/* a Research upon airline passenger experience

<context: aviation, Narita International Airport>

*An architectural research project
submitted to the Department of Architecture and Landscape Architecture.*

_In Partial Fulfillment of the Requirements
for the Degree of Master of Architecture".

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Aviation has a rich and long history. The industry has evolved increasingly over the year to accommodate technological advancement. However, along the way, the human part of it has been removed from the conversation. Aviation is one of the most important pieces in today’s society and economy, but at the same time it should be designed with human interaction in mind and not otherwise. Valuing human presence and adapting for the future. This reseach document leverage today’s technology and software to analyze one of the top airport in the world. From there, one can be evaluate kinks within the system. The data collected in this can be used to inform design choices later on the road. Design choices need to accommodate code and standards while putting human value first and foremost. Respecting and integrating nature and surrounding environmental resources to help reduce its carbon footprint and solving urban issues. Create what architecture means to do in the beginning. Create the physical environment in which people and cultures live.

Introduction

/* Air travel has been the fattest and safest travel in these recent years. It also outweighs other forms of transportation mean when compared side to side. Nevertheless, when talking about air travel, instant images flooding people’s minds are about confusing directions, horrifying security, and long lines.

When looking into the matter, one cannot pinpoint just one element since it includes the entire system and must be examined carefully.

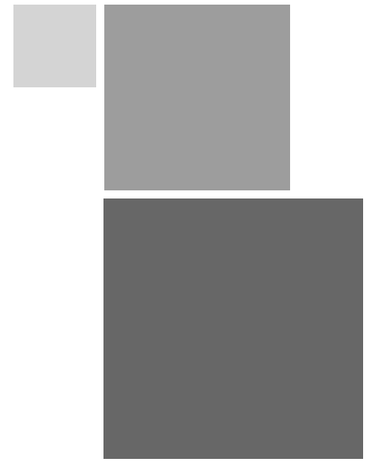
This research intends to look at passenger experiences when travelling via commercial aviation through the lens of modern technology. The research will look and analyze a typical passenger’s experiencewhen travelling via commercial aviation.

Narita Airport

/* Narita is the busiest airport in Japan for international passenger and cargo traffic. In 2018, Narita had 33.4 million international passengers and 2.2 million tonnes of international cargo. In 2018, Narita was also the second-busiest airport in Japan in terms of aircraft movements (after Haneda Airport in Tokyo) and the tenth-busiest air freight hub in the world.

/* Its 4,000-meter (13,123 ft) main runway shares the record for the longest runway in Japan with the second runway at Kansai International Airport in Osaka. Narita serves as the main international hub of Japan Airlines, All Nippon Airways and Nippon Cargo Airlines, and as a hub for low-cost carriers Jetstar Japan and Peach.

```
/*  Check-in is processed on the fourth floor, and de-
    partures and immigration control are on the third
    floor. Arriving passengers clear immigration on
    the second floor, then claim their baggage and
    clear customs on the first floor. Most shops and
    restaurants are located on the fourth floor of the
    Central Building.
```

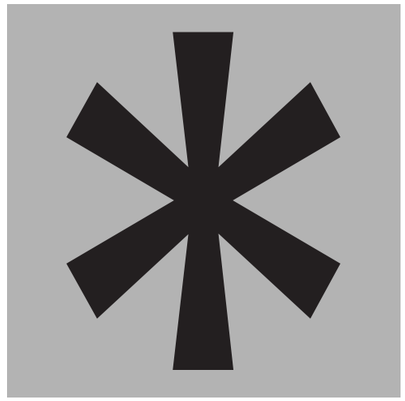
```
/*  Terminal 1 uses a satellite terminal design di-
    vided into a North Wing, Central Building, and a
    South Wing. Two circular satellites, Satellites 1
    (gates 11-18) and 2 (gates 21-24), are connect-
    ed to the North Wing. Satellites 3 and 4 (gates
    26-38 and gates 41-47) compose a linear concourse
    connected to the Central Building. Finally, sat-
    ellite 5 (gates 51-58) is connected to the South
    Wing. The terminal has a floor space of 463,000 m2
    (4,980,000 sq ft) and is equipped with 40 gates.
```

Figure 01 – Narita International Airport Site Plan

Methodology

/* Regarding highly designed airports, Tokyo International Airport is among the top, whether it is of its form or function.

The study will encompass a typical airline passenger experience travelling through Narita International Airport.



/* The schematic layout and operating system of Narita International airport will be analyzed. In junction with that, modern technology and simulation software will be used to visualize the data and translate that into designs.

/* AnyLogic is a multimethod simulation modelling tool developed by The AnyLogic Company (former XJ Technologies). It supports agent-based, discrete event, and system dynamics simulation methodologies. AnyLogic is used to simulate: markets and competition, healthcare, manufacturing, supply chains and logistics, retail, business processes, social and ecosystem dynamics, defence project and asset management, pedestrian dynamics and road traffic, IT, and aerospace.

/* The ability to analyze the model as it runs sets simulation modelling apart from other methods, such as those using Excel or linear programming. By inspecting processes and interacting with a simulation model in action, understanding and trust are quickly built.

