User Manual for Gartner Occupancy Project

People Detection and Group Identification

1. Introduction

This detection system utilizes YOLO object detection and pose estimation to identify individuals in images and group them based on proximity and pose-based similarity. Additionally, it creates a density heatmap to visualize crowded areas. The system produces three outputs: individual detections with bounding boxes, group bounding boxes, and a density heatmap. Each run is logged with image and detection details for tracking purposes.
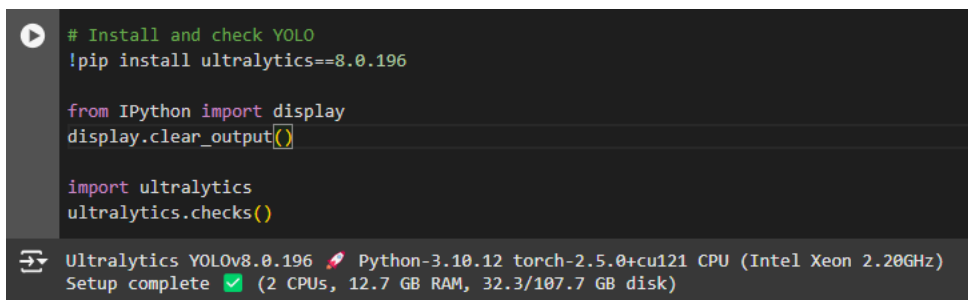
2. System Requirements

- **Hardware**: A computer with adequate processing power for image processing.
- **Software**: Google Colab (recommended), or a local environment with Python installed.
- **Libraries**:
  - ✓ OpenCV
  - ✓ Ultralytics (for YOLO)
  - ✓ SciPy
  - ✓ NetworkX

Ensure all libraries are installed with up-to-date versions.

3. Code Setup and Execution

1. **Clone or Download the Code**:
   - Download the code and access it using Google Colab or local server.
2. Run the first code chunk to ensure YOLO is installed successfully.

```
# Install and check YOLO
!pip install ultralytics==8.0.196

from IPython import display
display.clear_output()

import ultralytics
ultralytics.checks()
```
```
Ultralytics YOLOv8.0.196 🚀 Python-3.10.12 torch-2.5.0+cu121 CPU (Intel Xeon 2.20GHz)
Setup complete ✅ (2 CPUs, 12.7 GB RAM, 32.3/107.7 GB disk)
```

3. **Create a Test Directory**:

- **Local Setup**:
  - ✓ In your project directory, create a folder named test.
  - ✓ Place all images to be analyzed in the test folder and ensure each image has a unique name (e.g., image1.jpg, image2.jpg).

- **Google Colab or Cloud Platform Setup**:
  - ✓ Create a test folder in your workspace, and upload images with unique names to avoid overwriting results.
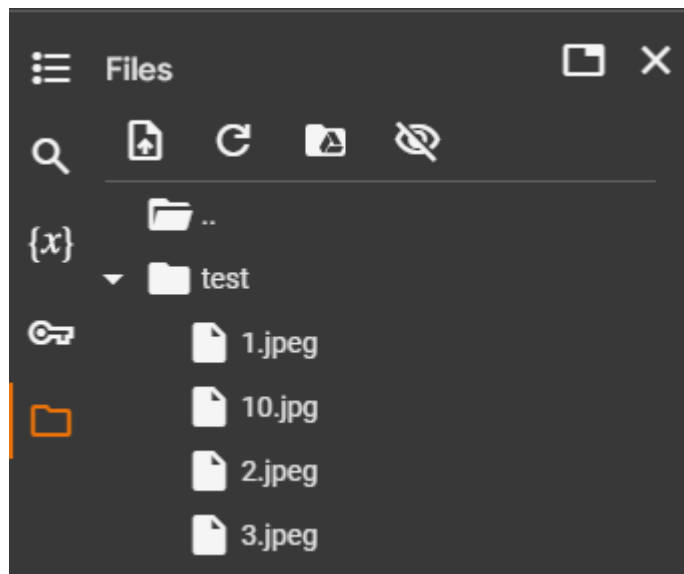


4. **Library Installation**:
   - ✓ In Google Colab or your local terminal, install the required libraries using pip command. For example: pip install ultralytics==8.0.196.

