

# Solutions Engineer Interview Exercise

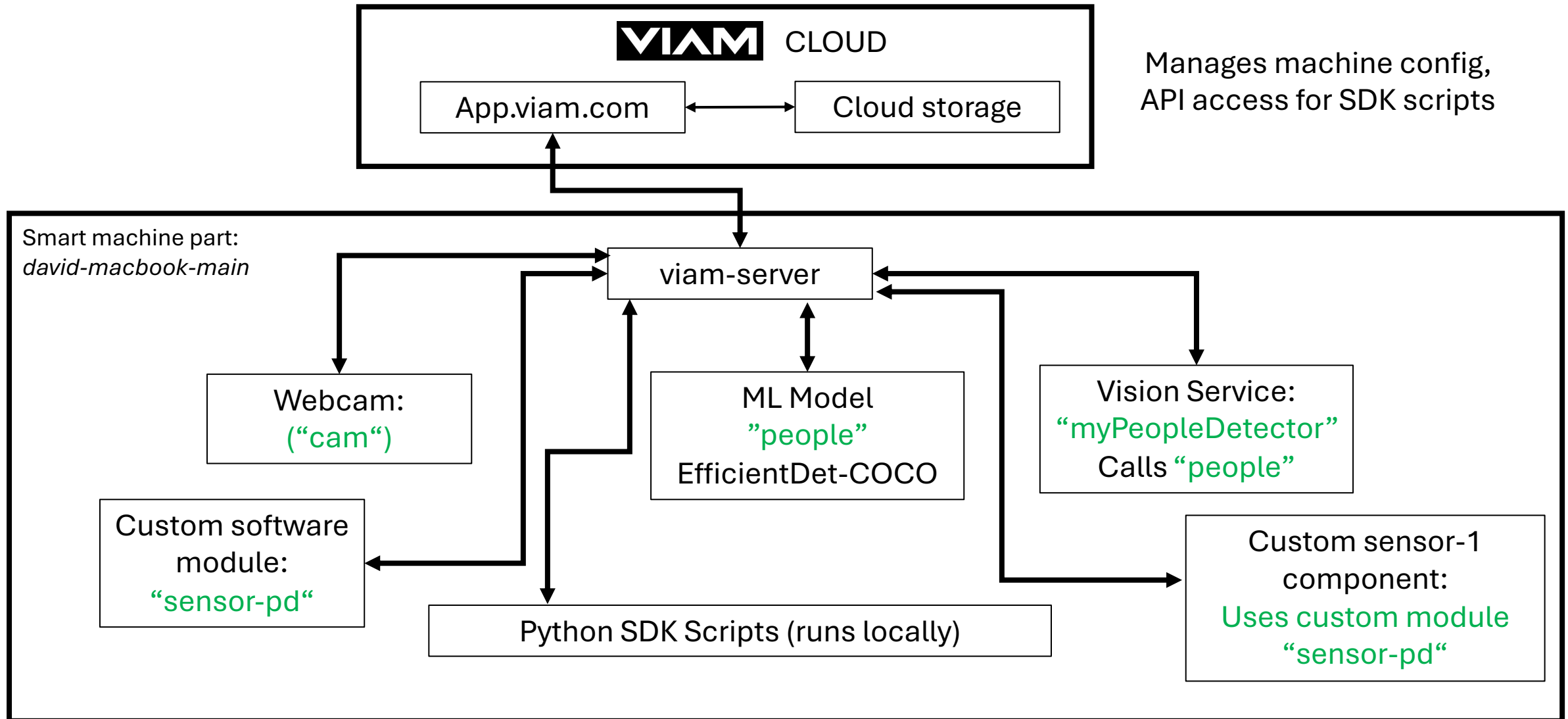
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# Overview of the Project

- Task 1: Vision
  - Configure a basic camera component and use Viam's vision service to implement a simple object detector
- Task 2: Cloud Integration
  - Configure Viam's data capture service to store camera frames into the cloud
  - How could we use this data to possibly create a custom model?
- Task 3: Modular Registry
  - Create a custom sensor (calling the previously created vision service)
  - Should have a single field called "person detected"
  - Set to 1 if a person is detected, and 0 if no person is detected

# Platform architecture: highlights







# Overview of the Project Directory

## Project Structure

```
viam-interview-project/  
├── camera_vision/      # Task 1: Vision service test script  
├── sensor-pd/          # Task 3: Custom person-detection sensor module  
├── screenshots/        # Screenshots/notes documenting steps for Tasks 1,2,3  
├── slides/             # Presentation deck for final submission  
├── README.md           # This file  
└── .gitignore          # Ignores virtual environments, cache, etc.
```

From GitHub README: <https://github.com/djlev8/viam-interview-project/tree/main>

Location	Machine	Part	Fragments	Status ▾	Viam server version	Viam agent version	Architecture
 david_home	 david-macbook	 david-macbook-main		 Live	0.76.0	–	Darwin > Arm64