Re-creation

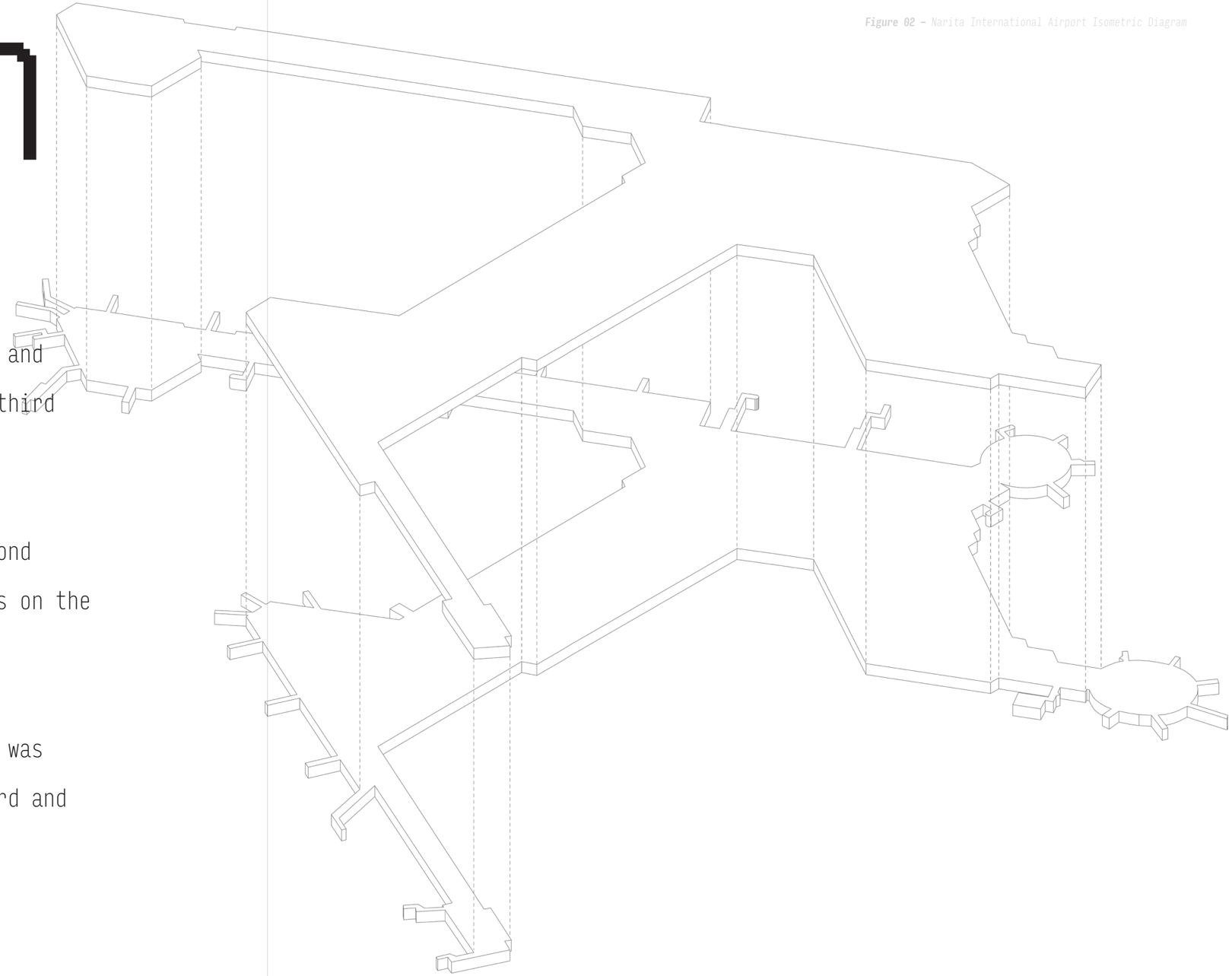


Figure 02 – Narita International Airport Isometric Diagram

/* The check-in process occurs on the fourth floor, and departures and immigration control occur on the third floor.

Arriving passengers clear immigration on the second floor, then claim their baggage and clear customs on the first floor.