5. **Set Up YOLO Detection Model**: Ensure the YOLO model file (yolov8n.pt) is accessible.

6. **Set up YOLO Pose Estimation Model**: Set up for detecting key points. Ensure model file ('yolov8s-pose.pt') is accessible.

7. **Configure Image Path**: Update image_path with the path to the image you want to analyze. For example: image_path = 'test/your_image_name.jpeg'

8. **Run the Code**: For local server and cloud platform open your command prompt or terminal where the script is present and enter "python your_script_name.py". For google colab simple hit the run button. We recommend using google colab as most of the libraries and dependencies are already installed there.
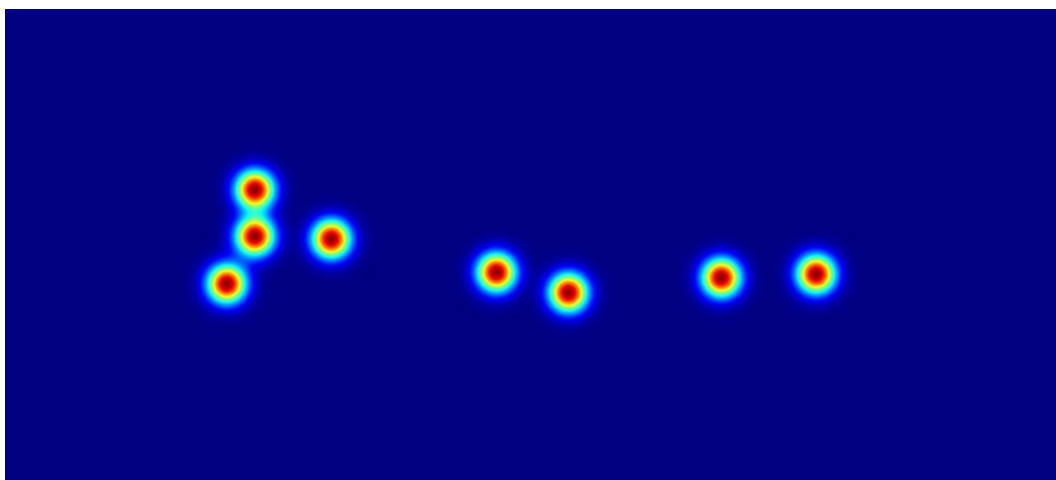
Upon execution, two outputs are generated for each image analyzed:
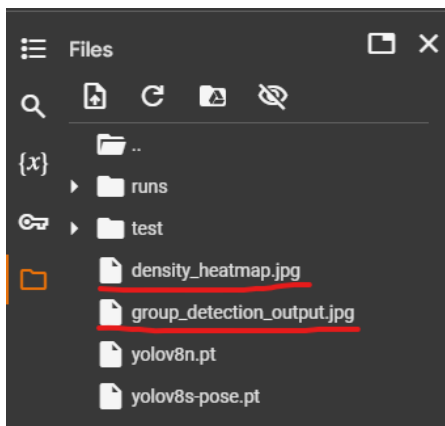