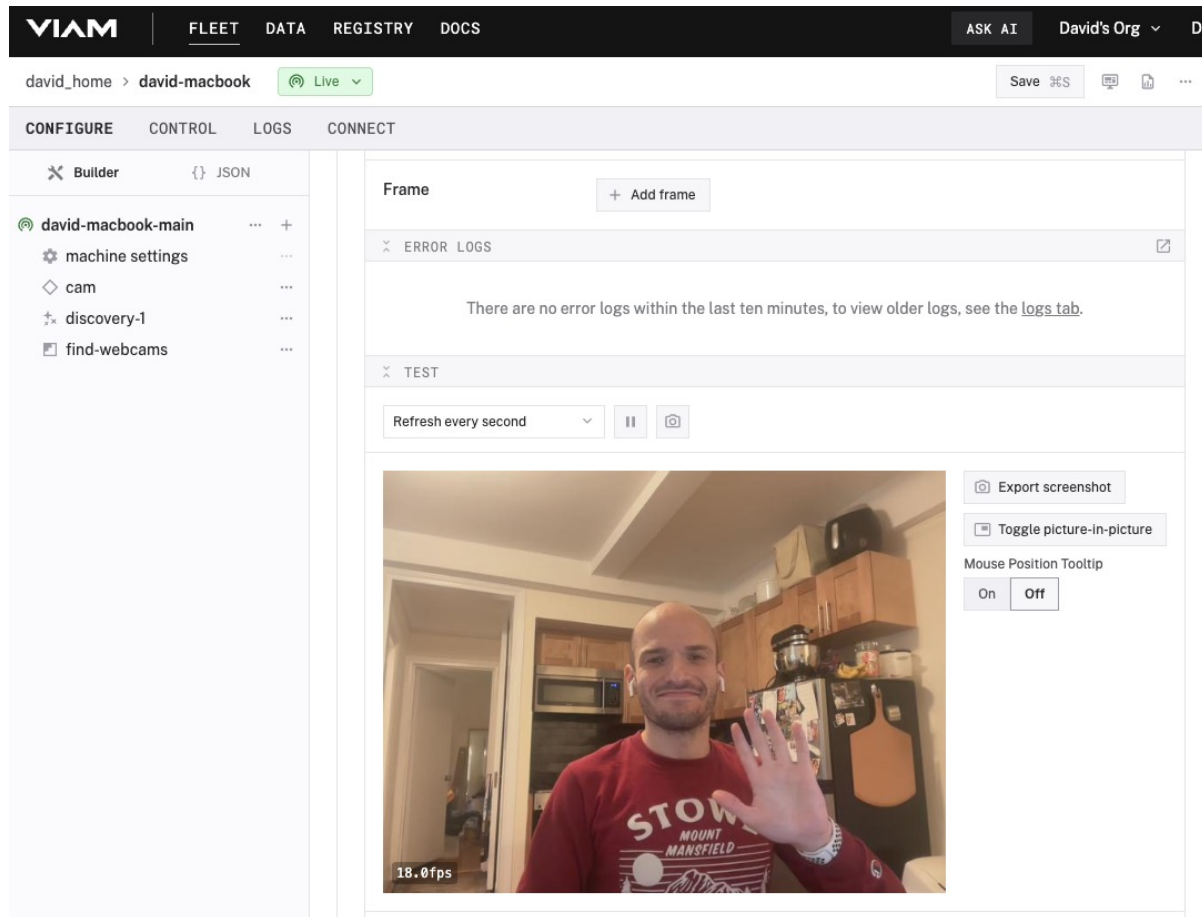
From Viam dashboard

# Task 1: Vision Service and Object Detection

Following the 'Detect a Person and Send a Photo' tutorial.

Goal: **Set up a webcam** → ML model (EfficientDet-COCO) → Vision Service → SDK-based person detection

Configured webcam test



Configured webcam JSON

```
1 {
2   "components": [
3     {
4       "name": "cam",
5       "api": "rdk:component:camera",
6       "model": "rdk:builtin:webcam",
7       "attributes": {
8         "video_path": "FDF90FEB-59E5-4FCF-AABD-DA03C4E19BFB"
9       }
10    }
11  ],
12  "services": [
13    {
14      "name": "discovery-1",
15      "api": "rdk:service:discovery",
16      "model": "rand:find-webcams:webcam-discovery",
17      "attributes": {}
18    }
19  ],
20  "modules": [
21    {
22      "type": "registry",
23      "name": "rand_find-webcams",
24      "module_id": "rand:find-webcams",
25      "version": "latest"
26    }
27  ]
28 }
```

# Task 1: Vision Service and Object Detection

Goal: Set up a webcam → **ML model (EfficientDet-COCO)** → **Vision Service** → SDK-based person detection

EfficientDet-COCO model deployed

▼ **people** mlmodel viam:mlmodel-tflite:tflite\_cpu

⌵ **CONFIGURE**

**Deployment** Deploy model on machine Path to exist

**Model** viam-labs:EfficientDet-COCO × [Upload a new model](#)

Vision Service created and linked to model

▼ **myPeopleDetector** vision mlmodel {} ...

⌵ **CONFIGURE**

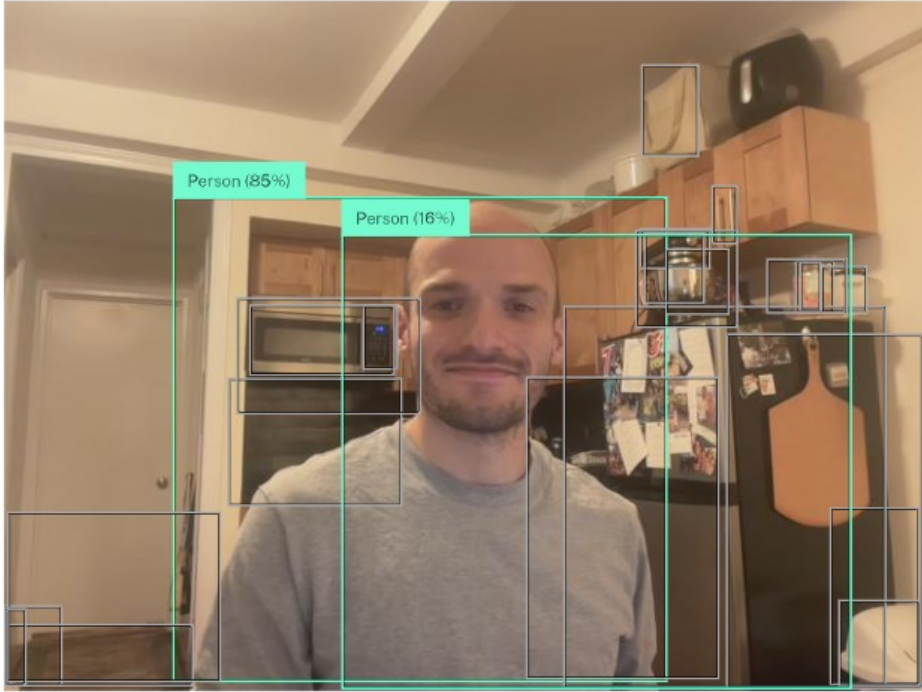
**ML Model** people ▼

**Attributes** Minimum confidence threshold ⓘ

0 0 1

**Depends on** Search resources ▼

Detection UI



Labels	
> Person	2
> Refrigerator	4
> Microwave	3
> Toilet	2
> Bottle	9
> Chair	4
> Cup	1