With that information, Narita airport Terminal 1 was recreated in the 3D spaces, specifically the third and fourth floors of Terminal 1.

/* WITH THE FLOOR PLAN RECREATED WITHIN THE 3D SPACE, THE FUNCTION WAS PROGRAMMED TO MATCH CLOSELY WITH NARITA AIRPORT.

DIFFERENT AGENTS, SIMULATION NODES ALONG WITH DIFFRENT TOOLS WAS USED TO PROGRAM THESE FUNCTIONS.

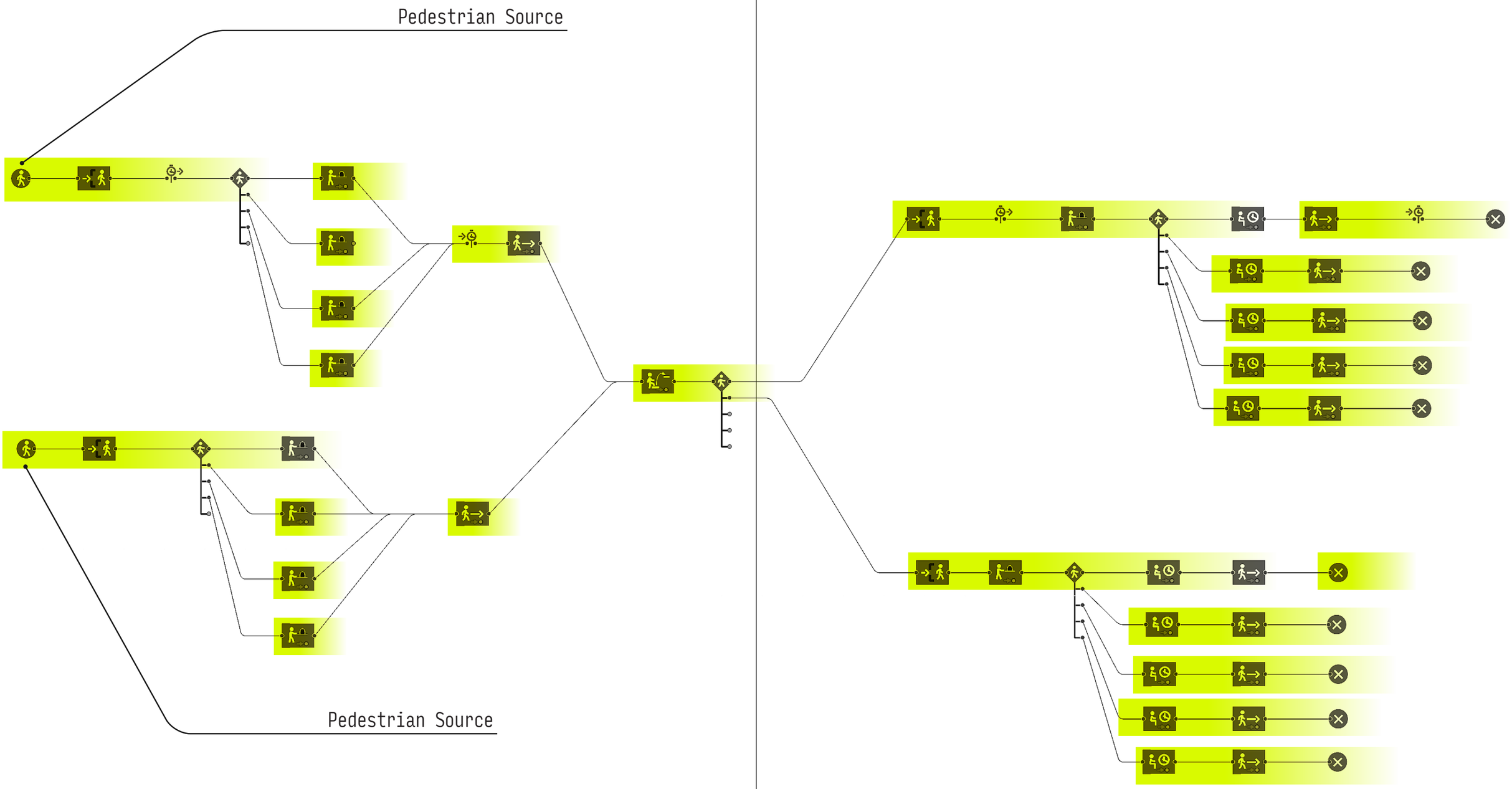
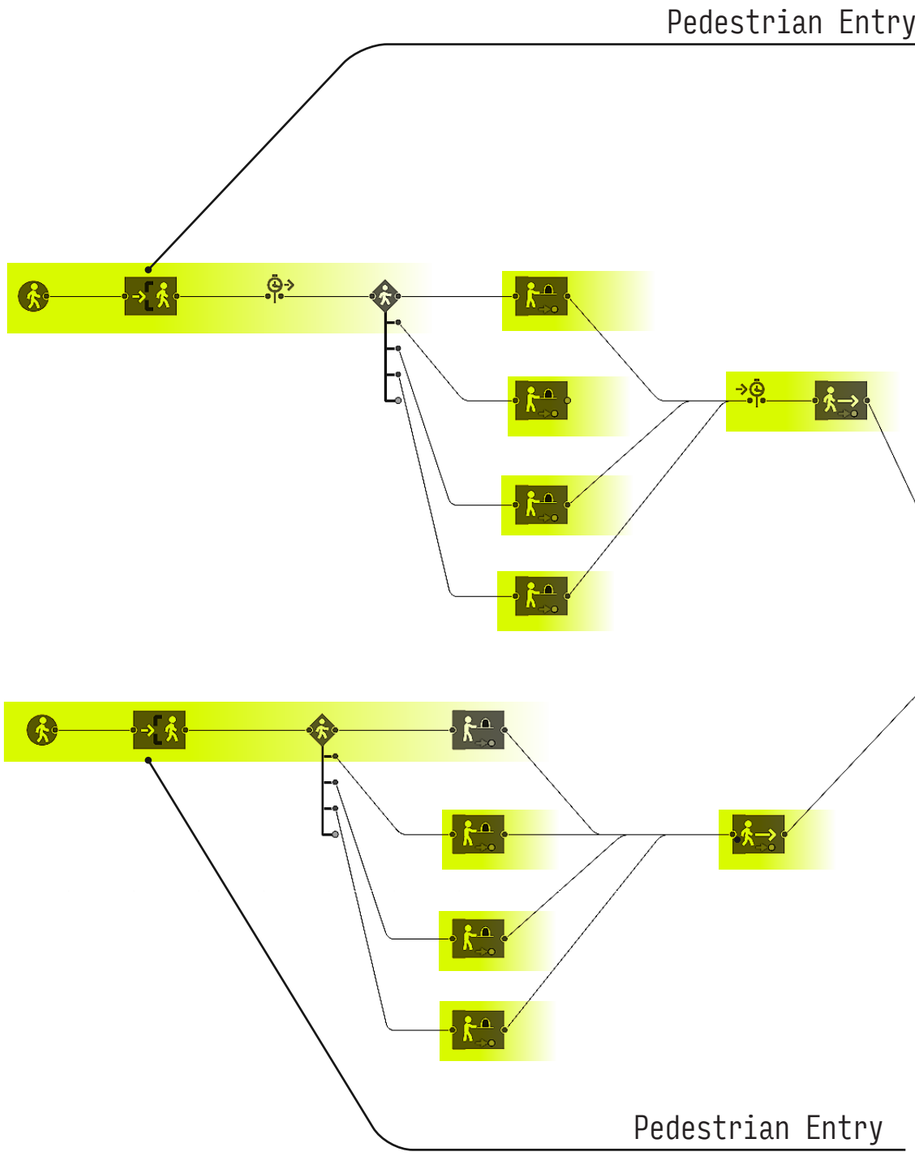


