

17-423/723 Homework 1: Domain and Design Modeling

Spring 2026

Released: Wednesday, January 21, 2026

Due: Wednesday, January 28, 2026 11:59 pm (on Gradescope)

Objectives

The goal of this homework is to give you practice with (1) specifying a context model and identifying assumptions that are important for satisfying system requirements, (2) making decisions for a high-level design of a system, and (3) describing those decisions using different design abstractions.

Case Study: ML-based Home Security System

You are a software engineer leading a team of developers at SecureHome, a company that builds various home security products. Your team has been tasked with building a new, innovative product called **IntelliGuard**, which uses the latest machine learning (ML) and computer vision technologies to keep your customers' home safe from intruders.

IntelliGuard comes with a high-resolution camera that can be placed near an entrance or another location around the house that the homeowner wishes to monitor. The camera is capable of generating a continuous stream of video images to be stored locally or transmitted elsewhere through Wi-Fi. The camera also has a built-in alarm that can be activated at request.

Each homeowner (i.e. a user of IntelliGuard) can register a set of individuals that are considered “trusted” (e.g., family members, friends, or frequent guests) by uploading a set of photos that contain the individuals’ faces. If IntelliGuard detects that a “stranger” has approached the home while the house is vacant, it notifies the user of a possible intruder (along with an image capture of the person). Given this alert, the user can select one of the following four responses: (1) add that person as a new “trusted” individual (e.g., a new mail delivery person), (2) sound the loud alarm in the camera, (3) alert the authority (e.g., local police), or (4) disregard the notification as “no risk”. If IntelliGuard does not receive a response from the user in some pre-set amount of time, it notifies the authority of a possible intrusion at the address. Each homeowner is assumed to possess a mobile phone and willing to install an app to access the features of IntelliGuard.

Your current task as the lead engineer of IntelliGuard is to design an initial prototype of the product. You carefully study the above product requirements and consider a series of design decisions to make, such as the set of software components that are needed to implement the key features of the product, what types of data are passed between those components, where those components are deployed on (e.g., on a cloud server, the owner’s mobile device, the camera, or another type of physical device), what information should be stored by the system, and how the system contacts the authority (e.g., cellular network or VoIP).

Tasks

Tip: You may use any diagramming tool of your choice to specify the figures needed for this homework (e.g., Google Drawings, Lucidchart, or diagrams.net). Alternatively, a scan of hand drawn diagrams are also acceptable as long as they are clearly readable.

Q1. Specify a context model for this system, including a set of domain entities, interactions, and assumptions over these entities. Your context model must include a set of assumptions that are necessary for the system to satisfy its requirements.

Q2. Design an architecture for IntelliGuard and specify it using a component diagram. Your diagram must clearly indicate data that is passed between components in your system. In addition, in text, (i) briefly describe the responsibility of each component (~1 sentence) and (ii) specify a hardware device/platform where each software component is deployed on (e.g., a cloud server, the camera, a mobile phone, or another type of physical device).

Q3. Use a state machine, a data model, **or** a sequence diagram to describe a particular aspect of the system design that you'd like to highlight. You need to provide **only one** type of model. The type of model should be appropriate for what it is describing: for example, a data model should describe information that the system stores to satisfy its specification.

Q4. Consider **two** design decisions that you've made for IntelliGuard. For each of the two decisions, provide a brief (1~3 paragraphs) discussion, including: (1) alternatives that you considered for that decision and (2) the justification for why you made the final decision.

Submission & Grading

Compile your answers into a single PDF file and upload it through Gradescope by the indicated deadline. **Please correctly map the pages in the PDF to the corresponding questions on Gradescope.**

This assignment is out of **100** points. For full points, we expect:

- **Q1 (20 pts):** A valid context model that includes a set of relevant domain entities and interactions between them (**10 pts**) and a list of assumptions about the behavior or properties of those entities (**10 pts**).
- **Q2 (30 pts):** A valid component model that contains a set of components and connections between them (**10 pts**), a description of the responsibilities of those components (**10 pts**), and an indication of hardware devices that software components are deployed on (**10 pts**).
- **Q3 (20 pts):** A valid state machine, data model, or sequence diagram. The selected type of model must be appropriate for the aspect of the system that it describes.

- **Q4 (30 pts):** A discussion of two design decisions, including for each decision: (1) a description of alternatives considered (**10 pts**) and (2) a justification for the final decision (**5 pts**).