# Task 1: Vision Service and Object Detection

Goal: Set up a webcam → ML model (EfficientDet-COCO) → Vision Service → **SDK-based person detection**

Terminal Output: Person Detected

```
● .venv(base) davidlevine@Davids-Air-3 camera_vi
2025-05-24 13:10:50,912 INFO viam.r
Resources:
[<viam.proto.common.ResourceName rdk:service:d
/myPeopleDetector at 0x10521dbc0>, <viam.proto
urceName rdk:service:mlmodel/people at 0x10521
detected_people: [x_min: 166
y_min: 170
x_max: 556
y_max: 479
confidence: 0.83984375
class_name: "Person"
x_min_normalized: 0.259375
y_min_normalized: 0.35416666666666669
x_max_normalized: 0.86875
y_max_normalized: 0.9979166666666667
]
```

Code snippet from detection script  
(vision\_service.py)

```
#Getting the VisionClient resource from the robot
my_people_detector = VisionClient.from_robot(machine, "myPeopleDetector")

#Getting the detections from the camera using the VisionClient resource
detected_people = [
    #Filtering the detections by confidence and class name
    person for person in (await my_people_detector.get_detections_from_camera("cam"))
    if person.confidence > 0.5 and person.class_name == "Person"
]

# Printing the detected people
print(f"detected_people: {detected_people}")

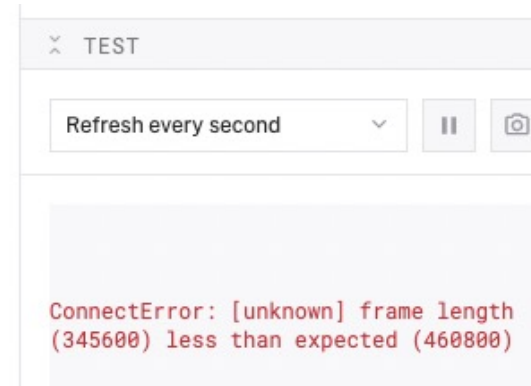
# Don't forget to close the machine when you're done!
await machine.close()
```

Used SDK to filter for confident (> 0.5) 'Person' detections, instead of printing all detections found, regardless of class name or confidence

# Task 1: Vision Service and Object Detection

## Challenges & Debugging:

- Encountered webcam connection error
  - Restarted `viam-server` and reconnected successfully
  - CLI: `viam-server -config ~/Downloads/viam-david-macbook-main.json`
- Needed to use discovery service to retrieve valid video path for my built-in webcam
- Filtered through list of detections to find confident 'Person' only detections after first obtaining all detections



Webcam connect error

```
detected_people: [x_min: 1
y_min: 43
x_max: 244
y_max: 479
confidence: 0.72265625
class_name: "Person"
x_min_normalized: 0.0015625
y_min_normalized: 0.08958333333333334
x_max_normalized: 0.38125
y_max_normalized: 0.9979166666666667
, x_min: 197
y_min: 133
x_max: 567
y_max: 479
confidence: 0.70703125
class_name: "Person"
x_min_normalized: 0.3078125
y_min_normalized: 0.27708333333333335
x_max_normalized: 0.8859375
y_max_normalized: 0.9979166666666667
, x_min: 184
y_min: 210
x_max: 272
y_max: 262
confidence: 0.6875
class_name: "Microwave"
x_min_normalized: 0.2875
y_min_normalized: 0.4375
x_max_normalized: 0.425
y_max_normalized: 0.545833333333333328
, x_min: 442
y_min: 206
x_max: 619
y_max: 472
confidence: 0.6875
class_name: "Refrigerator"
x_min_normalized: 0.690625
y_min_normalized: 0.42916666666666664
x_max_normalized: 0.9671875
y_max_normalized: 0.983333333333333328
, x_min: 450
y_min: 160
x_max: 493
y_max: 222
confidence: 0.18359375
class_name: "Bottle"
x_min_normalized: 0.703125
y_min_normalized: 0.33333333333333331
x_max_normalized: 0.7703125
```

Initial output: Detecting many objects



# Task 2: Data Capture & Cloud Storage

Following the 'Capture and sync edge data' document.

Goal: **Create data-manager service** → **Set capture rate & ReadImage method** → Store frames to cloud

Data management service enabled

The screenshot shows the configuration page for the 'data\_manager' service. It has a 'CONFIGURE' tab. Under 'Data capture', the 'Capturing' toggle is turned on, and there are input fields for 'Directory' and 'Tags'. Under 'Cloud sync', the 'Syncing' toggle is turned on, and there are input fields for 'Additional paths' and 'Interval (min)' set to 0.1. A 'Depends on' dropdown is at the bottom.

data\_manager data\_manager

CONFIGURE

Data capture

Capturing ☒

Directory

Tags

Cloud sync

Syncing ☒

Additional paths

Interval (min) 0.1

Depends on

Data capture settings specified (capture rate = 1 Hz, MIME type = JPG)

The screenshot shows the configuration page for the 'cam' service. It has a 'CONFIGURE' tab. Under 'Attributes', there is a 'video\_path' field with the value 'FDF90FEB-59E5-4FCF-A...'. Under 'Data capture', the 'Method' is 'ReadImage', 'Frequency (hz)' is '1', and 'MIME type' is 'image/jpeg'. There is a 'Depends on' dropdown and a 'Frame' section with an 'Add frame' button.

cam camera webcam

CONFIGURE

Attributes

video\_path \* FDF90FEB-59E5-4FCF-A...

