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1. General Guidelines
   1. General Expectations

We consider this to be a “full stack” developer test to help us get to know you, your skillsets, and your experience level as well as possible. We hire team members ranging from entry-level to seasoned developers across various areas of the stack, so our goal with this process is simply to determine if we’re a good fit to work together.

You may be comfortable answering all of the questions and if so that’s great! If you feel like some are just not “your thing” that’s fine too. Not every role on our team needs to know *everything* on this test, so just do your best and focus on showing us who *you* are!

* 1. Timebox

This test is intended to be something you can complete in approximately 4 hours depending on skill level. Everyone works at a different pace, so it’s completely acceptable if you want to spend more time, but please don’t spend all day on it.

* 1. Timeline

Generally, we expect to receive your completed response for this test within a week of us sending it to you. If you feel you need more time or something comes up, please let us know.

Once our team receives your completed test, we will generally review and respond within two weeks. At that point, we will either schedule an interview (via phone or in-person) or let you know that we have determined we aren’t the best fit for each other.

* 1. Sending Your Completed Response

For essay questions, please type your written response in the space provided. Each question has at least a half-page allotted for consistency. This simplifies formatting but is not an expectation of how much space each individual question should or shouldn’t take, please take as much or little space as you need.

For the questions that require code as part of the response, please send your completed code as a separate code file and not embedded in the Word document. Hosting on a public GitHub repo is also acceptable. Please be sure to note either the filename or the URL in your written answer to the question.

If you are sending completed code through email and not via a URL for a public repository, please:

1. **Do not attach zip files** as they are blocked by our email filters.
2. **Append “.txt” to the filename** of each code file before attaching to the email. (E.g., “validation.js” becomes “validation.js.txt” so it isn’t filtered by our email rules.)
3. **List the filenames of all attachments** so we can verify nothing was blocked by our email filters.

Name your completed Word document in the format of:

**MetroNet Developer Test - Your Name (YYYY-mm-dd)**

Name any file attachments (for code samples) in the format of:

**MetroNet Developer Test - Your Name (YYYY-mm-dd) - Question Name**

(If a question requires multiple files, please name them accordingly.)

Unless otherwise specified, you may simply reply to the email in which we sent you the test and attach the file containing your completed response.

* 1. Language/Environment

We believe that good developers can learn multiple programming languages, so our goal is to test your general ability to code and reason through problems, not quiz you on a specific syntax or library. Unless otherwise specified, feel free to use whatever programming language you feel most comfortable with to complete this test.

* 1. Online Resources

We believe that searching for answers in Google, Stack Overflow, etc. is part of a developer’s daily workflow and knowing where to find an answer is often as important if not more important than knowing it.

If you use any online resources to help you complete an answer please indicate which ones and a short description of your thought process, including any information you feel relevant such as search terms, what syntax you wanted to verify, etc.

We reserve the right to verify your answers with online tools to check for plagiarism, so be sure not to just copy/paste something from Wikipedia.

* 1. Asking For Help

We believe that helping other team members and being willing to ask questions is an important part of a being a developer. If you get stuck or something doesn’t make sense, please reach out! Just email your hiring contact explaining what’s up and we’ll do our best to accommodate.

1. Requests & Debugging
2. 1. Request Lifecycle

Describe what happens in between clicking on a link on one web page and the new page being loaded and rendered by the browser. Be as detailed as you can.

**Answer**:

Let’s take a top down approach to answer this question. I will first write all the major steps and then dive into each one with greater details. Clicking on a link on a web page follows very similar path as to search for a link in a web browser. The <a> tag assigns the text with link passed in href. When we click on this link the browser follows following steps:

1. DNS lookup for URL
2. HTTP request to web server

Server response redirect(optional)

Browser follows redirect(optional)

1. Server handles request
2. Server send back HTML response
3. Rendering the HTML

Browser send request for HTML embedded objects

Browser send further requests.