- **Group Detection Output** (group_detection_output.jpg): Shows individual detections with green bounding boxes and grouped people (if any) with blue bounding boxes.
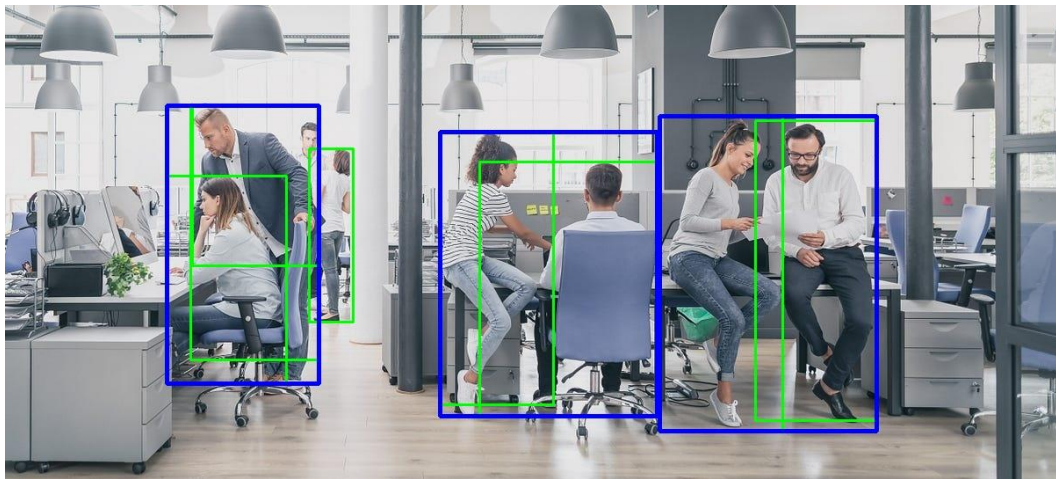


- **Density Heatmap** (density_heatmap.jpg): Shows a heatmap indicating concentration of people in the 2D space.

Additionally, a new folder inside runs/detect/predict logs each code execution, storing:

- The image analysed.

- Number of detected people along with their bounding box coordinates and confidence scores.

*Repeat steps 5 and 6 for each image, updating image_path accordingly.*

## 4. Adjusting Hyperparameters

Optimizing hyperparameters ensures accurate occupancy detection tailored to various office setups and camera perspectives. Here's how to adjust each parameter effectively:

```
# Parameters to tune
min_distance = 50      # Minimum distance between people to be considered in the same group
max_distance = 150     # Maximum distance threshold for grouping
area_threshold_ratio = 0.5  # Bounding box area ratio threshold for distance-based grouping
```

Key Hyperparameters for Adjustment

1. **min_distance and max_distance**:

   - **Purpose:** Defines the proximity at which people are considered part of the same group.

   - **Adjustments**:

     ✓ **Larger Individuals (close-range view)**: Increase max_distance to ensure people aren't grouped prematurely if they appear larger in the frame.

     ✓ **Smaller Individuals (wide-angle or distant view)**: Decrease max_distance to avoid grouping individuals who are too far apart, as they will appear smaller in the frame.

2. **area_threshold_ratio**:

   - **Purpose:** Compares bounding box sizes to determine if people are interacting or merely overlapping due to perspective.
   - **Adjustments**:

     ✓ **Overlapping (front and back)**: Lower area_threshold_ratio if people overlap without interaction, helping prevent them from being misgrouped.

     ✓ **Similar Sizes (consistent layout or grouping)**: Raise area_threshold_ratio slightly for areas where bounding boxes are of similar size due to uniform camera positioning.
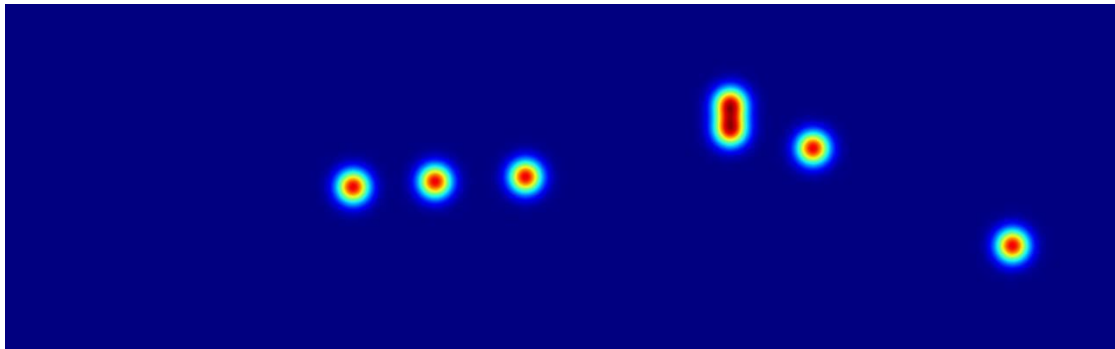
5. Output Explanation

- **Group Detection Output (group_detection_output.jpg)**:

✓ Each person is identified with a **green bounding box**.

