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Question 1. Word Bank Matching (1 point each, 14 points)

For each statement below, input the letter of the term that is *best* described. Note that you can click each word (cell) to mark it off. Each word is used at most once.

A. — Automated Program Repair	B. — Composite Design Pattern	C. — Concurrency Bug	D. — Conditional Breakpoint
E. — Delegation	F. — Factory method pattern	G. — Fault Localization	H. — Functional Requirement
I. — Informal goal	J. — Interview	K. — Perverse Incentive	L. — Postconditions
M. — Productivity	N. — Profiling	O. — Quality Requirements	P. — Readability
Q. — Requirements Elicitation	R. — Singleton Design Pattern	S. — Stakeholder	T. — Strong Conflict
U. — Top-down comprehension	V. — Validation	W. — Verification	X. — Watchpoint
Y. — Weak Conflict			

Q1.1:

Luffy is a new employee at Netfleecs. They utilize their experience from prior jobs to understand the codebase and quickly get up to speed.

Q1.2:

Pearl is developing a banking application for FloorMart, allowing users to make various types of payments. FloorMart does not want the specific types of payment objects to be associated with client source code. Pearl suggest using *this term*.

Q1.3:

MunchyRoll is developing a streaming service and says that their catalog function must indicate whether or not each video has associated subtitles.

Q1.4:

Devforce has created a privacy policy for their latest app, stating that a user's personal information will not be shared with other users without their consent. Their app must implement this policy.

Q1.5:

Yuxuan wants to determine which of the 50 patches committed last night cause a bug. To do this, they use delta debugging to find a minimal subset of those patches that induces a failure.

Q1.6:

Aang is developing a game for EECS 494, where game objects react to game physics based on how much time has elapsed since the last game update. Aang uses this to implement the game clock.

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Q1.7:

Bank of Michigan is assessing whether selling sports software would be profitable. Their discussions incorporate multiple *this term*, helping to ensure that they consider diverse factors such as legality, software feasibility, company executive opinion, and sales projections.

Q1.8:

481andMe wants to create promotional videos for their debut product. They outsource this project to a third-party company led by Rohit. Rohit first meets with 481andMe to discuss the key elements to include in the video.

Q1.9:

After creating a new application, Wahoo ensures that the application conforms to its specifications.

Q1.10:

Eugene recently identified a bug in Boogle's banking application that results in users being charged without their money being transferred. To localize the issue, Eugene begins reviewing the code base, but finds it challenging. Eugene believes that it would be beneficial to improve *this term*.

Q1.11:

Omkar recently discovered a bug that causes Miscord's website to display incorrect text. To track changes in the variable holding the text value, Omkar uses *this term*.

Q1.12:

Naruto is developing a program. Amazoon specifies that the program should be designed so that the return value is always 0.

Q1.13:

Spongebob is building a document management application for PiedPiper, where documents can contain individual elements (such as text, images or tables) as well as groups of elements. PiedPiper wants users to be able to copy, paste and delete entire groups with a single action. Spongebob suggests using *this term*.

Q1.14:

MoonChips is developing a new application and assigns Priscila the task of documenting wants and needs. As one part of doing so, Priscila does this.

Question 2. Guest Lectures and Course Concepts (18.5 points)

The following questions will ask you about the 4 guest lectures. Please read the question carefully and follow instructions as directly as possible.

(a) (3 points)

At least two guest lecturers mentioned their work related to AI for SE. Give one lecturer's name and briefly describe what they did or talked about on this topic in their lecture. (one sentence maximum) Then provide an example of SE for AI that you have learned in EECS 481 class. (one sentence maximum)

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Your answer here.

(b) (3 points)

Aidan Yang mentioned four techniques for software quality assurance, starting with software testing. What are the other three techniques he mentioned? (one sentence). EECS 481 discussed model checking and its definition. What technique described by Aidan is the closest to the definition we covered, and why? (two sentences maximum)

Your answer here.

(c) (3.5 points)

Henry Beckstein mentioned software testing at Subaru in his guest lecture. Quote one sentence describing his idea of the purposes of testing from his lecture slides. Then describe, in one sentence, a purpose of software testing from the EECS 481 lectures or readings. To what degree do those two ideas align? Briefly explain your answer. (three sentences maximum)

Your answer here.