Lets try to understand each step:

1. **DNS lookup for URL:**

DNS = The Domain Name System (DNS) is a distributed directory that resolves human-readable hostnames, such as www.google.com, into machine-readable IP addresses like 64.233.160.0.DNS look ups is performed at many caches in following order: browser cacahe, os cache, router cache and ISP DNS cache

1. **HTTP request to web server**

When the browser sends a request, it includes several headers which informs the server about what is required.

If there is an issue with the address you are requesting, you can get several different negative responses. In the response header you can get some information about what went wrong, especially in the response status. like 404 Not found, 500 Server error, 301 Moved permanently

1. **Server handles the request:**

The web server software (e.g., IIS or Apache) receives the HTTP request and decides which request handler should be executed to handle this request. A request handler is a program (in ASP.NET, PHP, Ruby, …) that reads the request and generates the HTML for the response.

In the simplest case, the request handlers can be stored in a file hierarchy whose structure mirrors the URL structure.

1. **Server sends back response:**

The request handler reads the request, its parameters, and cookies. It will read and possibly update some data stored on the server. Then, the request handler will generate a HTML response. When the server figures this out it’s ready to send the page content back in the response.

1. **Rendering the HTML:**

As it renders, the browser comes across several other assets required to complete the page. This could be images, CSS files or JS files. The browser doesn’t get all of this in the original request, so now it needs to send out more requests for each individual asset it needs. As the browser starts to get responses it can continue rendering the page.

I initially didn’t know the detailed process. So, I used following resources to answer this question.

I read some Blogs on medium.com. Then I followed resources suggested in that blog to get better grasp of the process. I also read some discussions on Quora. To further solidify the process with visualizations I used YouTube.

* 1. Debugging: Page Doesn’t Load

You’ve developed a **(known working)** web application that, when accessed, will dynamically retrieve a set of data from an SQL database and display it as HTML. When you visit the URL of the application, the page is blank. Describe your troubleshooting steps.

**Answer**:

While developing a library management system as a mini project in database management system’s class, I came across similar problem as described in the question. I was using Flask at front end to develop web layout and SQLite for database. All the scripts were written in python.

I used following steps to troubleshoot:

1. Verified the localhost or Port connection.
2. Verified availability of the port
3. Verified query that gathers information from database
4. Verified connection with database.

Generally, I try to get console output for each step and see if the code is following expected path.

1. Development
2. 1. Data Types

Describe the differences, similarities, and common development pitfalls between: null, undefined, an empty string, the number 0, a string containing only the number 0, and false.

Answer:

**Null**: Null should be assigned to an when we do not want to get garbage values. Null indicates that the variable doesn’t refer to any object. Sometimes assigning null generates type errors where comparisons are used for edge cases. In Python, I use None to assign null values to a variable. In case of data I normally use Nan to assign null values.

**Empty** **string**: Though empty string contains no value it represents that the variable is only going to take string when it is being concatenated. When numerical output is significant and is being concatenated empty string can be used to create readable and error free execution.

**Undefined**: If we want to create a stencil of an object rather than using null, we should use undefined variable. The structure of the object can be predefined. For example, in Python, if we want to specify that object is list we can initialize it as ,

list\_example = list() or list\_example = []

**Number** **0**: I generally avoid assigning 0 to any variable while working with datasets, because most of the time 0 is significant value for data and it messes up statistics. I only assign 0 to counters to keep track of iterations.

**A String containing only the number zero**: string “0” represents ASCII value and it extremely unusual to use string zero in python.

**False**: it represents Boolean value. It comes very handy when we are creating condition statements.

* 1. Recursion

Explain recursion. What are some common pitfalls when using it? Is it ever necessary? If so, what are some ways to determine whether or not a specific situation calls for it?

Answer:

In simple words, we can expand the work recursion in to re occurrence. When a function calls itself until some end condition is met, it is called recursion.

I believe that recursion is not at all necessary. Each recursive logic can be converted to a iterative logic.

It should be used only when we know the maximum number of recursive calls is small (relative with size of memory). Using recursion makes the logic easier to read. So, when readability is one of the requirements of the problem at hand, we can use recursion.