✓ Groups of people are highlighted with a **blue bounding box** encompassing the group.
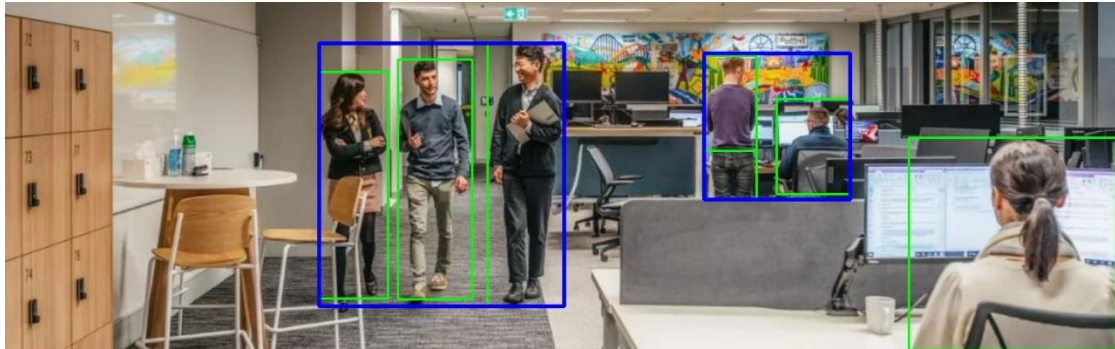

- **Density Heatmap (density_heatmap.jpg)**:

  ✓ Visualizes the density of individuals, with hotter colors indicating higher concentrations.

6. Tracking Run History

Each run generates a new folder inside runs/detect/predict, logging:

- Image used.

- Number of people detected, along with each person's confidence score. This serves as a track of how many times the code has run, which images were processed, and the count and confidence of detections in each image.
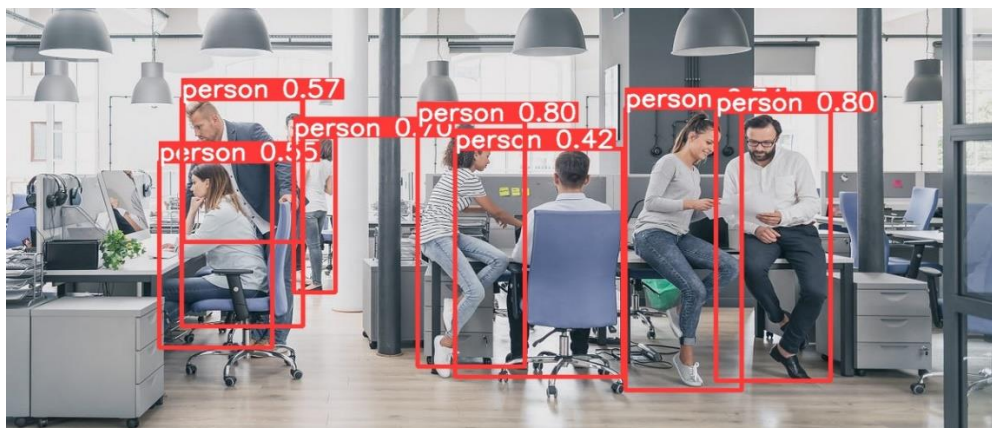
7. Common Issues and Troubleshooting

- **Error: No Module Found**:
  - ✓ Ensure all libraries are installed:
  - ✓ Use pip command to install a specific library, for example: pip install numpy

- **Detection Errors**:
  - ✓ Adjust min_distance and max_distance for accurate grouping.

