DS-100 Practice Midterm Questions

Spring 2018

Note: The following questions are intended to be representative of what you'll see on the midterm. The actual exam will have a single page (front and back) answer sheet on which to write each of the answers. The following questions are not guaranteed to cover every topic that's fair game for the exam, and this set is not representative of the length of the exam.

Contents

1 Data Science Basics **4**

2 SQL **5**

3 Data Visualization **6**

4 Sampling **7**

5 Probability **8**

6 Pandas **9**

7 Regular Expressions **11**

8 Modeling and Loss Minimization **12**

9 Web Technologies **13**

Syntax Reference

Regular Expressions

"^" matches the position at the beginning of string (unless used for negation `"[^]"`)

"$" matches the position at the end of string character.

"?" match preceding literal or sub-expression 0 or 1 times. When following `"+"` or `"*"` results in non-greedy matching.

"+" match preceding literal or sub-expression *one* or more times.

"*" match preceding literal or sub-expression *zero* or more times

"." match any character except new line.

"[ ]" match any one of the characters inside, accepts a range, e.g., `"[a-c]"`.

"( )" used to create a sub-expression

"\d" match any *digit* character. `"\D"` is the complement.

"\w" match any *word* character (letters, digits, underscore). `"\W"` is the complement.

"\s" match any *whitespace* character including tabs and newlines. `\S` is the complement.

"\b" match boundary between words

Some useful `re` package functions.

`re.split(pattern, string)` split the `string` at substrings that match the `pattern`. Returns a list.

`re.sub(pattern, replace, string)` apply the `pattern` to `string` replacing matching substrings with `replace`. Returns a string.

Useful Pandas Syntax

```
df.loc[row_selection, col_list]  # row selection can be boolean
df.iloc[row_selection, col_list] # row selection can be boolean
df.groupby(group_columns)[['colA', 'colB']].sum()
pd.merge(df1, df2, on='hi') # Merge df1 and df2 on the 'hi' column
```

```
pd.pivot_table(df,                  # The input dataframe
               index=out_rows,      # values to use as rows
               columns=out_cols,    # values to use as cols
               values=out_values,   # values to use in table
               aggfunc="mean",      # aggregation function
               fill_value=0.0)      # value used for missing comb.
```

1 Data Science Basics

1. True or False

   (1) [1 Pt.] All data science investigations start with an existing dataset.

   (2) [1 Pt.] Because smoking is viewed as a cause for lung cancer, it does not make sense to use lung cancer status to predict smoking status.

   (3) [1 Pt.] Exploratory data analysis is the process of testing key hypotheses.

   (4) [1 Pt.] In most data science applications only a small amount of time is spent cleaning and preparing data.

2 SQL

2. Consider the following real estate schema:

```
Homes(home_id int, city text, bedrooms int, bathrooms int,
      area int)
Transactions(home_id int, buyer_id int, seller_id int,
             transaction_date date, sale_price int)
Buyers(buyer_id int, name text)
Sellers(seller_id int, name text)
```

For the query language questions below, fill in the blanks in the answer to complete the query. For each SQL query and nested subquery, please start a new line when you reach a SQL keyword (SELECT, WHERE, AND, etc.). However, do not start a new line for aggregate functions (COUNT, SUM, etc.), and comparisons (LIKE, AS, IN, NOT IN, EXISTS, NOT EXISTS, ANY, or ALL.)

(1) Fill in the blanks in the SQL query to find the duplicate-free set of id's of all homes in Berkeley with at least 6 bedrooms and at least 2 bathrooms that were bought by "Bobby Tables."

SELECT ________________________________

FROM ________________________________

WHERE ________________________________

____

____

____

____

____

(2) Fill in the blanks in the SQL query to find the id and selling price for each home in Berkeley. If the home has not been sold yet, **the price should be NULL**.