* 1. Code Quality

How would you describe "good code"? What role (if any) do comments, refactoring, and code reviews play?

Answer:

In my opinion, “good code” should have following characteristics:

1. Relevant variable naming convention.
2. Explanation of logic using comments.
3. Reduce complexity and scope of each function and class.
4. Proper indentation and spacing
5. Reusability

For comments, I believe they are the inseparable part of any solution. It makes the code self-explanatory. When the logic of the code is complex, it helps others to understand the solution. In python libraries, it also helps in documentation of the code for ease of use.

Refactoring reduces the complexity of the code and it is necessary when the scope of the solution is not limited to a single problem.

I believe that code reviews are used to mitigate the mistakes made by the developers by their teammates. But I have never been a part of the process of code review.

* 1. Code Structure

What criteria do you have for deciding when a single method/function does "too much" and needs to be broken down into multiple methods/functions?

Answer:

Generally, I try to take top down approach while creating a solution. Breaking the problem in to chronological subproblems makes it easier to define the functions that will be used to get outcome. But I do not stress about how big a function gets and put everything that comes in my mind in one function initially and refactoring the definition later. Mostly it depends on the scope of the function. While refactoring, if the function is containing more than one logical component of the solution then I take each component and create new function for it. Also if I feel that some work is repeated then it is marked for refactoring.

1. Process
   1. Starting a Project

Explain your approach to a new project. Where do you start?

**Answer**:

I believe that internalization of a problem is crucially important to come up with an effective solution. One must understand the problem at hand thoroughly before jumping to the solution. If working with a team, I would suggest a moderated brainstorming session. As mentioned earlier, I take top down approach in solving a problem. My strategy is to divide the problem in to smaller subproblems of which solutions are known or can be easily solved using basic problem-solving analogies. I also tend to keep the focus on the end goal, to get intuition while developing the flow. If I feel that the problem is too complex, I try to come up with a bad solution and then optimize it. Test cases plays important role in such cases. So, I try to include all the edge case scenarios to check if there are any logical errors.

* 1. Software Development Methodologies

Describe the differences and similarities between common software development methodologies. Which do you think is better and why?

**Answer**:

Most common methodologies in software development as agile and waterfall. Software life cycle can be divided in to following phases:

1) Requirement Analysis 2) Design & Planning 3) Development 4) Testing 5) Deployment 6) Maintenance

Waterfall model follows a sequential flow of the phases mentioned above whereas agile model promotes continuous iteration of development and testing.

Waterfall is a structured methodology so it can be quite rigid. In contrast, Agile methodology is flexible.

Waterfall methodology cannot change according to changes in requirement like Agile.

Agile performs testing concurrently in each iteration of development whereas in Waterfall methodology testing comes after the development phase.

In my opinion, Agile methodology is better because of its flexibility to accommodate changes and reduced backlog at step in development process of a software. Furthermore, in Agile environment, collaboration in team members helps faster delivery of the intended product. It reduces point of failures and also reduces impact of errors in the final product.

* 1. Testing

What role (if any) do you think testing plays in the development process? When would you use manual testing vs automated testing?

**Answer**:

Testing plays significant role while developing any product. Following are some reasons why a product must be tested:

1. To point out the defects and errors made during the development phases.
2. To enhance customer satisfaction and reliability of the solution provider
3. To increase quality of the product and reduce maintenance costs
4. To make the product fault tolerant.

Manual Testing is a process in which you compare the behavior of a developed piece of code against the expected behavior.

Automation testing is used to automate repetitive tasks and other testing tasks which are difficult to perform manually. It can be achieved by writing test scripts or using any automation testing tools like selenium.

1. Past Projects
   1. Wrong Approach

Have you ever spent all day (or even several days/weeks) working on a problem, only to find the solution you implemented was the wrong approach? What did you do?

Yes. This has happened many times during my research assistantship with Dr. Wenjia Lee at New York Institute of technology. I believe that this is a part of research workflow to find dead ends and mark them so that others can be prevented following that path.