(d) (4 points)

Farhad Arbab introduced a programming language in his guest lecture. What kind of program is this new language designed for? (quote one relevant sentence from his slides, and then answer the question in another one sentence) For this kind of program, what is a common issue and what is a solution that we covered in EECS 481 could help resolve that issue? (two sentences maximum)

Your answer here.

(e) (5 points)

Henry Beckstein mentioned software analysis at Subaru in his guest lecture. Quote one sentence from his lecture slides that shows his idea of the use case and limitation of software analysis. In two sentences, describe why this limitation exists for most software analysis techniques. Finally, name two verification approaches from the EECS 481 lectures or readings that might apply in the domain Henry described. (five sentences maximum)

Your answer here.

Question 3. Short Answer (25 points)

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You are a manager. You want to figure out how much time your team spends on the following tasks: investigating bug reports, reading requirements, debugging, and browsing Stack Overflow. You have a hypothesis that your team is spending too much time reading bug reports. To assess this, you consider two options: (1) use a software tool that tracks which window each team member has active (i.e., bug report window vs. coding window) and logs how much time they spend doing each activity, including when they switch tasks, or (2) use a software tool that displays a pop-up window to each team member every 15 minutes, asking each person to select the activity they are currently doing from a list.

(a) (4 points)

Identify two profiling-related concepts in the above scenario. For each concept, explain the concept and its relationship to the scenario in two sentences. (2 * 2 = four sentences total)

Your answer here.

You are programming a calendar. When the current month is not December, all events created and added will be regular type events. When the current month is December, all events created and added to the calendar will be of a special holiday type instead. Events can be shown in different fonts. Using some or all of the following method signatures:

```
create_event()

add_event()

is_december()

change_fonts(string font_type)
```

(b) (2 points)

Describe a (bad) way to solve this problem with an anti-pattern in 4 sentences or less.

Your answer here.

(c) (2 points)

Describe a way to solve this problem with the abstract factory design pattern in 4 sentences or less.

Your answer here.

(d) (2 points)

Give one reason why the abstract factory design pattern is preferred to the anti-pattern in 4 sentences or less. Your answer should identify a desired maintainability property and indicate why the design pattern promotes it.

Your answer here.

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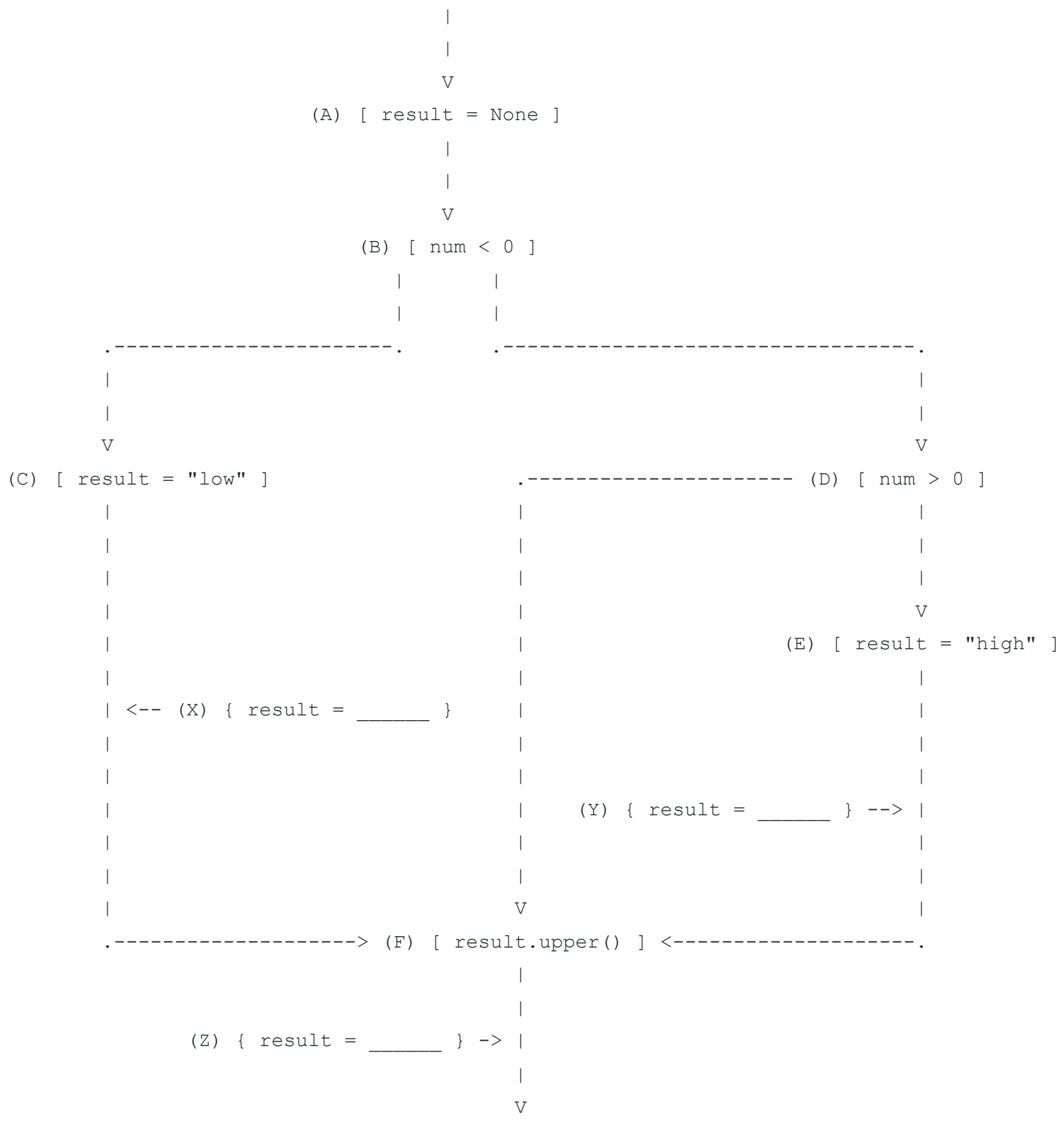
(e) (4 points)