SELECT ____________________________

FROM ________________________________

________________ **JOIN** ________________

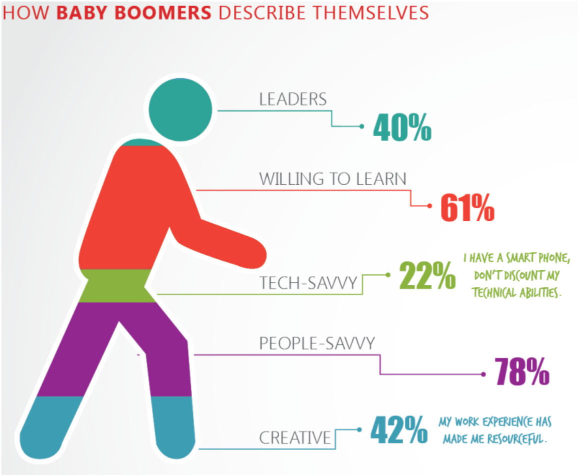
ON ________________________

WHERE ________________________;

3 Data Visualization

3. [3 Pts.] Consider the following plot about how baby boomers describe themselves. Which mistakes does it make? Select all that apply.

□ sampling bias □ jiggling base line □ stacking □ jittering □ area perception



4. [3 Pts.] The FEC data includes contributions to the Clinton and Sanders campaigns. If we want to create a visualization that helps us compare the sizes of donations to their campaigns, which of the following plots should we make? Select all that apply.

□ scatter plot with donations to Clinton's campaign on one axis and Sanders' on the other.

□ density curve of Clinton donations over laid on density curve of Sanders donations.

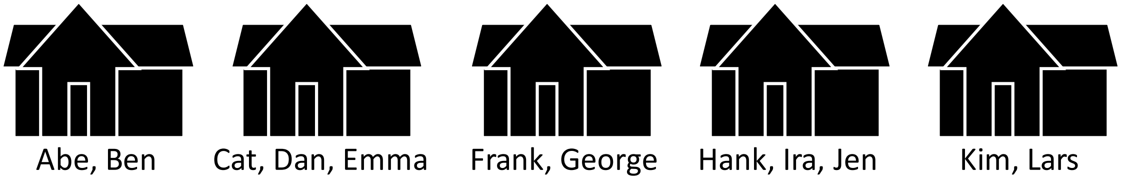
□ side-by-side bar plot of their donations

□ Two box plots, one for Clinton donations and one for Sanders.

□ None of the above

4 Sampling

5. A small town has 5 houses with the following people living in each house:



Suppose we take a **cluster sample** of 2 houses (without replacement), what is the chance that:

(1) [2 Pts.] Kim and Lars are in the sample

○ 0 ○ 1/20 ○ 1/10 ○ 1/6 ○ 1/5 ○ 2/5 ○ 1

(2) [2 Pts.] Kim, Abe, and Ben are in the sample

○ 0 ○ 1/20 ○ 1/10 ○ 1/6 ○ 1/5 ○ 2/5 ○ 1

(3) [1 Pt.] Kim and Dan are in the sample - **Select all that apply**

□ The same as the chance Kim and Lars are in the sample

□ The same as the chance Kim, Abe, and Ben are in the sample

□ Neither of the above

5 Probability

6. A jar contains 3 red, 2 white, and 1 green marble. Aside from color, the marbles are indistinguishable. Two marbles are drawn at random without replacement from the jar. Let X represent the number of red marbles drawn.

   (1) [2 Pts.] What is $\mathbb{P}(X = 0)$?

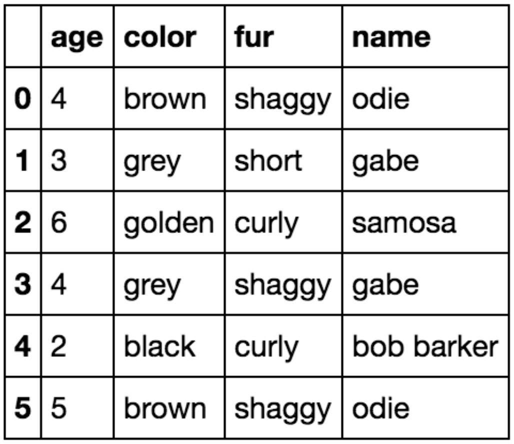
   ○ $1/9$ ○ $1/5$ ○ $1/4$ ○ $2/5$ ○ none of the above

   (2) [2 Pts.] let Y be the number of green marbles drawn. What is $\mathbb{P}(X = 0, Y = 1)$?