I was working on Baby sound classification project and our work was to be submitted to INTERSPEECH 2019. I was assigned to reproduce results from a research paper to compare our work. The model suggested in that research paper was developed using deferent library and I converted it to the library we used in our experiments. Just on the date of submission I realized that the result generated are flawed because I misunderstood the model architecture and we need to review it before we can submit our work to this conference or else wrong results would be submitted.

So, I had to convince the professor that I have made a mistake and we must revoke our submission. After that I rectified the mistake by recreating the model from scratch and requested the professor to submit the work in another conference.

* 1. Completed Project

Describe the project you have worked on that you are most proud of. What was your part in the project that worked out particularly well?

While working as a Research Assistant for Dr. Houwei Cao at New York Institute of Technology, I was working on emotion recognition project and I am most proud of that project.

I was responsible for the following on that project:

* Creating a baseline model to classify emotions using simplest machine learning algorithms which surpassed the human prediction.
* Literature review for the work done in past on emotion recognition through voice and video.
* Organizing the experiments, results and models into a central repository.
* Extracting, cleaning and normalizing features form audio and video clips.
* Comparing the results with work done in past
* Changing the train-test strategy to minimize experimentation time from several days to couple of hours which also increased the generalization in prediction of different emotions. It also helped us to compare the work with other researches.
* Helping other researchers to get on board on this project.

1. Work Style
2. 1. Work Environment

Describe your ideal work environment.

There are two things I would love to have in my work environment:

1. Communication should not follow rigid hierarchy in a multi-layer team structure.
2. Moderated brain storming sessions should be a part of the development lifecycle.

Other than that, a friendly and helping environment would help me flourish in any environment.

* 1. Existing Systems

Have you ever worked with existing legacy or third-party systems? If so, what were some of the challenges you faced and how did you solve them?

Answer:

To be very honest, I didn’t know what legacy code or system is before I came across this question. I searched for what it really is and realized that I have done something similar while working as a Research Assistant for Dr. Houwei Cao at New York Institute of Technology.

The task was to classify basic emotions from audio-video clips using different machine learning and deep learning techniques. A lot of work was done before I joined this project. But all the work was scattered. All the scripts were to be maintained properly into a central repository so that we can reproduce the results generated before, modify and/or extend the experiments, or review them to include the results while submitting the work to different conferences. So, when I joined the project, I took the initiative to data, scripts, models and results generated by previous researchers into a central repository. I created a naming convention for the project so that each experiment can be review or improved effortlessly by other researchers. I organized the work done according to the naming convention and wrote step by step instructions to reproduce the results for each experiment. I also created requirement files for each experiment so that different environments used by different researches can be recreated. It helped me a lot to understand the basic architecture of the algorithms, dataset and workflow of machine learning and deep learning models.

The biggest challenge was to maintain extracted features for the dataset. To maintain the scripts that extracted features from dataset for each iteration of experiment was very confusing and time consuming as there were many ambiguous scripts created by previous researchers. So, I coordinated many zoom meetings so that I can contact the responsible researcher and understand the feature extraction for particular experiment.

1. Additional Comments
2. 1. Is there anything else you think we should know or you’d like to share?

Apart from my resume, I am very much fascinated by cloud computing technologies available in the current market. I have recently got certified for Microsoft Azure Fundamentals (AZ-900). I am also preparing for Microsoft Azure Artificial Engineer Certification (AI-100) and planning to get certified by the end of January 2020.

In my free time, I like to read books specifically about Indian ancient mythology. I really enjoy fusion of past and present in such books. I also like drawing using only charcoals. I also try to keep up with today’s social media with my drawings. Some of them can be found on my Instagram account. <https://www.instagram.com/ravi_3394/>

1. Coding Samples
2. 1. Custom Sorting

**Task:** Write a function to sort a hand of cards.

**Input Parameters:** a list/vector/array of Card objects

**Return Parameter:** a list/vector/array of Card objects that are sorted

**Assumptions you don’t have to code:**

* Each card object has an attribute called **suit** that returns the suit of the card as a string: “Hearts”, “Spades”, “Clubs”, “Diamonds”
* Each card object has an attribute called **value** that returns a character representing their value: 2, 3, 4, 5, 6, 7, 8, 9, J, Q, K, A

**Requirements:**

* The cards should be sorted in **ascending** order unless you implement the bonus flag below. In that case, the default should be ascending unless overridden by the flag.
* **Bonus:** Add a flag to say whether to sort in ascending or descending order.