Figure 03 – AnyLogic Algorithm_Pedestrian Sources

Algorithm AnyLogic

AnyLogic

Algorithm



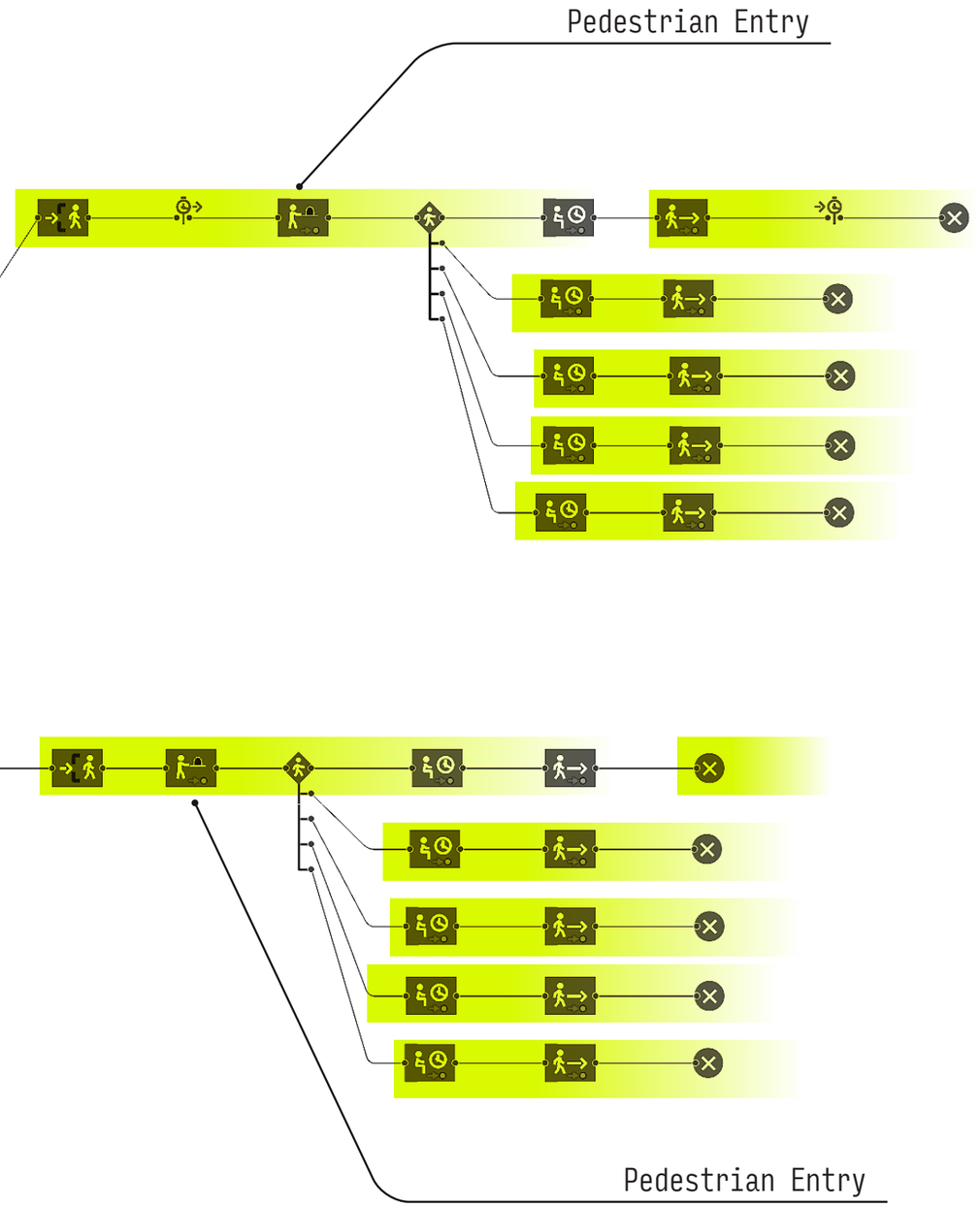


Figure 04 – AnyLogic Algorithm_Pedestrian Entry

AnyLogic

Algorithm

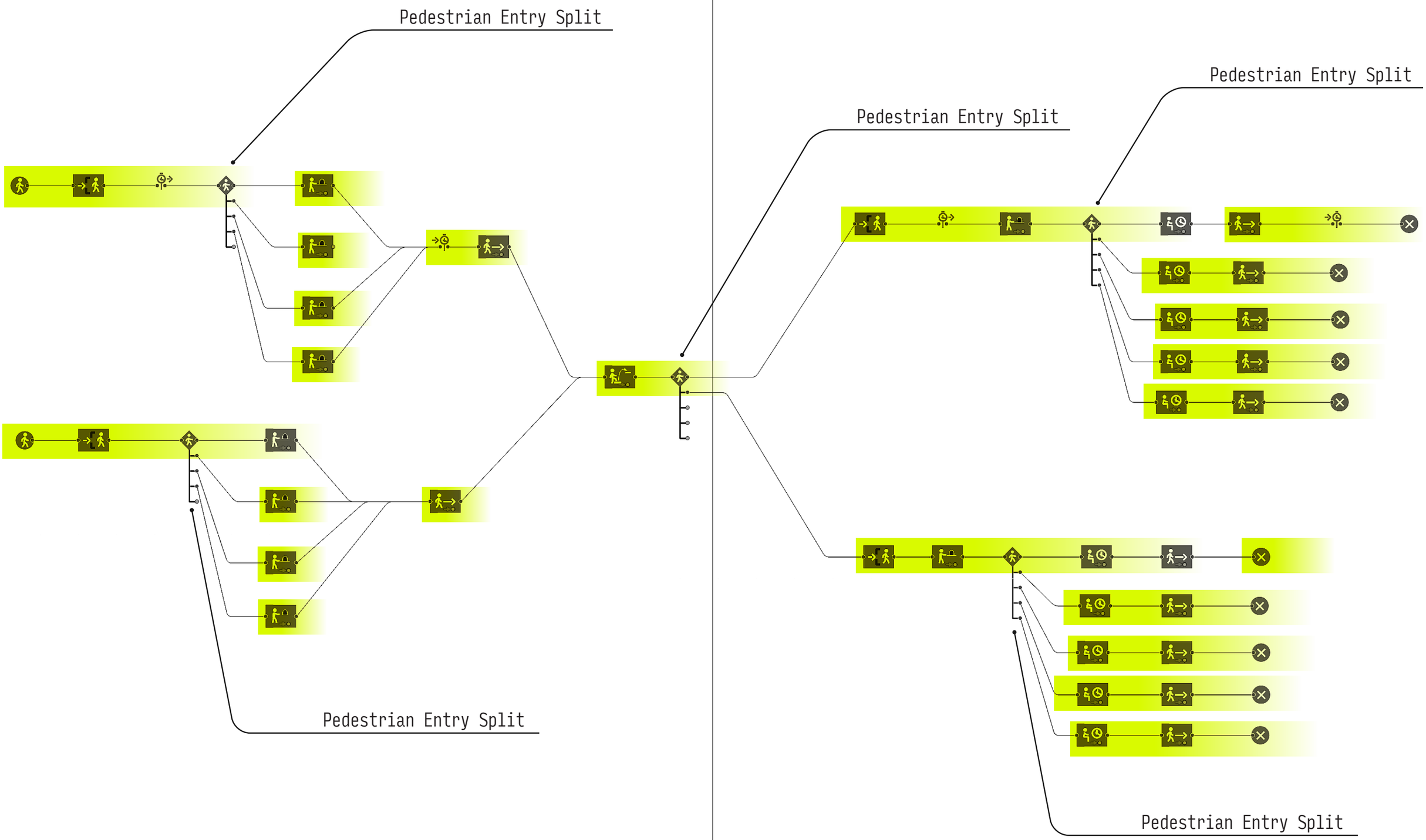
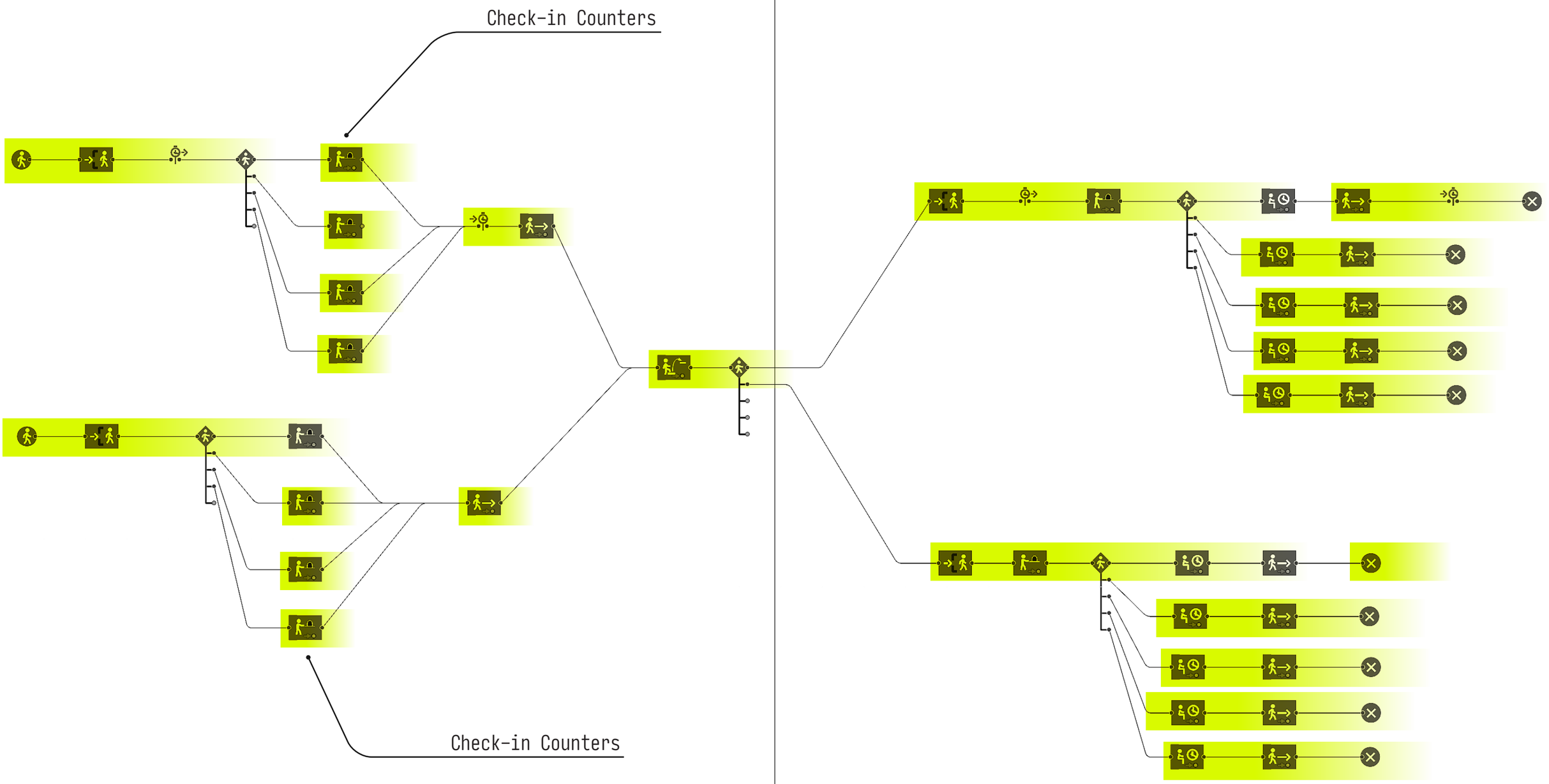