   ○ $\frac{1}{15}$ ○ $\frac{2}{15}$ ○ $\frac{1}{12}$ ○ $\frac{1}{6}$ ○ $\frac{7}{15}$ ○ $\frac{8}{15}$

6 Pandas

7. [8 Pts.] The pandas dataframe *dogs* contains information on pets' visits to a veterinarian's office. A portion of the dataframe is shown below.



	age	color	fur	name
0	4	brown	shaggy	odie
1	3	grey	short	gabe
2	6	golden	curly	samosa
3	4	grey	shaggy	gabe
4	2	black	curly	bob barker
5	5	brown	shaggy	odie

For each question, provide a snippet of pandas code as your solution. Assume that the table *dogs* has the same column format as the provided table (just more rows).

(1) How many different dogs visited the veterinarian's office? Provide code that outputs the answers as an integer. Assume that no two dogs have the same name.

○ `len(dogs.groupby("name").count())`
○ `len(dogs["name"])`
○ `len(dogs)`

(2) What was the name of the oldest dog that visited the veterinarian's office?

○ `dogs.sort_values("age", ascending=False).name[0]`
○ `dogs.sort_values("age", ascending=False).name.iloc[0]`
○ `dogs.groupby("name").agg({"age": "max"})`

(3) What was the most common fur color among dogs?

□ `dogs.groupby("color").count().sort_values("name", ascending=False).index[0]`
□ `dogs.groupby("color").count().sort_values("age", ascending=False).index[0]`
□ `dogs.groupby("color").count().sort_values("fur", ascending=False).index[0]`
□ None of the above.

(4) What proportion of dogs had the most common fur type? (For instance, if the most common fur type was curly, what proportion of dogs had curly fur)?

□ `dogs.groupby("fur").count().sort_values("age", ascending=False).age.iloc[0]/len(dogs)`

□ `dogs.groupby("fur").count().sort_values("age", ascending=False).age.iloc[0]/len(dogs["age"])`

□ `dogs.groupby("fur").count().sort_values("age", ascending=False).age.iloc[0]/len(dogs["fur"])`

□ None of the above.

7 Regular Expressions

8. [2 Pts.] Select **all** the strings that **fully match** the regular expression: **`[^dp]an`**

   □ `Dan` □ `pan` □ `fan` □ `man` □ None of the above.

9. [2 Pts.] Select **all** the strings that **fully match** the regular expression: <**`[a-z]*@\w+.edu`**>

   □ `<xin.wang@berkeley.edu>`

   □ `<@berkeley$edu>`

   □ `<xinwang@berkeley#edu>`

   □ `<xinwang@.edu>`

   □ None of the above strings match.

10. [2 Pts.] Select **all** the strings that **fully match** the regular expression: **`^Go.*`**

    □ `Way to ^Go!`

    □ `Go Bears!`

    □ `go trees?`

    □ None of the above strings match

11. [2 Pts.] What is the result of evaluating the following python command?

```
len(re.split(r"\d+", "You get a 99.9 on the exam."))
```

   ○ 2 ○ 3 ○ 4 ○ 5

12. For the following tasks, write the corresponding Python code or regular expression.

    (1) [2 Pts.] Write a regular expression that only matches sub strings consisting of an `a` immediately followed by zero or one `b` characters.

    `regx = r’`____’

    (2) [3 Pts.] Suppose we’ve run the code below:

```
text = ’Data\t \t Science  100’
```

    Use a method in the `re` module to replace all the continuous segments of spaces with a single comma. The resulting string should look like `"Data,Science,100"`.

    `re.`____

8 Modeling and Loss Minimization

13. [6 Pts.] We propose the following simple model for a dataset consisting of four points $\mathcal{D} = \{0, 2, 4, 10\}$:

$$y = \theta^*$$

Use the following plots of loss functions for this model to answer the following questions.

The plot on the left shows the average squared loss versus θ; the plot on the right shows the average absolute loss.