- **Improper Group Bounding**:
 - ✓ Tune area_threshold_ratio and ensure consistent lighting and angle in image captures.

Accessing the Dashboard

To access the dashboard:

- Open Power BI on your desktop or through the Power BI online portal.
- Navigate to the Real-Time Office Occupancy and Group Analysis Dashboard from the available reports.

Dashboard Overview

The dashboard consists of several sections designed to provide insights into real-time occupancy, room usage, and event-based trends. Each section serves a specific purpose, providing both high-level overviews and detailed breakdowns of office occupancy data.
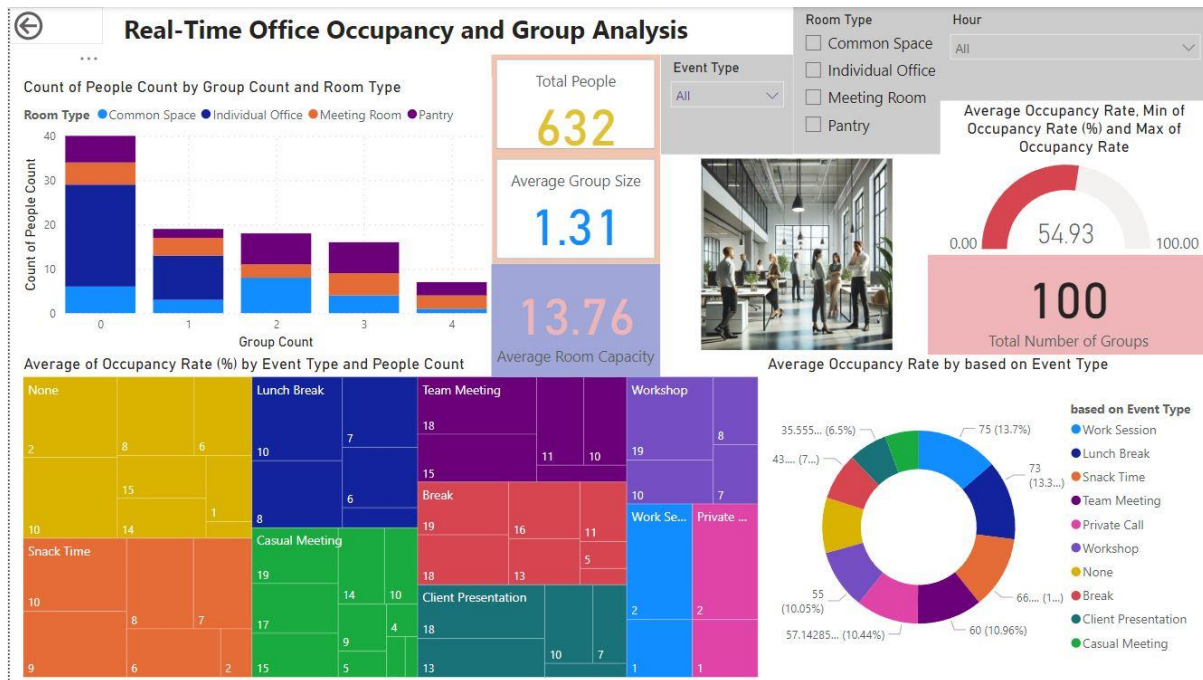
Key Sections of the Dashboard

Top KPI Metrics

- **Purpose:** The KPI metrics give a quick, high-level view of overall office space utilization.
- **Metrics Displayed:**
- **Total People:** The total count of individuals present in the office.

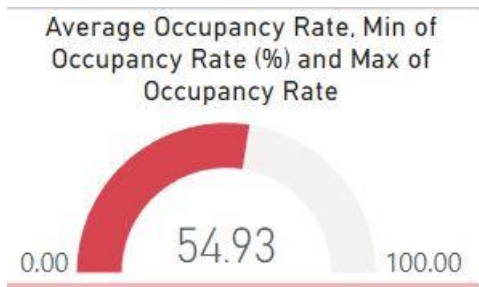**Average Group Size:** Shows the average number of people per group across the office.