Figure 05 – AnyLogic Algorithm_Pedestrian Entry Split

AnyLogic

Algorithm



Algorithm

AnyLogic

Figure 06 – AnyLogic Algorithm_Check-in Counters

AnyLogic Algorithm

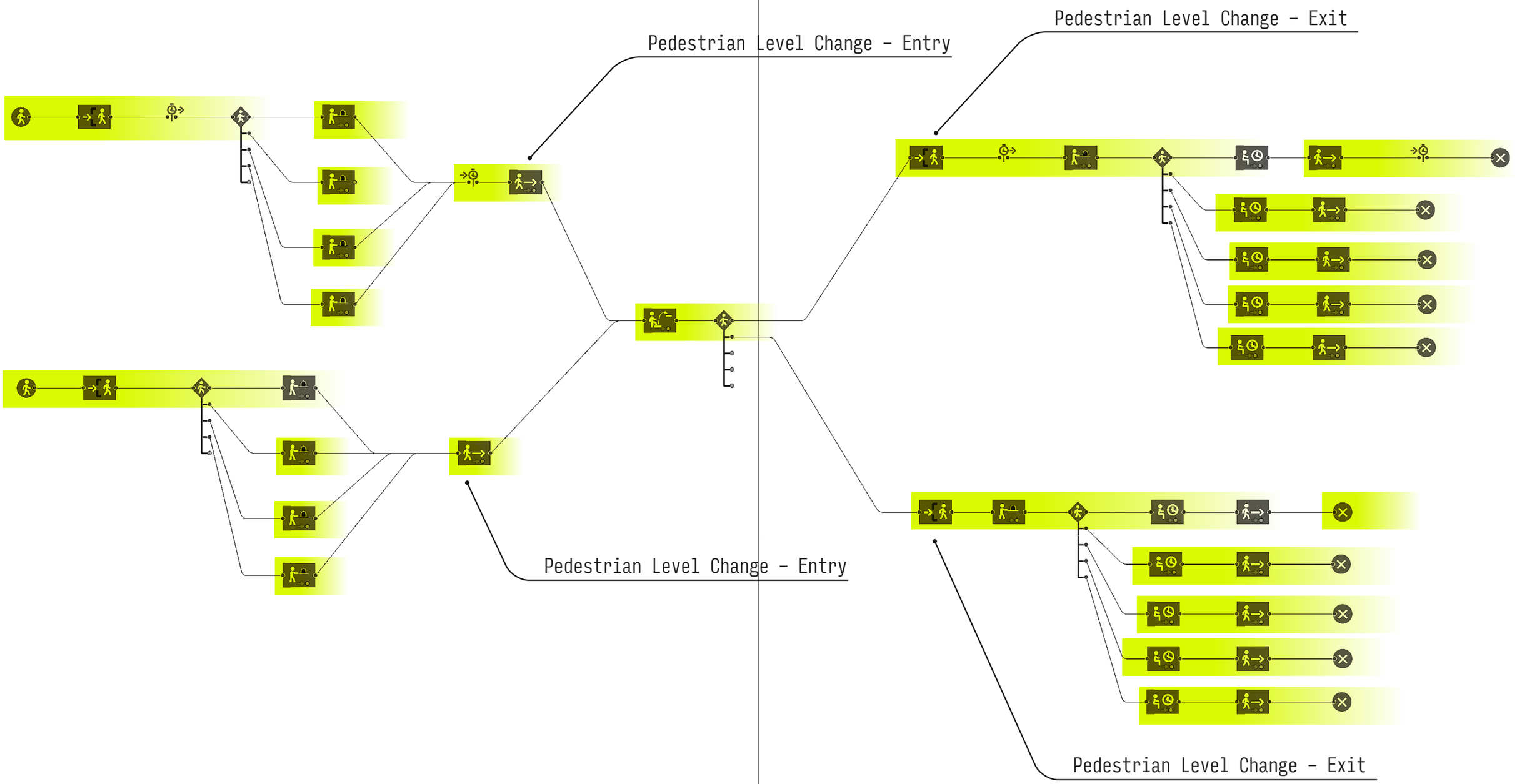


Figure 07 – AnyLogic Algorithm_Pedestrian Level Change

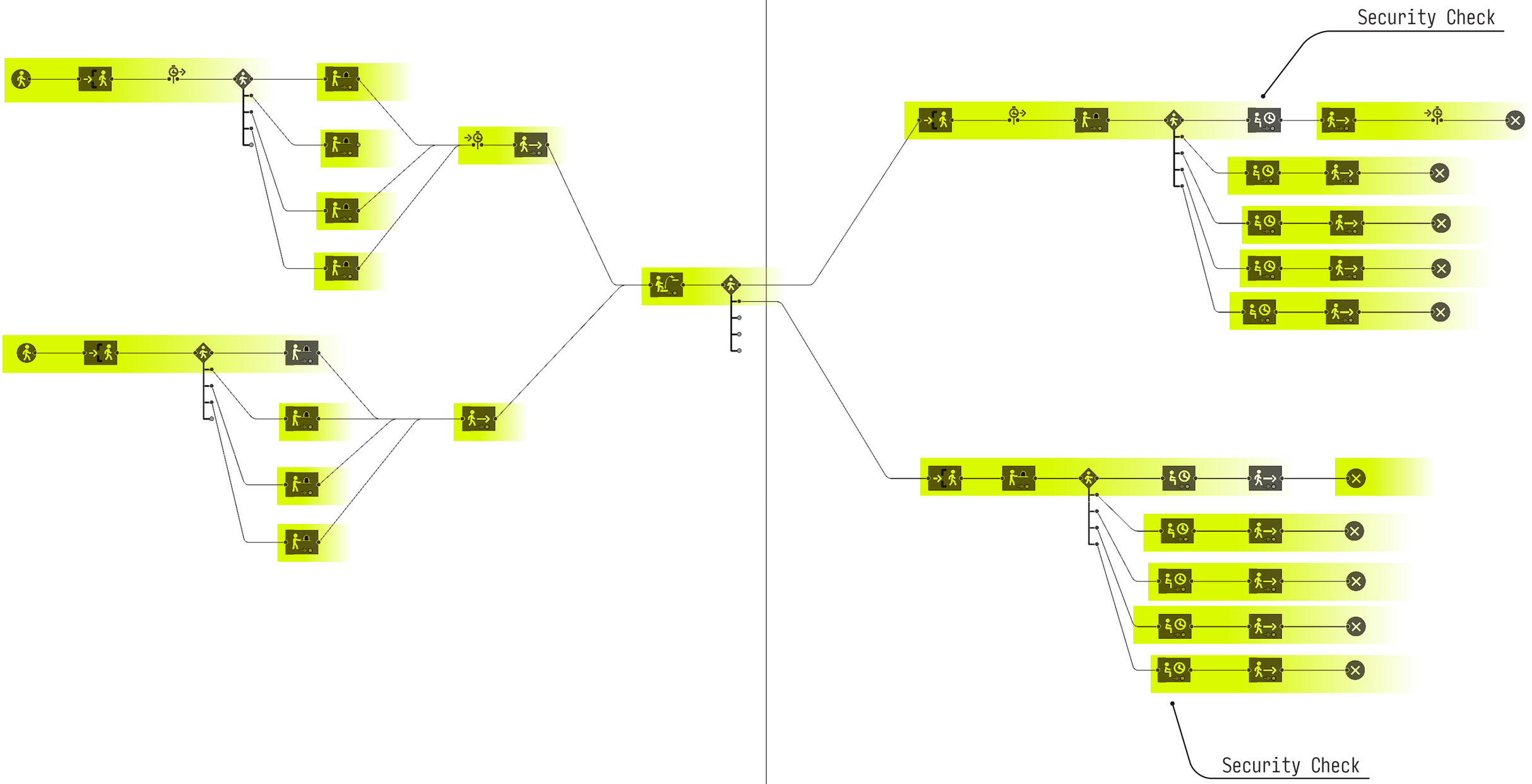
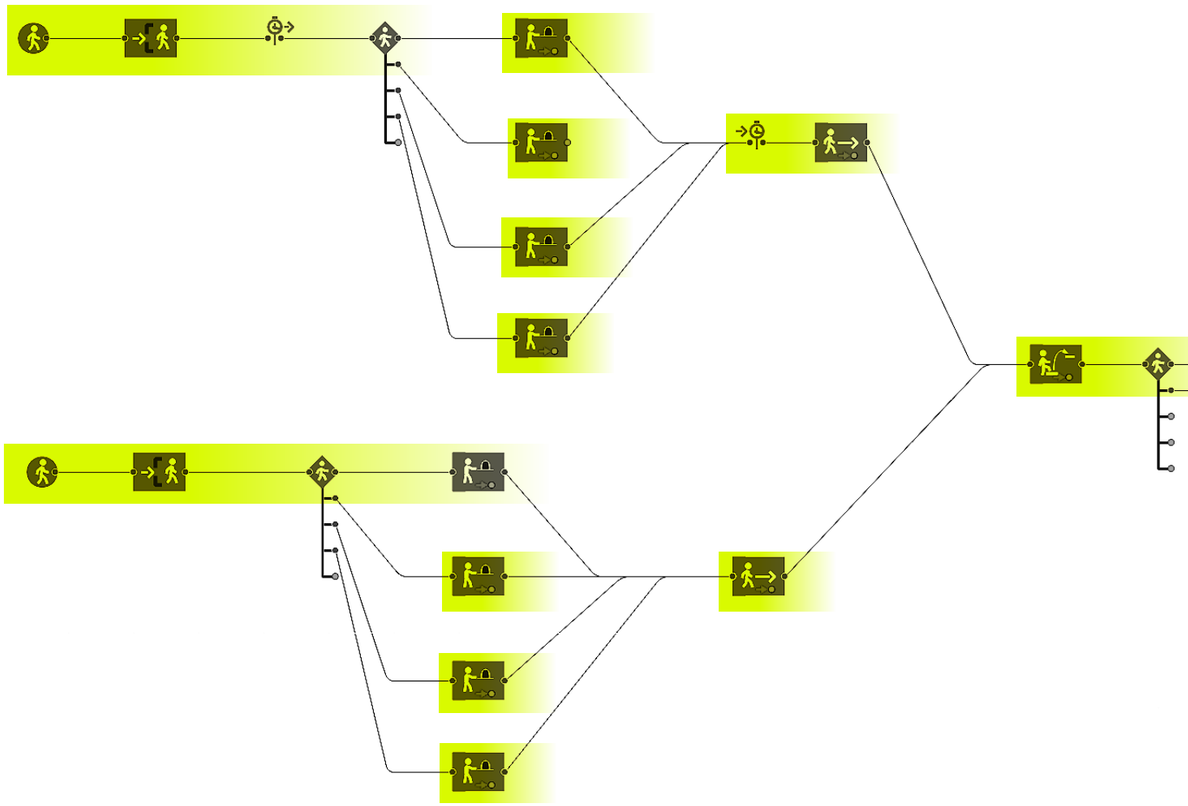