Depends on

Data capture

Method ReadImage Frequency (hz) 1 60x / min On ☒

Additional parameters

MIME type image/jpeg

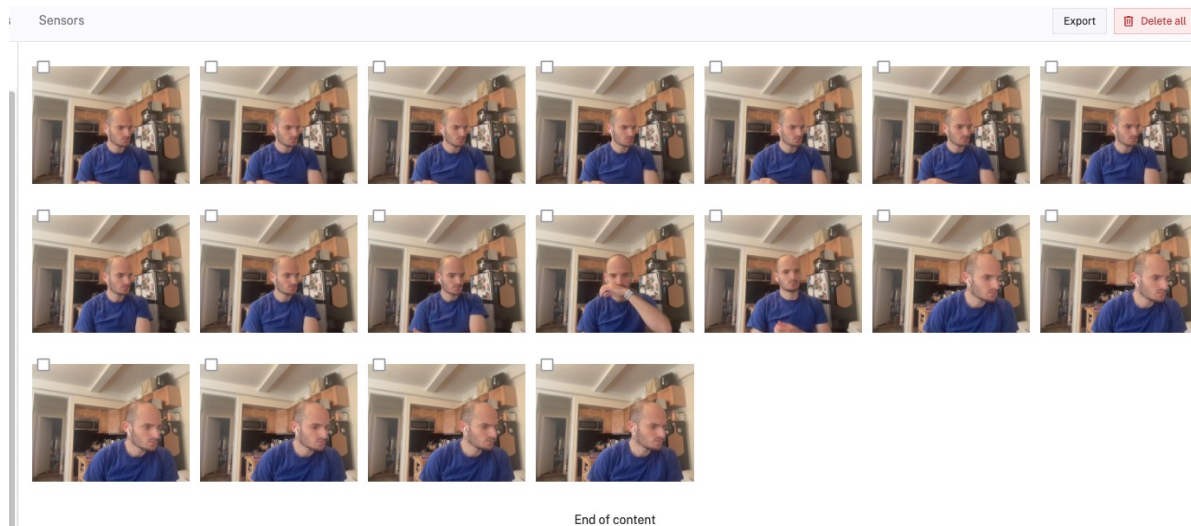
Frame

**Note:** Needed to create data management service prior to configuring data capture with configured camera.

# Task 2: Data Capture & Cloud Storage

Goal: Create data-manager service → Set capture rate & ReadImage method → **Store frames to cloud**

Images stored to the cloud



Installed viam CLI to run image export

```
(base) davidlevine@Davids-Air-3 ~ % brew tap viamrobotics/brews
brew install viam
==> Auto-updating Homebrew...
Adjust how often this is run with HOMEBREW_AUTO_UPDATE_SECS or disable with
HOMEBREW_NO_AUTO_UPDATE. Hide these hints with HOMEBREW_NO_ENV_HINTS (see 'man brew').
==> Downloading https://ghcr.io/v2/homebrew/portable-ruby/portable-ruby/blobs/sha256:fd162df7a6c190ee808a9e6afd28f4466d33548821a480ba043cd927b44d60f7
##### 100.0%
==> Pouring portable-ruby-3.4.4.arm64_big_sur.bottle.tar.gz
==> Auto-updated Homebrew!
Updated 2 taps (homebrew/core and homebrew/cask).
==> New Formulae
addons-linter      erlang@27      miniprot       style-dictionary
alejandra          fastoa         oxen           syloh
autocycler         gcc@14         qnm            webdav
boa               gccli          readsb
concurrentqueue    goshs          rna-star
cram              hyper-mcp      shamrock
==> New Casks
font-formudpgothic font-matangi    lobehub        zoo-design-studio

You have 2 outdated formulae installed.

==> Downloading https://ghcr.io/v2/viamrobotics/brews/viam/manifests/0.76.0-3
##### 100.0%
==> Fetching viamrobotics/brews/viam
==> Downloading https://ghcr.io/v2/viamrobotics/brews/viam/blobs/sha256:0977a828
##### 100.0%
==> Installing viam from viamrobotics/brews
==> Pouring viam--0.76.0.arm64_sonoma.bottle.3.tar.gz
📦 /opt/homebrew/Cellar/viam/0.76.0: 6 files, 42.7MB
==> Running 'brew cleanup viam'...
Disable this behaviour by setting HOMEBREW_NO_INSTALL_CLEANUP.
Hide these hints with HOMEBREW_NO_ENV_HINTS (see 'man brew').
(base) davidlevine@Davids-Air-3 ~ % viam login
Info: You can log into Viam through the opened browser window or by following the URL below.
Ensure the code in the URL matches the one shown in your browser.
https://auth.viam.com/oauth2/device?user_code=LDJ5LX

@@@0..  "%000%00< .lj. 1B08$V'. 'nBSS$!
.*@S%1 fSS@X %SS+ &@SS 1SSSS@0^ "BSSSS@!
(@SS0'M0S@: BSS- ~BSS0$01 !SSBQ00@q.0@SS00$S!
'WBS$B@p BSS- qB$-!@000. 1$B..B0$0$0%; @S@!
.uSS$! BSS- ;000& ... oB$0~!1$S0. zSS$z'. $$$!
:h' BSS-L%0$| | -00$bi$0B 'M' $$$!

Logged in as "david.j.levine8@gmail.com", expires Tue May 27 09:44:10 EDT 2025
(base) davidlevine@Davids-Air-3 ~ % viam data export binary --mime-types=image/jpeg,image/png --org-ids=649e1748-312e-4cb7-830c-cf4c3c5ded08 --destination=.
Downloaded 100 files
Downloaded 200 files
Downloaded 246 files
(base) davidlevine@Davids-Air-3 ~ %
```

# Task 2: Data Capture & Cloud Storage

Goal: Create data-manager service → Set capture rate & ReadImage method → **Store frames to cloud**

Images stored to the cloud with detection details from myPeopleDetector Vision service

myPeopleDetector

vision

mlmodel

CONFIGURE

ML Model

people

Attributes

Minimum confidence threshold ⓘ

001

Depends on

Search resources

Data capture

Method

CaptureAllFromCamera

Frequency (hz)