Total Groups: The total number of detected groups in the workspace.

Occupancy Rate Gauge: A gauge that displays the overall occupancy rate as a percentage of available space.

Average Occupancy Rate, Min of Occupancy Rate (%) and Max of Occupancy Rate

0.00   54.93   100.00

How to Interpret: These metrics help users understand the current occupancy level, average group sizes, and overall workspace usage. A high occupancy rate indicates a crowded office, while a low rate suggests available space.

Room Type Occupancy Analysis

Purpose: This section provides insights into room usage across different types of office spaces.

Visuals Displayed:

Bar Chart: The bar chart shows the count of people grouped by room type (e.g., Meeting Room, Common Space, Private Office, Pantry).
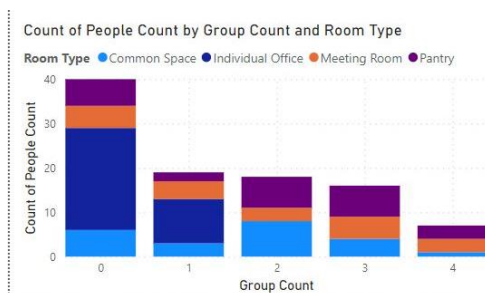
How to Interpret: The bar chart helps identify the most frequently used room types. Rooms with higher people counts indicate high-demand spaces, which may require additional resources or monitoring.

Event-Based Usage Patterns

Purpose: To understand how different types of events impact occupancy levels.

Visuals Displayed:

Treemap: The treemap shows the average occupancy rate based on event type, such as Team Meeting, Workshop, Casual Meeting, and Lunch Break.

Pie Chart: This chart provides a breakdown of occupancy rates across various event types, allowing users to see which events contribute most to space utilization.

Average Occupancy Rate by based on Event Type
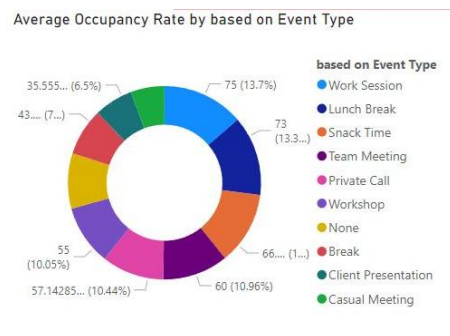
How to Interpret: The treemap and pie chart help identify high-occupancy events, such as workshops or team meetings. This information can be useful for scheduling and resource planning, especially if certain events consistently lead to high space utilization.

Using Filters to Customize the View

Filters are available on the right side of the dashboard to customize the view based on room type, event type, and time. These filters allow users to focus on specific data relevant to their analysis.

Room Type Filter

Description: Select specific room types (e.g., Common Space, Meeting Room, Private Office, Pantry) to view occupancy and utilization data for only those spaces.

Usage: Check or uncheck the boxes next to each room type to include or exclude them from the visuals.
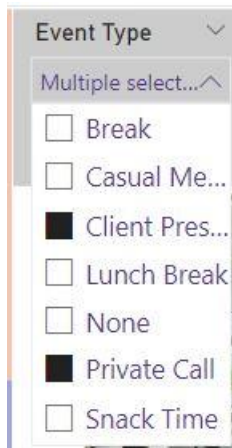

Event Type Filter

Description: Focus on particular events (e.g., Team Meeting, Casual Meeting, Lunch Break) to analyse occupancy patterns during these activities.
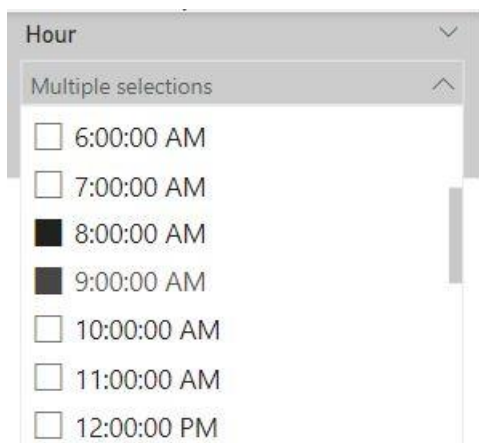
Usage: Use the dropdown to select one or more events.