You are part of a team of developers that is using model checking for quality assurance. Your model checker assesses whether an abstraction (model) of the program adheres to its formal specification. To directly improve model checking outcomes, one of your teammates proposes expanding the current test suite to obtain higher branch coverage. Support or refute the recommendation in 4 sentences or less.

Your answer here.



The control flow graph above corresponds to a short Python code snippet. We want to use a dataflow analysis to detect possible NoneType errors (i.e., any uses of, or operations on, a variable that has value None). In your response, answer the following questions:

(f) (2 points)

What direction of data analysis, forward or backward, should we employ to determine if there is a possibility that a NoneType error could occur (i.e., can the assignment at point A reach point F)? Justify your answer in 4 sentences or less.

Your answer here.

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(g) (3 points)

Consider the constant propagation dataflow analysis applied to the control flow graph above. Use the transfer functions discussed in class to determine what final dataflow value would be associated with "result" at each of (X), (Y), and (Z). Possible dataflow values in this context are: top, bottom, constant. Write your answer as three words separated by commas. The first word corresponds to your answer for (X), the second for your answer for (Y), and the third for your answer for (Z).

Your answer here.

You are eliciting requirements for a company making an app to handle regrade requests for exams. Students would be able to submit regrade requests via student accounts and course staff members would respond to them via staff accounts. The customer tells you the following four statements: "(1) All valid accounts can submit regrade requests and respond to regrade requests. (2) Students will always be given a week to submit a regrade request after the exam scores are posted. (3) Regrades will be responded to within a week. (4) Regrades are not available over the holiday break."

(h) (2 points)

Does the first customer statement have a terminology, designation, structure inconsistency, or no inconsistency with the specifications? Do NOT use statements (2) and (3) when answering this. Support your claim in 3 sentences or less.

Your answer here.

(i) (2 points)

Do any of the customer's statements have a strong conflict, weak conflict, or neither? Support your answer in 4 sentences or less.

Your answer here.

(j) (2 points)

What strategy would you use to resolve these sorts of conflicts, and why? Support your answer in 3 sentences or less.

Your answer here.

Question 4. Delta Debugging (10 points)

```
1 FIRST=0
2 SECOND=0
3 for i in $* ; do
4     if [ $i -eq 5 ]; then FIRST=1 ; fi
```

```
    if [ $i -eq 8 ]; then SECOND=1 ; fi
done

if [ $FIRST -eq 1 ]; then
  if [ $SECOND -eq 1 ]; then
    exit 1 # yes, this set is interesting
  fi
fi

```

(a) (2 points)

Above is a bash script is-interesting.sh which describes one particular definition of "interesting" for Delta Debugging. Given the above bash script, how many tests (probes, considered subsets, calls to is-interesting.sh) does the Delta Debugging algorithm perform to identify the minimal subset when applied to `input_list = [4, 5, 6, 8, 9, 10]` ? Assume that in the case of an odd sized set, the split will result in the first half being smaller. Your answer should be just a number (no spacing or other characters).