12x / min

0.2

On

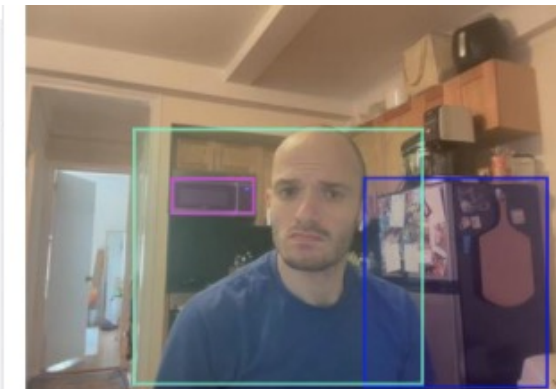
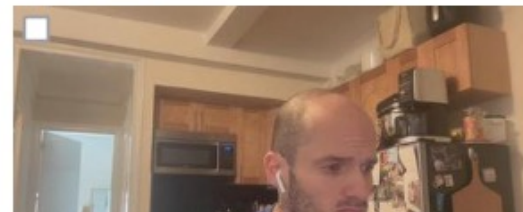
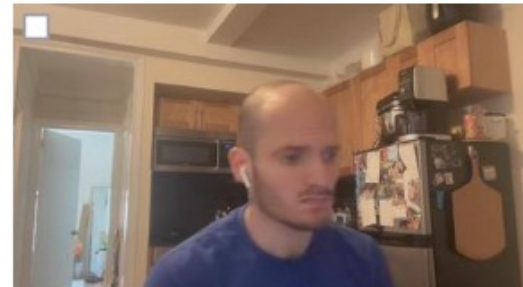
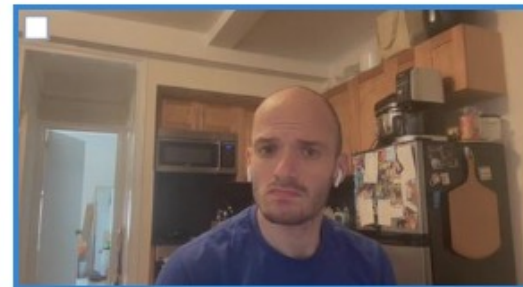
☒

Additional parameters

Camera name

cam

+ Add method



ACTIONS

DETAILS

Annotate

Objects

Microwave	1
Person	1
Refrigerator	1

# Task 2: Discussion – How the data enables custom models

This type of captured image data is valuable for:

- **Evaluating model accuracy:** comparing what the model detects vs what's actually in the frame.
- **Labeling custom datasets:** using stored images and metadata to label people or other objects (annotate within Viam).
- **Retraining or fine-tuning models:** creating a customer-specific version of EfficientDet-COCO that performs better on their environment or edge cases (varying lighting, backgrounds, angles).

Exported image data and detection logs can be used to train or validate models in frameworks like PyTorch, TensorFlow, or AutoML pipelines.

Going forward, combining image data with detection metadata (e.g., bounding boxes + class + confidence) **provides a complete training set for a custom object detector.**

# Task 3: Modular Registry: Overview

Following the 'Integrate other physical or virtual hardware' document.

Goal: Build a custom sensor module that uses the Vision service I previously created and returns:

**{'person\_detected': 1} if a person is visible to the camera,**

**and**

**{'person\_detected': 0} if a person is NOT visible to the camera.**

Steps:

- 1) Module Setup
- 2) Module Implementation
- 3) Adding the Custom Sensor Component to my Machine
- 4) Local Testing
- 5) Error Handling & Fixes

# Task 3: Modular Registry: Module Setup

Goal: Scaffold and generate the custom module, generating the necessary stub files (in the sensor-pd folder).

```
Generate a new modular resource

For more details about modular resources, view the documentation at
https://docs.viam.com/registry/

Set a module name:
The module name can contain only alphanumeric characters, dashes, and underscores.
> sensor-pd

Specify the language for the module:
> Python
Go

Visibility
Public Private

Namespace/Organization ID
> dl-org

Select a resource to be added to the module:
Arm Component
Audio Input Component
Base Component
Board Component
Camera Component
Encoder Component
Gantry Component
Generic Component
Gripper Component
Input Component
Motor Component
Movement Sensor Component
Pose Tracker Component
Power Sensor Component
> Sensor Component
Servo Component
Generic Service
MLModel Service
Motion Service
Navigation Service
SLAM Service
Vision Service

Set a model name of the resource:
This is the name of the new resource model that your module will provide.
The model name can contain only alphanumeric characters, dashes, and underscores.
> pdetect

Enable cloud build
If enabled, this will generate GitHub workflows to build your module.
Yes No

Register module
Register this module with Viam.
If selected, this will associate the module with your organization.
Otherwise, this will be a local-only module.
Yes No

</> toggle • shift+tab back • enter submit • y Yes • n No
```

Module successfully generated!

```
Module successfully generated at sensor-pd
(base) davidlevine@Davids-Air-3 ~ %
```

## Prompts filled:

Name: **sensor-pd**

Language: **Python**

Visibility: **Private**

Namespace/Org-ID: **dl-org**

Resource to be added: **Sensor Component**

Model name: **pdetect**

Cloud build? **Yes**

Register module? **Yes**

From the CLI, I used `viam module generate` and followed the relevant prompts.

# Task 3: Modular Registry: Module Setup

Goal: Scaffold and generate the custom module, generating the necessary stub files (in the sensor-pd folder).

Final file structure within the generated sensor-pd folder:

```
sensor-pd/  
├── build.sh  
├── meta.json  
├── module.tar.gz  
├── reload.sh  
├── requirements.txt  
├── run.sh  
├── setup.sh  
├── src/  
│   ├── main.py  
│   └── models/  
│       └── pdetect.py
```

I added or changed files from the auto-generated structure to implement my custom sensor logic and enable local development and testing:

- reload.sh (**I added**)
  - Script I wrote for **hot reloading** the module locally.
- meta.json (**I modified**)
- src/models/pdetect.py (**I modified**)
- src/main.py (**I modified**)

# Module Architecture: How Viam Registers and Runs the Custom Sensor

- `viam-server` automatically launches the module when the smart machine boots.
  - For local testing, I used `reload.sh` to call `main.py`.
  - The module (your code) is registered using `Module.from_args()` in `main.py`.
  - The custom model `dl-org:sensor-pd:pdetect` is registered to point to the `Pdetect` class in `pdetect.py`.
- When a modular resource is created (e.g. `sensor-1`), the following flow happens:
  - `validate_config()` checks for required attributes (`camera_name`, `detector_name`) and declares dependencies.
  - `new()` instantiates the `Pdetect` class and calls `reconfigure()`.
  - `reconfigure()` receives a dependency map and retrieves the Vision service using the user-supplied detector name.
  - That Vision service is stored internally to enable live detection in `do_command`.
- The sensor is now live. The Viam app can call `get_readings()` → `do_command()` to check if a person is detected.
- Logs and live values are visible in the Viam UI for easy debugging.