Figure 08 – AnyLogic Algorithm_Security Check

Algorithm AnyLogic

AnyLogic

Algorithm



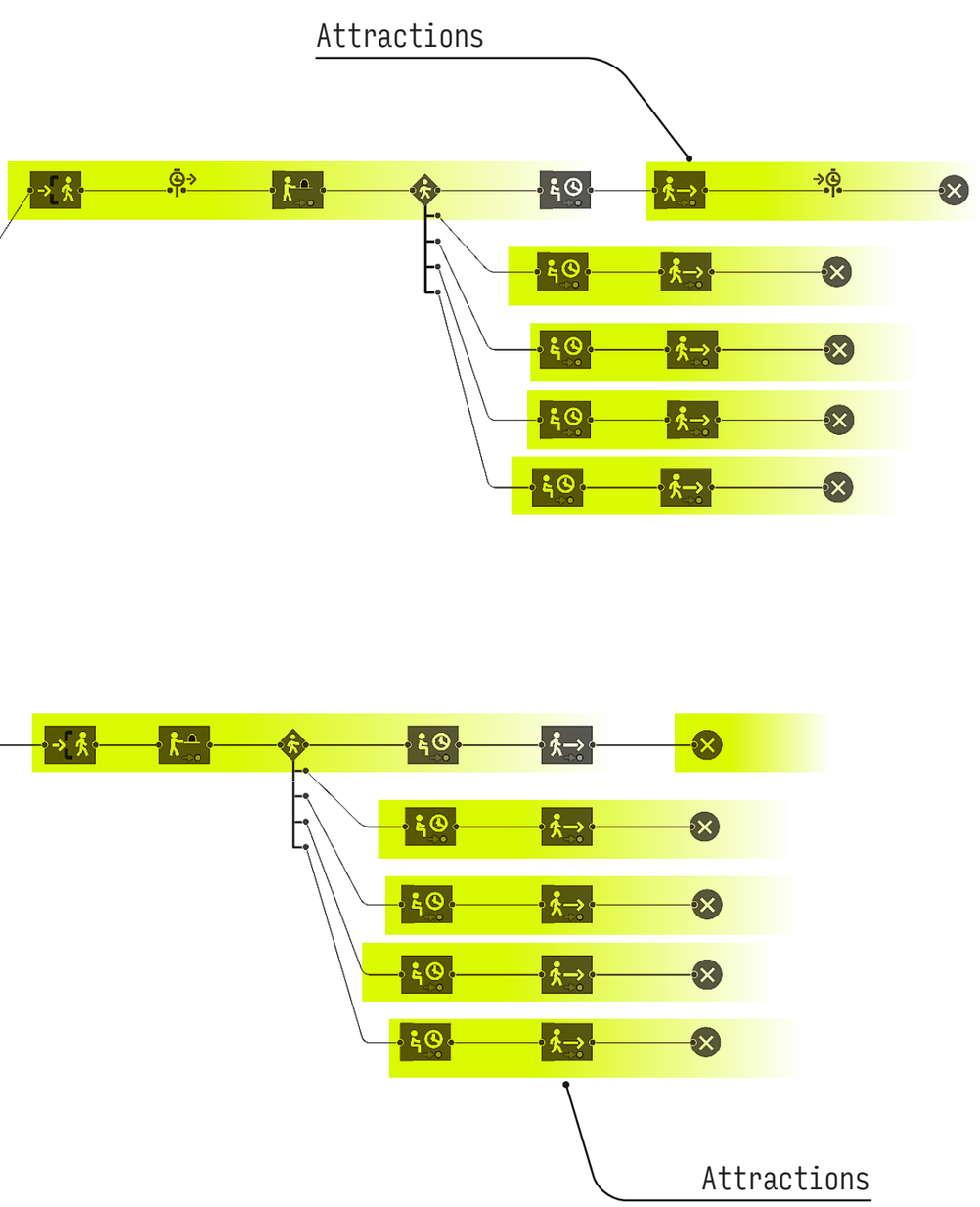


Figure 09 – AnyLogic Algorithm_Attractions