Your answer here.

(b) (2 points)

With the above interesting definition, give an `input_list` such that Delta Debugging will encounter interference exactly ONE time. Remember that the input list must be interesting itself. Format your answer in the form of a Python list. (e.g., `[1,2,3]`). If it's not possible, type "NOT POSSIBLE".

Your answer here.

(c) (2 points)

With the above interesting definition, give an `input_list` such that Delta Debugging will encounter interference TWO OR MORE times. Remember that the input list must be interesting itself. Format your answer in the form of a Python list. (e.g., `[1,2,3]`). If it's not possible, type "NOT POSSIBLE".

Your answer here.

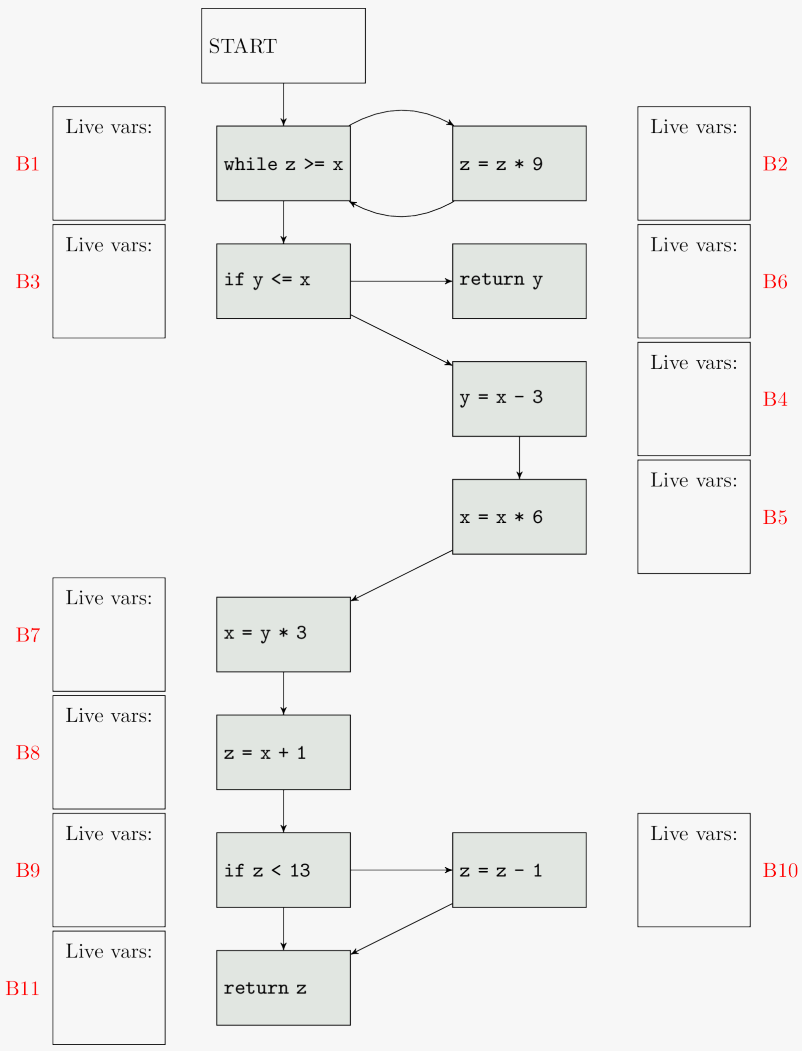
(d) (4 points)

Delta Debugging can identify a minimal set of conditions that cause a failure in a program. In the context of *Andreas Zeller's Automated Debugging: Are We Close?*, explain how Delta Debugging contrasts with traditional debugging methods and why it is considered more systematic and efficient in some cases. Support your answer with a relevant quote from the text using no more than 6 sentences.

Your answer here.