# Task 3: Modular Registry: Module Implementation

Goal: Add custom logic to Pdetect class (**pdetect.py**) to execute the goals of Task 3. Following the docs & looking at the 'simple-module' example in the Viam Python SDK, I had to make sure I edited the following within Pdetect:

new()

validate\_config()

get\_readings()

reconfigure()

do\_command()

# Task 3: Modular Registry: Implement the Component API

`validate_config()`:

- Ensures that the user-supplied configuration is valid before the module is started.
  - Checks for required attributes: `camera_name` (required attribute) and `detector_name` (required attribute & dependency)
  - Raises errors if required fields are missing or improperly typed
- Declares required and optional dependencies for the module.
  - Dependencies returned: required: `detector_name`
  - This tells Viam to pass in the Vision service resource with this name at runtime.

```
#Defining the validate_config method that validates the configuration object received from the machine
@classmethod
def validate_config(
    cls, config: ComponentConfig
) -> Tuple[Sequence[str], Sequence[str]]:
    """
    This method allows you to validate the configuration object received from the machine,
    as well as to return any required dependencies or optional dependencies based on that `config`.

    Args:
        config (ComponentConfig): The configuration for this resource

    Returns:
        Tuple[Sequence[str], Sequence[str]]: A tuple where the
            first element is a list of required dependencies (detector_name) and the
            second element is a list of optional dependencies (empty in this case)
    """
    req_deps = []
    #Checking if the camera_name attribute is present in the config
    if "camera_name" not in config.attributes.fields:
        #If the camera_name attribute is not present, raise an exception
        raise Exception("Missing required attribute: camera_name")
    elif not config.attributes.fields["camera_name"].HasField("string_value"):
        #If the camera_name attribute is not a string, raise an exception
        raise Exception("camera_name must be a string")
    if "detector_name" not in config.attributes.fields:
        #If the detector_name attribute is not present, raise an exception
        raise Exception("Missing required attribute: detector_name")
    elif not config.attributes.fields["detector_name"].HasField("string_value"):
        #If the detector_name attribute is not a string, raise an exception
        raise Exception("detector_name must be a string")

    detector_name = config.attributes.fields["detector_name"].string_value
    req_deps.append(detector_name)

    #Returning the list of required dependencies and an empty list of optional dependencies
    return req_deps, []
```

# Task 3: Modular Registry: Implement the Component API

`new()`:

- This method is responsible for creating and returning a new instance of the Pdetect sensor class.
  - It receives the config and dependencies from the Viam system.
  - It initializes the sensor (`sensor = cls(config.name)`) and then immediately calls `reconfigure()` to apply the configuration and wire up dependencies.
  - It returns the fully ready-to-use sensor instance.

```
@classmethod
def new(
    cls, config: ComponentConfig, dependencies: Mapping[ResourceName, ResourceBase]
) -> Self:
    """
    Instantiate a new Pdetect sensor instance and configure it with the given settings.

    Args:
        config (ComponentConfig): The configuration for this sensor
        dependencies (Mapping[ResourceName, ResourceBase]): The dependencies (both implicit and explicit)

    Returns:
        Self: A fully initialized instance of the Pdetect sensor.
    """
    #Instantiating a new Pdetect sensor instance with the name of the sensor
    sensor = cls(config.name)
    #Configuring the sensor with the given settings
    sensor.reconfigure(config, dependencies)
    return sensor
```

# Task 3: Modular Registry: Implement the Component API

`reconfigure()`:

- Triggered when the component's configuration is updated in the Viam app
  - Reads the latest `camera_name` and `detector_name` value from the incoming `config`
  - Retrieves the required dependency `detector_name` from the dependency map (throws error if not available)
  - Casts the required dependency as the correct type
  - Stores vision client and camera name internally as instance variables for use in detection logic in `do_command()`
  - Prepares the module for dynamic behavior based on configurable dependency names

```
def reconfigure(
    self, config: ComponentConfig, dependencies: Mapping[ResourceName, ResourceBase]
):
    """This method allows you to dynamically update your service when it receives a new `config` object.

    Args:
        config (ComponentConfig): The new configuration
        dependencies (Mapping[ResourceName, ResourceBase]): Any dependencies (both implicit and explicit)
    """
    fields = config.attributes.fields

    # Validate and extract camera_name
    if "camera_name" not in fields or not fields["camera_name"].HasField("string_value"):
        raise ValueError("Missing or invalid 'camera_name' attribute")

    # Validate and extract detector_name
    if "detector_name" not in fields or not fields["detector_name"].HasField("string_value"):
        raise ValueError("Missing or invalid 'detector_name' attribute")
    detector_name = fields["detector_name"].string_value

    # Lookup Vision service using user-provided detector_name
    vision_resource = dependencies.get(Vision.get_resource_name(detector_name))
    if not vision_resource:
        raise ValueError(f"Required Vision service '{detector_name}' not found")

    # Setting the vision attribute to the vision resource (casting the vision resource to a VisionClient)
    self.vision = cast(VisionClient, vision_resource)

    # Setting the camera_name attribute to the value of the camera_name attribute in the config
    # (to be used in the do_command method)
    self.camera_name = fields["camera_name"].string_value

    # Returning the result of the superclass (Sensor) reconfigure method
    return super().reconfigure(config, dependencies)
```

# Task 3: Modular Registry: Implement the Component API

`do_command()`:

- Allows the sensor to query the ``myPeopleDetector`` vision service and returns ``person_detected: 1`` if a person is seen with  $>0.5$  confidence, otherwise 0.

```
async def do_command(
    self,
    command: Mapping[str, ValueTypes],
    *,
    timeout: Optional[float] = None,
    **kwargs
) -> Mapping[str, ValueTypes]:
    """
    Execute a custom command to check for the presence of a person using the vision service.

    This method queries the configured vision service (`detector_name`) for object
    detections from the specified camera. If any detection is classified as a "person"
    with a confidence greater than 0.5, the method returns a result indicating a person
    was detected. Otherwise, it indicates no person was found.

    Args:
        command (Mapping[str, ValueTypes]): A dictionary of command arguments.
            This implementation does not use any input arguments.
        timeout (Optional[float]): An optional timeout in seconds for the operation.
        **kwargs: Additional optional keyword arguments.

    Returns:
        Mapping[str, ValueTypes]: A dictionary with a single key `person_detected`:
            - 1 if a person is detected
            - 0 if no person is detected
    """
    #Getting the detections from the camera using the vision resource
    detections = await self.vision.get_detections_from_camera(self.camera_name)
    #Iterating through the detections
    for d in detections:
        #Checking if the class name is "person" and the confidence is greater than 0.5
        if d.class_name.lower() == "person" and d.confidence > 0.5:
            #Returning the result of the do_command method
            return {"person_detected": 1}
    #Returning the result of the do_command method
    return {"person_detected": 0}
```

# Task 3: Modular Registry: Implement the Component API

- `get_readings()`:
  - sensor interface that Viam calls to retrieve the latest data from the sensor.
  - Invokes the internal `do_command` method to perform the actual person detection logic.
- Wraps the result from `do_command` in a dictionary with a consistent key:
  - Returns: `{"person_detected": 1}` if a person is detected, Returns: `{"person_detected": 0}` if no person is detected.
- This method ensures compatibility with the Viam Sensor API, allowing the module to be used like any other built-in Viam sensor.

```
async def get_readings(
    self,
    *,
    extra: Optional[Mapping[str, Any]] = None,
    timeout: Optional[float] = None,
    **kwargs
) -> Mapping[str, int]:
    """
    Retrieve the latest reading from the person detection sensor.

    This method queries the associated vision service to check whether a person
    is currently detected in the video feed from the configured camera. It returns
    a dictionary containing a single reading: 1 if a person is detected, 0 otherwise.

    Args:
        extra (Optional[Mapping[str, Any]]): Additional metadata or parameters
            passed to the sensor (not used in this implementation).
        timeout (Optional[float]): Timeout in seconds for the operation, if applicable.
        **kwargs: Additional keyword arguments passed to the method (unused).

    Returns:
        Mapping[str, int]: A dictionary with the key ``person_detected``
            mapped to an integer with a value of 1 (detected) or 0 (not detected).
    """
    #Executing the do_command method with an empty command
    result = await self.do_command({})
    #Returning the result of the do_command method
    return {"person_detected": int(result["person_detected"])}
```

# Task 3: Modular Registry: Implement the Component API

- `main.py`:
  - Uses Viam's registry to register the `pdetect` model under the Sensor API, linking the model name (`dl-org:sensor-pd:pdetect`) to my `Pdetect` implementation.
  - Includes error handling to avoid duplicate registration when hot reloading.
  - Attaches the registered model to the module so it can be discovered and used by Viam.
  - Initializes and launches the module to connect with the Viam cloud, enabling remote control and configuration.

```
# sensor-pd/src/main.py
#Importing the necessary libraries
#Importing the asyncio library for asynchronous operations
import asyncio
#Importing the Viam SDK components for Module, Registry, ResourceCreatorRegistration, Sensor, and DuplicateResourceError
from viam.module.module import Module
from viam.resource.registry import Registry, ResourceCreatorRegistration
#Importing the Viam SDK components for Sensor
from viam.components.sensor import Sensor
from viam.errors import DuplicateResourceError

#Importing the Pdetect sensor class from the models.pdetect module
try:
    from models.pdetect import Pdetect
except ModuleNotFoundError:
    # when running as local module with run.sh
    from .models.pdetect import Pdetect

#Defining the main function
async def main():
    """
    Register the custom sensor model and start the module.

    This function registers the 'Pdetect' sensor model with the Viam resource registry
    and initializes a 'Module' instance using command-line arguments. It handles
    duplicate registration errors, then starts the module to serve
    the registered model.
    """
    #Registering the Pdetect sensor model with the Viam resource registry
    try:
        Registry.register_resource_creator(Sensor.API, Pdetect.MODEL, ResourceCreatorRegistration(Pdetect.new, Pdetect.validate_config))
    except DuplicateResourceError:
        #If the Pdetect sensor model is already registered, pass
        pass

    #Initializing a new Module instance using command-line arguments
    module = Module.from_args()
    #Adding the Pdetect sensor model to the module
    module.add_model_from_registry(Sensor.API, Pdetect.MODEL)
    #Starting the module
    await module.start()

if __name__ == '__main__':
    asyncio.run(main())
```

# Task 3: Modular Registry: Local Testing

Goal: Test my custom module locally.

```
Module successfully generated at sensor-pd
[(base) davidlevine@Davids-Air-3 ~ % cd Desktop/viam-interview-project/sensor-pd
[(base) davidlevine@Davids-Air-3 sensor-pd % chmod 755 reload.sh
[(base) davidlevine@Davids-Air-3 sensor-pd % sh setup.sh
Virtualenv found/created. Installing/upgrading Python packages...
[(base) davidlevine@Davids-Air-3 sensor-pd % viam module reload --local --part-id accf7c3d-370b-4268-a869-70d878f3e61a
Info: Starting build
Info: Starting setup step: "./setup.sh"
Virtualenv found/created. Installing/upgrading Python packages...
Info: Starting build step: "rm -f module.tar.gz && tar czf module.tar.gz requirements.txt src/*.py src/models/*.py meta.json setup.sh reload.sh"
Info: Completed build
Info: Reload complete
(base) davidlevine@Davids-Air-3 sensor-pd %
```

Steps to configure my local module on my machine



# Task 3: Modular Registry: Adding & Testing the Sensor Component

Goal: Add my custom sensor component in the Viam UI.