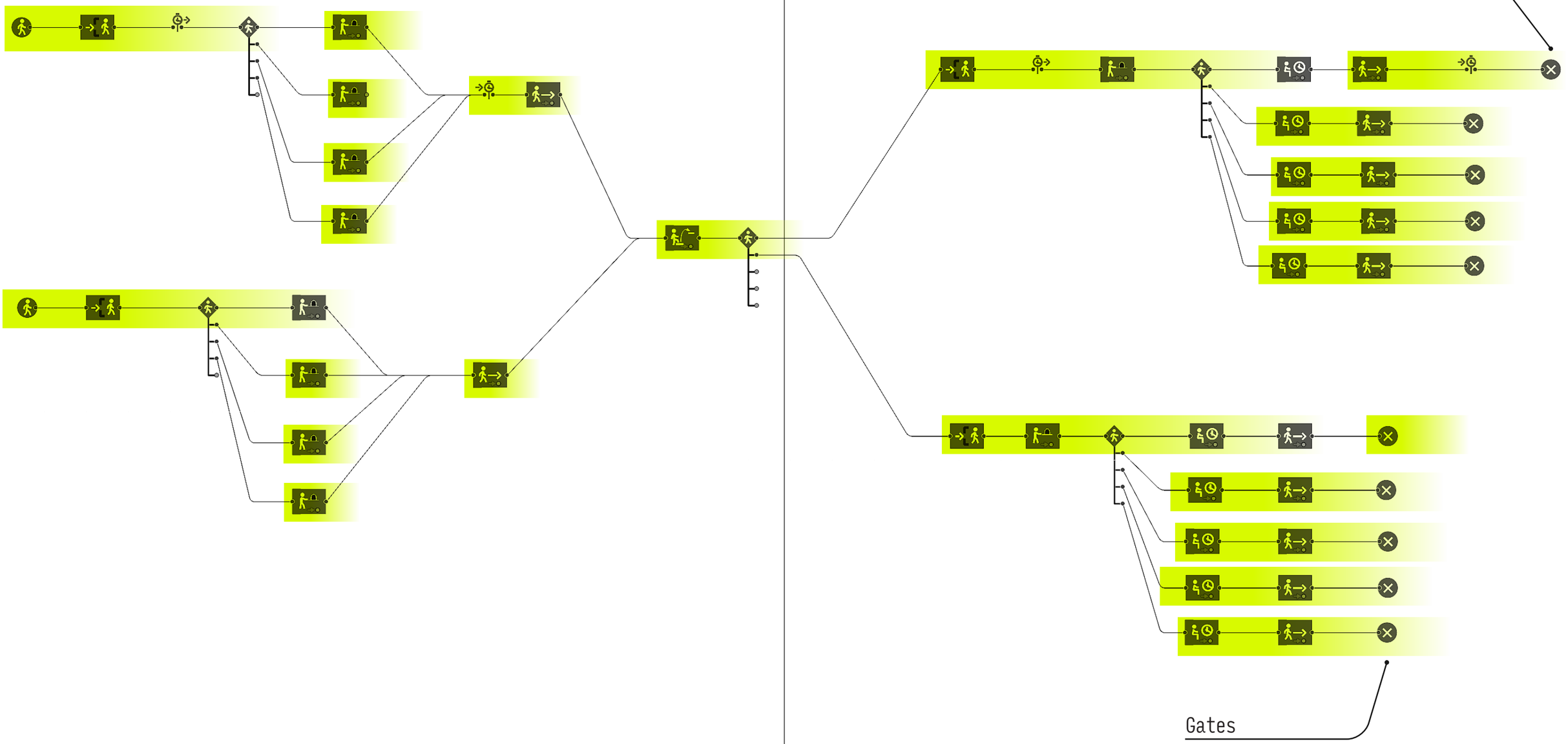


Figure 10 – AnyLogic Algorithm_Gates

AnyLogic

Algorithm

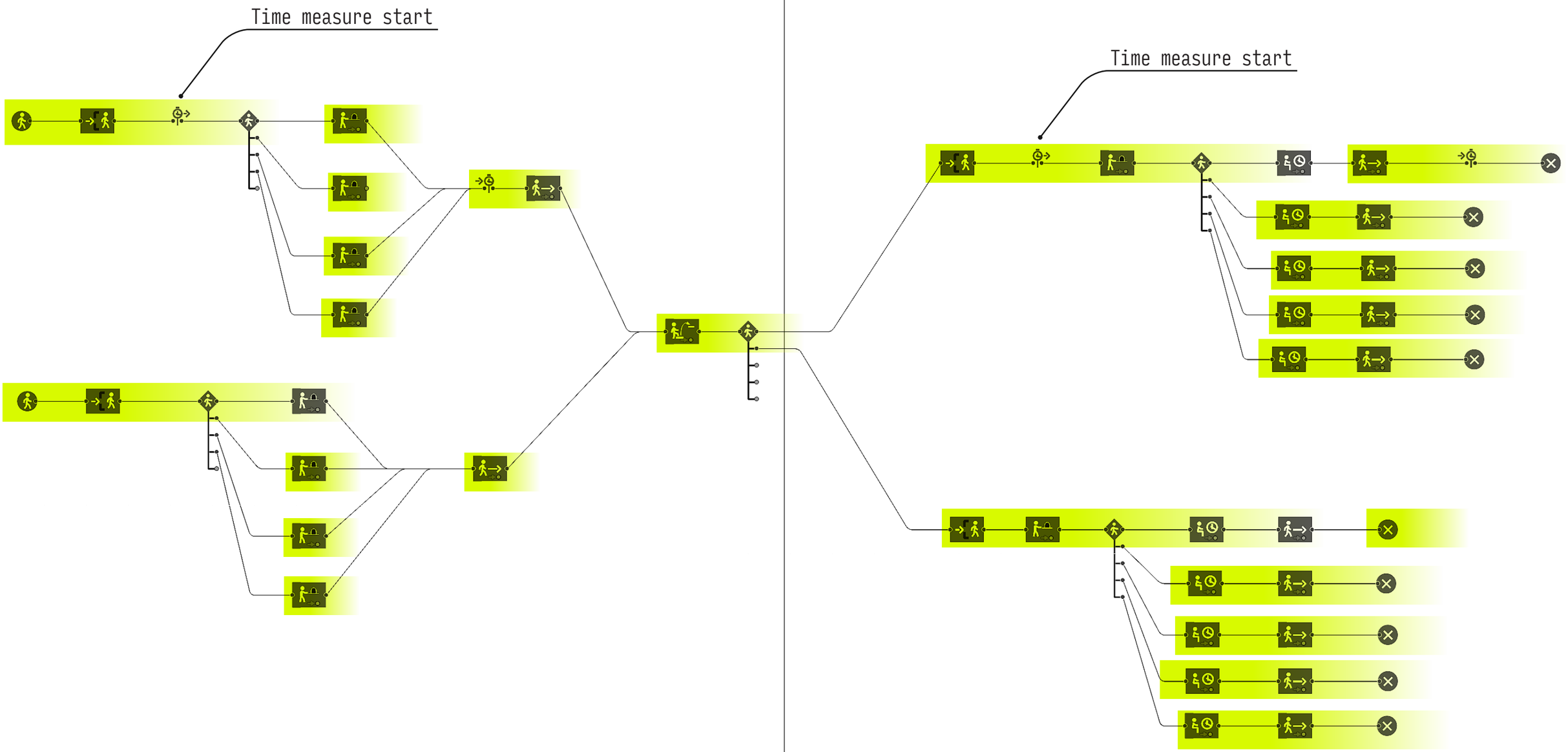
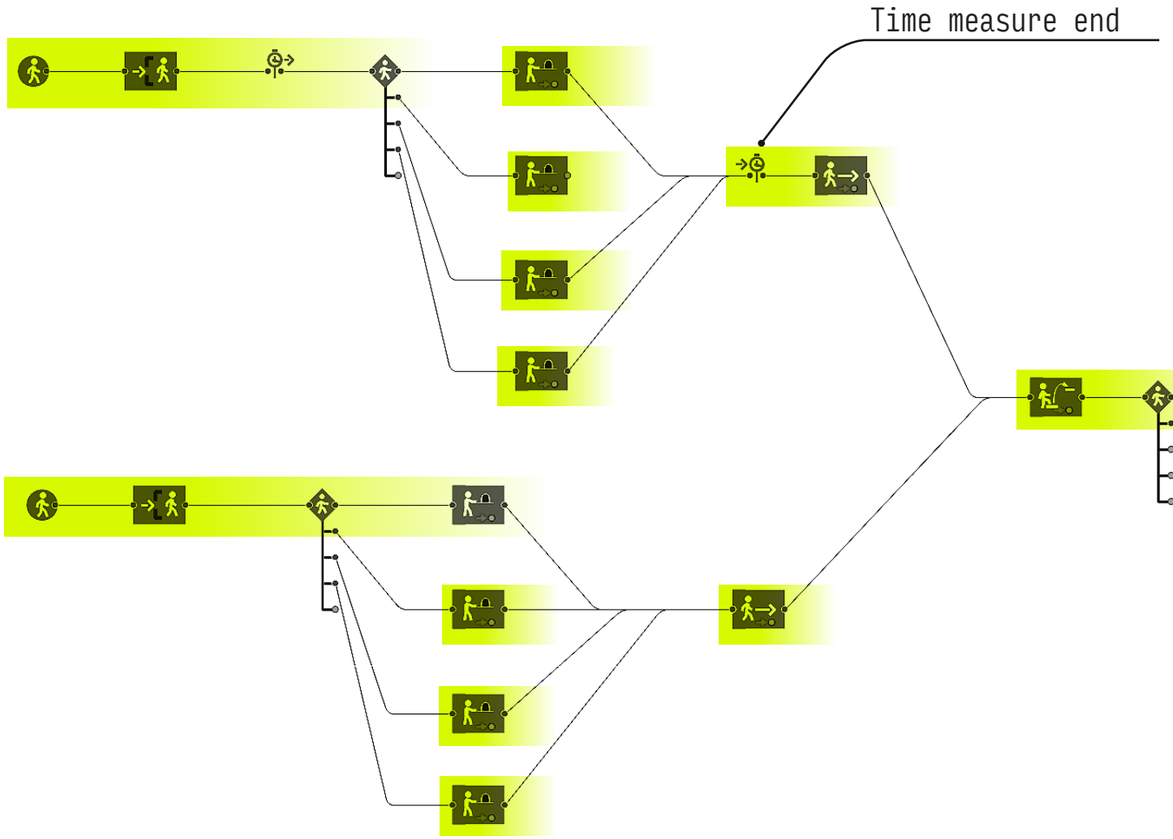