Question 5: Dataflow Analysis (16.5 points)

Consider a *live variable dataflow analysis* for three variables, `x`, `y`, and `z` used in the control-flow graph below. We associate with each variable a separate analysis fact: either the variable is (1) possibly read on a later path before it is overwritten (live), or (2) it is not (dead). We track the set of live variables at each point: for example, if `x` and `y` are alive but `z` is not, we write `{x, y}`. The special statement `return` reads, but does not write its argument. In addition, `if` and `while` read, but do not write all of the variables in their predicates. (You must determine if this is a forward or backward analysis.)



(1.5 points each) For each basic block `B1` through `B11`, write down the list of variables that are live *right before* the start of the corresponding block in the control flow graph above. Please list only the variable names in lowercase without commas or other spacing (e.g., use either `ab` or `ba` to indicate that `a` and `b` are alive before that block).

B1	B2	B3	B4
B5	B6	B7	B8
B9	B10	B11	

Question 6. Automatic Program Repair (16 points)

Automatic Repair Tools (like Repairnator or GenPRog or SapFix) and recent Large-Language Models (like ChatGPT or Codex) are algorithms that have been used to produce patches for buggy programs. We consider 4 concepts associated with these tools: fault localization, abstract syntax tree edits, machine learning, and maintenance costs. For each concept, identify the general approach (APR or LLMs) that uses, relates to, or improves that concept the MOST and describe how it does so in 4 sentences or less. In addition, you must support each claim with a separate quote from the *Automatic Program Repair* slides or *AI for SE* slides or *Monperrus et al.'s Repairnator patches programs automatically* reading.

(a) (2 points)

Fault Localization

Your answer here.

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(b) (2 points)

Abstract Syntax Tree Edits

Your answer here.

(c) (2 points)

Machine Learning

Your answer here.

(d) (2 points)

Maintence Costs

Your answer here.

(e) (4 points)

Are tools that use the notion of "Generate and Validate" (like Repairnator) static or dynamic analysis? Are tools like LLMs used to repair buggy programs static or dynamic analysis? Explain in 6 sentences or less. In addition, you must include a quote from the *Automatic Program Repair* slides or *AI for SE* slides or *Monperrus et al.'s Repairnator patches programs automatically* reading to support your claim.

Your answer here.

(f) (4 points)

"Hallucinations" are programming outputs that, although seemingly plausible, deviate from users' intent, factual knowledge, or contexts. Both APR and LLMs tool can generate candidate patches that might be hallucinations. Pick a broad category of tool (APR or LLM) and give a concrete example of the sort of hallucination it might create. Explain why this might happen in 6 sentences or less. In addition, you must include a quote from the *Automatic Program Repair* lecture slides or *AI for SE* slides or *Monperrus et al.'s Repairnator patches programs automatically* reading to support your claim.

Your answer here.

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- Question 6
- Extra Credit
- Pledge & Submit

Extra Credit

(1) What was your favorite topic or activity during the course? (1 point)

Your answer here.

(2) What do you think we should do more of next semester (or what is the thing you would most recommend that we change for future semesters)? (1 point)

Your answer here.

(3) Identify a different single optional reading (anything with the phrase *optional*) that was assigned after Exam 1 or a "long-instructor-post" that was posted on Piazza after Exam 1. Write two sentences about it that convince us you read it critically. (1 points)

Your answer here.

(4) List one thing you learned and liked from ANY of the 4 guest speakers. Convince us that you paid careful attention during that lecture. For full credit, your answer must be different from your responses in the exam AND you must identify the guest speaker by name. (1 points)

Your answer here.

(5) Identify ANOTHER different single *optional* reading that was assigned after Exam 1 or a "long-instructor-post" that was posted on Piazza after Exam 1. Write two sentences about it that convince us you read it critically. (1 points)

Your answer here.

(6) Identify a course non-professor staff member (e.g., Priscila, Hanchi, Youcef, Leena, Livia, Christina, Rohit) by name and either describe one instance in which you had a positive interaction with that person or describe a potential area for improvement for that person as an instructor. (We take these comments seriously and use this information to determine who we ask back next year and to put people up for awards and recognition.) (1 points)

Your answer here.

Honor Pledge and Exam Submission

You must check the boxes below before you can submit your exam.

- [ ] I have neither given nor received unauthorized aid on this exam.
- [ ] *I am ready to submit my exam.*

Note that your submission will be marked as late. You can still submit, and we will retain all submissions you make, but unless you have a documented extenuating circumstance, we will not consider this submission.

Submit My Exam

Once you submit, you will be able to leave the page without issue. Please don't try to mash the button.

The exam is graded out of 100 points.