag)
             else:
                 pass

         tag_list = pd.Series(tag_list)

         tag_list.value_counts()[:30].plot(kind='bar')
         plt.title("Top 10 Most Common Tags")
         plt.show()
```



difficulty: * The difficulty attribute does not seem to follow a strict distribution but since it all values range from 0 to 100, we would not consider any values outliers for this attribute

```
In [17]: numeric_histogram(table_A, "difficulty",
                           range=[0,100], stdev=4)
```



```
There are 0 outliers outside of 4 standard    deviations of difficulty.
```

```
Out[17]: Empty DataFrame
         Columns: [outliers]
         Index: []
```

7 Step 6: Format Standardization

- **title:** All values are textual. This is also the problem's unique identifier, so we must be sure that none of these are the same (they are all unique).
- **added_by:** There are no specific criteria with this attribute.
- **description, input, & output:** These attributes are free-form text so there are no major formatting concerns other than that the input and output should not be included in the description. If they are, the description must be parsed to move the input and output to their respectives attribute locations.
- **upper_time_limit:** All values in this are numeric, so there are no concerns with this attribute's format.
- **accuracy:** All values in this are numeric, so there are no concerns with this attribute's format.
- **solved_by:** All values in this are numeric, so there are no concerns with this attribute's format.
- **tags:** Many instances have no associated tags, but those that do may have more than one so this attribute is technically a list of categories. As a result, we must be able to parse this during matching and analysis.
- **difficulty:** All values in this are numeric, so there are no concerns with this attribute's format.

8 Step 7: Synomyms

- The only attribute that may contain synomyms is the **tags** attribute where multiple tags could essentially have the same meaning. We will have to investigate this before preforming any matching or analysis tasks.

9 Step 8: Sprinkled Values

- The most notable area of concern related to sprinkled values appears between the **description**, **input**, and **output** attributes. As previously stated, the description often contains the values that should be listed under the input and output attributes, so we will have to parse these attributes out before preforming any matching or analysis tasks.

10 Step 9: Other Data Quality Concerns

- At this point, we do not have any other major data quality concerns.