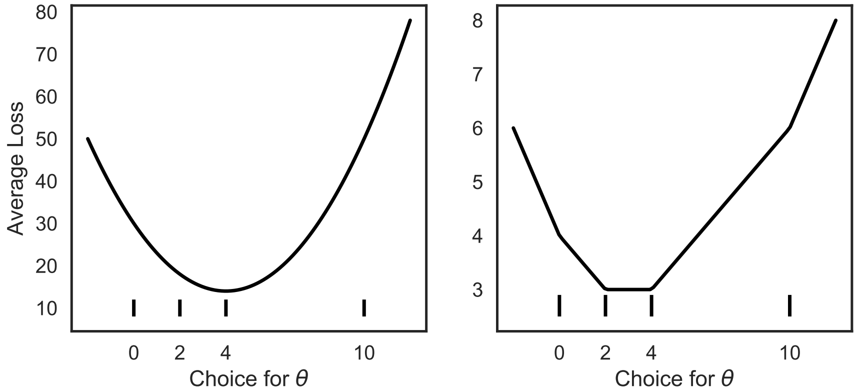


Figure 1:

(1) [2 Pts.] Which choice(s) for θ minimize the average squared loss? **Select all that apply.**

□ 2 □ 3 □ 4 □ 10 □ None of the above

(2) [2 Pts.] Which choice(s) for θ minimize the average absolute loss? **Select all that apply.**

□ 2 □ 3 □ 4 □ 10 □ None of the above

(3) [2 Pts.] Suppose we add an observation at $y_5 = 100$. Which choice(s) for θ minimize the average absolute loss? **Select all that apply.**

A. A value smaller than 3

B. 3

C. 4

D. 5

E. A value larger than 5

14. Which θ minimizes the following loss function for a dataset D comprised of (x_i, y_i) pairs? **Show your work in the space provided.**

$$L(\theta, D) = \sum_{i=1}^{n} (y_i - \theta x_i)^2$$

○ $\theta = \frac{1}{n} \sum_{i=1}^{n} \frac{y_i}{x_i}$ ○ $\theta = \frac{\sum_{i=1}^{n} x_i y_i}{\sum_{i=1}^{n} x_i^2}$ ○ $\theta = \frac{\sum_{i=1}^{n} y_i}{\sum_{i=1}^{n} x_i}$ ○ $\theta = \frac{\sum_{i=1}^{n} y_i^2}{\sum_{i=1}^{n} x_i^2}$

15. Suppose we observe a dataset $\{x_1, \ldots, x_n\}$ and the following loss function for the parameter λ:

$$L(\lambda, \mathcal{D}) = -\frac{1}{n} \sum_{i=1}^{n} \ln(\lambda e^{-\lambda x_i})$$

Derive the loss minimizing parameter value $\hat{\lambda}$. **Circle your answer.**

9 Web Technologies

16. [1 Pt.] HTTP is a simple _____ protocol.

   A. Push - Pull

   B. Get - Post

   C. Request - Response

   D. Read - Write

17. [3 Pts.] Data100 grade-book server can do two things:

   1. Reader can add/update student's grade on the server.
   2. Students can retrieve their grade but cannot modify them.

   What's the appropriate REST request type for adding/updating grade?

   A. GET

   B. POST

   C. OPTIONS

   What's the appropriate REST request type for retrieving grade?

   A. GET

   B. POST

C. OPTIONS

Reader can submit multiple grades in JSON format. Given the following JSON, select all the true statements:

```
1  [{
2      "student_id": 1,
3      "assignment_id": 23,
4      "grades": {
5          "q1": 2,
6          "q2": 3
7      },
8      "comments": "great plot!",
9      "comments": "nice explanation!"
10 }, {
11     "student_id": 1,
12     "assignment_id": 24,
14     "grades": {
15         "q1": "20",
16         "q2": "10"
17     }
18 }]
```

A. The square bracket at line 1 and 18 are redundant. They should be taken out.

B. Duplicate keys on line 8 and 9 are not allowed.

C. All the integer should be string type.

D. “grades” field should be a list of grade not a nested JSON.