The screenshot displays the Viam UI interface for managing components. On the left, a sidebar lists components under the 'david-macbook-main' workspace. An arrow points to the 'sensor-pd' component, which is currently disabled (indicated by a grey square icon). The main panel shows the configuration for the 'sensor-1' component, which is of type 'sensor' and uses the 'dl-org:sensor-pd:pdetect' module. The 'CONFIGURE' section shows a JSON configuration for the 'sensor-1' component:

```
1 {
2   "camera_name": "cam",
3   "detector_name": "myPeopleDetector"
4 }
```

Below the configuration, there is a 'Name' field and a 'Create' button. The 'local component' section provides instructions on how to define a custom model using a triplet string, with an example: 'Ex: my-org:mymodulename:mynewmodel'.

# Task 3: Modular Registry: Adding & Testing the Sensor Component

Goal: Test my custom sensor component in the Viam UI.

The screenshot displays the Viam UI interface for a project named 'david-home' under the 'david-macbook' organization. The top navigation bar includes 'FLEET', 'DATA', 'REGISTRY', and 'DOCS'. The left sidebar shows a tree view of the project components: 'cam', 'sensor-1', 'discovery', 'myPeopleDetector', and 'people'. The main panel is divided into sections for each component.

**cam component (camera):** Includes a 'TEST' button and a 'DO COMMAND' button.

**sensor-1 component (sensor):** Includes a 'TEST' button, a 'Refresh every second' dropdown, and a 'DO COMMAND' button. The 'GetReadings' section shows 'person\_detected' with a value of 1.

**discovery component (service):** Includes a 'TEST' button and a 'DO COMMAND' button.

**myPeopleDetector component (vision):** Includes a 'TEST' button, a 'cam' dropdown, a 'Live' dropdown, and a 'DO COMMAND' button. Below the controls is a video feed showing a person in a kitchen. To the right of the video is a 'Labels' list with the following items and counts:

Label	Count
Person	1
Refrigerator	5
Microwave	2
Toilet	2
Bottle	10
Handbag	2
Toaster	1
Dining table	1
Oven	1

# Task 3: Modular Registry: Error Handling

Goal: Find errors and fix bugs to complete Task 3.

- **Errors:** `DuplicateResourceError`: Cannot add resource with duplicate name "`rdk:component:sensor/dl-org:sensor-pd:pdetect`" → caused registration error (below)
  - Cause:
    - The module attempted to register the same resource more than once during hot reloads.
  - Fix (**main.py**):
    - Wrapped the registration line in a try/except block to catch and suppress the `DuplicateResourceError`.

```
5/28/2025, 10:10:08 AM error
rdk.resource_manager.rdk:component:sensor/sensor-1
resource/graph_node.go:297 resource build error: unknown
resource type: API "rdk:component:sensor" with model "dl-
org:sensor-pd:pdetect" not registered resource
rdk:component:sensor/sensor-1 model dl-org:sensor-pd:pdetect
```

Registration error caused by  
duplicate registration

Before fix:

```
Registry.register_resource_creator(Sensor.API, Pdetect.MODEL, ResourceCreatorRegistration(Pdetect.new, Pdetect.validate_config))
```

After fix:

```
try:
    Registry.register_resource_creator(Sensor.API, Pdetect.MODEL, ResourceCreatorRegistration(Pdetect.new, Pdetect.validate_config))
except DuplicateResourceError:
    pass
```

try/except block to catch and suppress the  
`DuplicateResourceError`

# Task 3: Modular Registry: Error Handling

Goal: Find errors and fix bugs to complete Task 3.

- **Error:** `TypeError` - Cannot instantiate `typing.Union`
  - Cause:
    - Attempted to wrap a basic type (`int`) inside `SensorReading`, which isn't necessary and led to incompatible typing. (`SensorReading` is a type alias)
  - Fix (`pdetect.py` → `get_readings()` method):
    - Removed the use of `SensorReading()` and returned a plain `int` instead.

## GetReadings

```
ConnectError: [unknown] TypeError - Cannot instantiate typing.Union -  
file_name='/Users/davidlevine/miniconda3/lib/python3.12/typing.py'  
func_name='__call__' line_num=501
```

Type Error found in sensor\_1 log

## Before fix:

```
return {"person_detected":  
SensorReading(int(result["person_detected"]))}
```

## After fix:

```
return {"person_detected":  
int(result["person_detected"])}
```

Removed the use of  
`SensorReading()`

# Upload Module to Viam Registry

## **1. Create a GitHub repo & update meta.json.**

Ensure the entrypoint, build, path, and supported arch values are set correctly (back to original).  
This file tells Viam how to build, package, and run the module.

## **2. Upload your module.**

Push the module to the registry using PyInstaller.

## **3. Use the module in the cloud.**

[Follow the guide here.](#)

# Potential Next Steps

- Customizable Configuration via Viam UI
  - Support configurable confidence thresholds, detection classes (add `class_filter`, `min_confidence` to config)
  - Log detection scores at the debug level to tune thresholds based on field behavior.
- Capture & Store Data with Viam
  - Extend to support other ML models beyond people detection in the Vision service.
  - Integrate with Viam's Data Capture UI to view and download results.
- Build a UI for Sensor Control
  - Develop a lightweight frontend to:
    - Display live detection results from `get_readings`.
    - Visualize logs and sensor state.
- Robust Error Handling
  - Add better exception management, validation, and user-visible error messages.
  - Add timeout support (`do_command`), add retries (if Vision service is unavailable).
- Developer Experience & Docs
  - Publish module to Viam Registry.
  - Include links to my GitHub, Docs, and example `meta.json` in the Registry.

# Conclusions

## Task 1: Vision

- Configured a basic camera component and use Viam's vision service to implement a simple object detector

## Task 2: Cloud Integration

- Configured Viam's data capture service to store camera frames into the cloud
- Described use cases for custom models

## Task 3: Modular Registry

- Created a custom vision-based detection module using Viam's Python SDK
- Registered and deployed on a real robot
- Validated config, managed dependencies, and handled real-time camera input
- Explained how to deploy, configure, and debug the module via the Viam app
- Documented and tested configurable parameters (camera, detector, thresholds)

## Future Extensions

- Add retries, logging, and advanced config options
- Generalize for multi-class detection
- Integrate with Data Capture for real customer workflows