Time Filter

Description: Filter data by specific time periods, such as hours of the day, to examine how occupancy varies throughout the day.

Usage: Use the time filter to select a specific hour or range of hours.

Interpreting the Data

Understanding Key Metrics

Total People: Indicates the overall number of individuals detected in the office. High numbers suggest high usage or peak times.

Average Group Size: Helps understand collaboration levels. Large group sizes indicate that more collaborative spaces might be required.

Total Groups: Provides insight into the number of distinct groups in the office, helping assess social interactions.

Occupancy Rate: Indicates how much of the office space is utilized. High occupancy rates suggest the need for more space or better scheduling.

6.2 Room Utilization Insights

Use the Room Type and Occupancy Analysis section to identify:
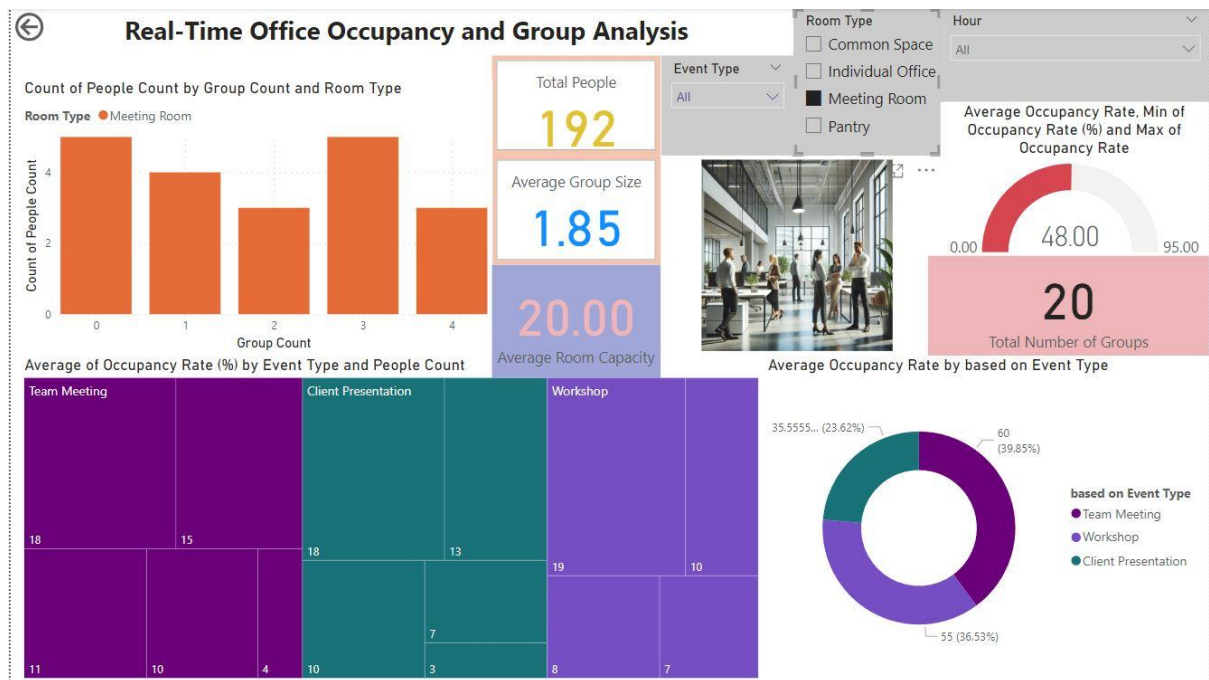
High-Demand Spaces: Rooms with high occupancy counts are in demand and may need to be prioritized for future resource allocation.