**Domain Knowledge:**

* Playing cards are ordered by **value** then by **suit**.
* For values, assume: 2 < 3 < 4 < 5 < 6 < 7 < 8 < 9 < J < Q < K < A
* For suits, assume: Hearts < Diamonds < Clubs < Spades

**Example of Sorted Cards:**

1. 3 of Clubs
2. 7 of Hearts
3. Ace of Hearts
4. Ace of Spades

**Context/Hints:**

* Try to treat this like you would any other real-world sorting problem you may encounter in normal business logic.
* Feel free to write additional helper functions or other functions associated with the Card object to help accomplish the task.

**Answer**: solution for this problem can be found at: <https://github.com/ravishah3394/MetroNet_Developer_Test/blob/master/8.1%20Custom%20Sorting.ipynb>

* 1. Data Validation

**Task:** Write a simple script to validate a set of contact records and report on any errors.

**Given:**

* A list of 20 contact objects (full names, city, phone number, and email address)

**Step 1: List all contact records with the following output:**

* Full name
* Whether the phone and email fields are "valid":
  + Output "Valid" if both email and phone are valid.
  + Output "Email is invalid." if email is invalid and phone is valid.
  + Output "Phone is invalid." if phone is invalid and email is valid.
  + Output "Email and Phone are invalid." if both phone and email are invalid.

**Step 2: List each city and report the following output:**

* Name of city
* Number of validation errors

**Requirements:**

* Contacts should be sorted alphabetically in **ascending** order.
* Cities should be sorted by number of validation errors in **descending** order.

**Validation criteria:**

* Email field: has exactly one @ symbol with data on each side
* Phone field: is numeric with only digits, dashes, and spaces allowed

**Data Set:** Use the records in Contacts.json, which are based off of U.S. census data via Wikipedia’s list of [given names](https://en.wikipedia.org/wiki/List_of_most_popular_given_names) and [surnames](https://en.wikipedia.org/wiki/List_of_most_common_surnames_in_North_America).

**Answer**: solution for this problem can be found at:

<https://github.com/ravishah3394/MetroNet_Developer_Test/blob/master/8.2%20Data%20Validation.ipynb>

* 1. Regular Expressions

**Task:** Write a regular expression to parse timestamps.

**Requirements:**

* Extract the year/month/date and hours/minutes/seconds from a date timestamp.
* **Bonus:** Write the expression so that it will work if the timestamp is not included.

**Example Data**

With timestamps:

1. 2014-08-18T13:03:25Z
2. 2014/08/18T13:03:25Z

Without timestamps:

1. 2014-08-18
2. 2014/08/18

**Answer**: solution for this problem can be found at:

<https://github.com/ravishah3394/MetroNet_Developer_Test/blob/master/8.3%20Regular%20Expressions.ipynb>

* 1. Simple Web Form

**Requirements:**

* Page title should be “Team Introduction”.
* Page should have a simple HTML form that requests two fields of input: your name and a fun fact about yourself.
* The form should have a button to introduce yourself.
* When the submit button is clicked, both input fields should be validated and an alert message shown if there is an error.
* If there are no errors when the form is submitted:
  1. The validated data should be logged to the browser’s developer console.
  2. The form should be hidden and replaced with a new box displaying the input (name and fun fact).
* The “introduction box” should have a link or button to reset the form and allow “introducing” a different team member.
* **Bonus:** Use SCSS or describe how you’d refactor your CSS if SCSS was available in the build environment.

**Answer**: solution for this problem can be found at:

<https://github.com/ravishah3394/MetroNet_Developer_Test/tree/master/8.4%20Simple%20Web%20Form>