Underutilized Spaces: Rooms with low occupancy counts may need to be repurposed or made available for other uses.
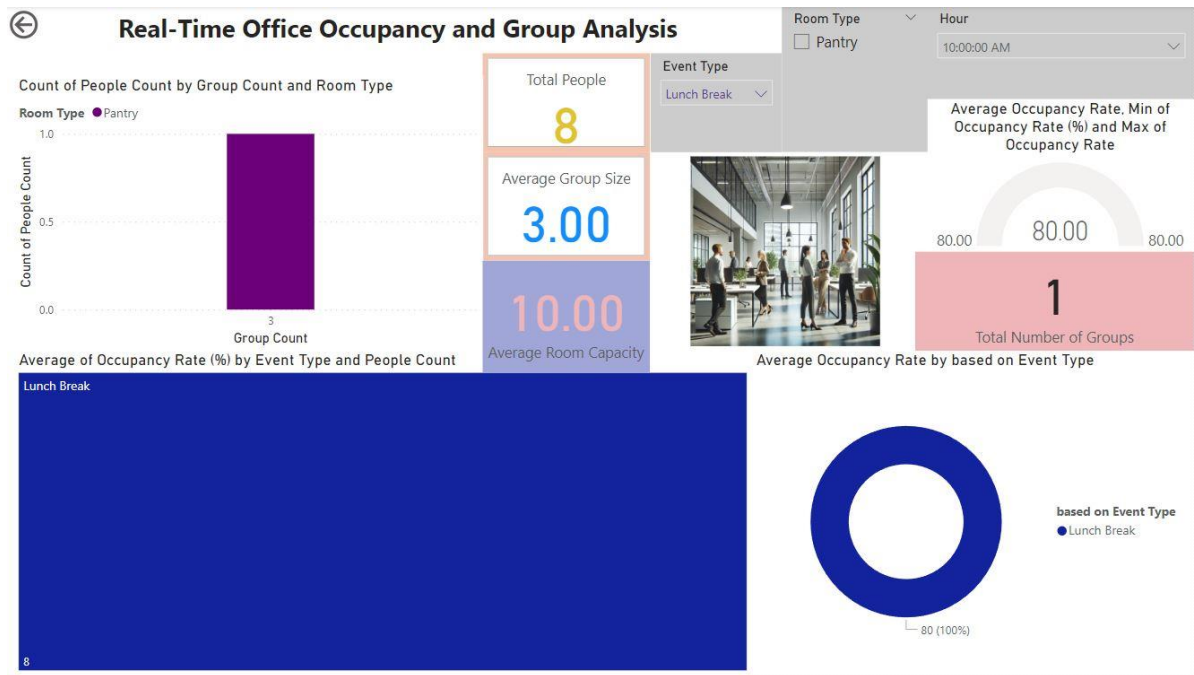
Event-Based Analysis

The event-based visuals (tree map and pie chart) help identify:

Peak Events: Events that contribute the most to space utilization.

Scheduling Needs: Identifying high-occupancy events allows for better planning and scheduling of rooms to avoid overcrowding.

Best Practices

- **Use Filters:** Filters are powerful tools for focusing on specific data. Make use of room type, event type, and time filters to tailor the dashboard view to your needs.

- **Monitor Key Metrics:** Regularly monitor the Total People, Average Group Size, and Occupancy Rate to understand general trends in office usage.

- **Identify High-Use Spaces and Events:** High-occupancy rooms and events may need additional resources or different scheduling to optimize space usage.

Troubleshooting

Common Issues:

1. **Data Not Updating:** If the dashboard data seems outdated, ensure that the data refresh settings in Power BI are correctly configured to refresh every 15 minutes.

2. **Slow Performance:** If the dashboard is slow, reduce the number of visuals displayed or apply filters to limit the data shown.