Figure 11 – AnyLogic Algorithm_Time Measure Start

Algorithm

AnyLogic



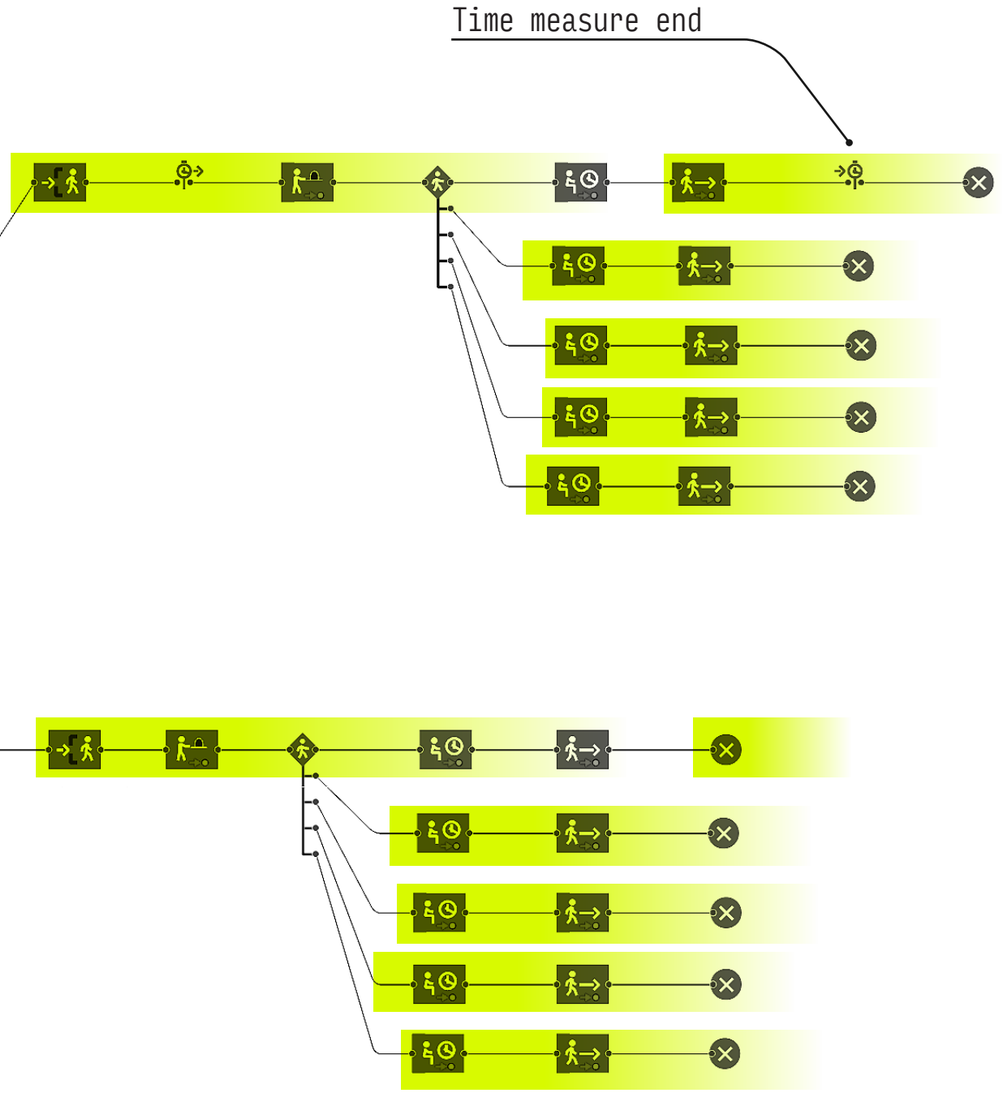


Figure 12 – AnyLogic Algorithm_Time Measure End

Simulation

The Narita Airport Model was simulated for two period of time in order to capture the system with different level of details.

6 Hours

12 Hours

This way, one can differentiate the performance of one system more easily. The shorter time period can show the fast-moving or sudden changes within the system. In contrast, the longer time period can show the overall picture of the system.

One minute will be simulated in the airport model for every real-time second.

6 Hours

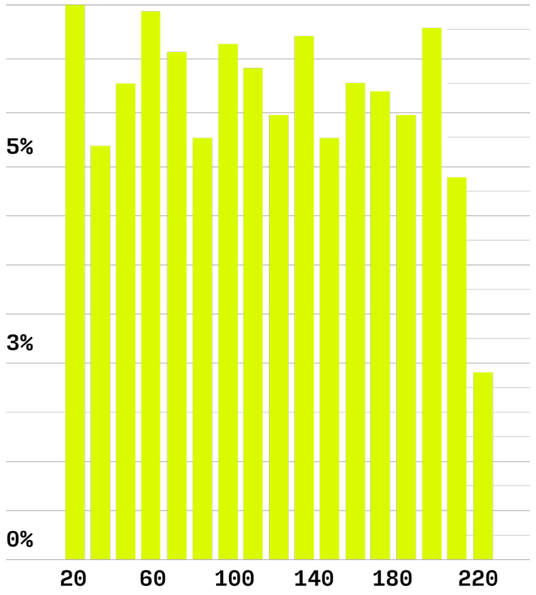


Figure 13 – *East wing Check-in 4th floor Histogram*

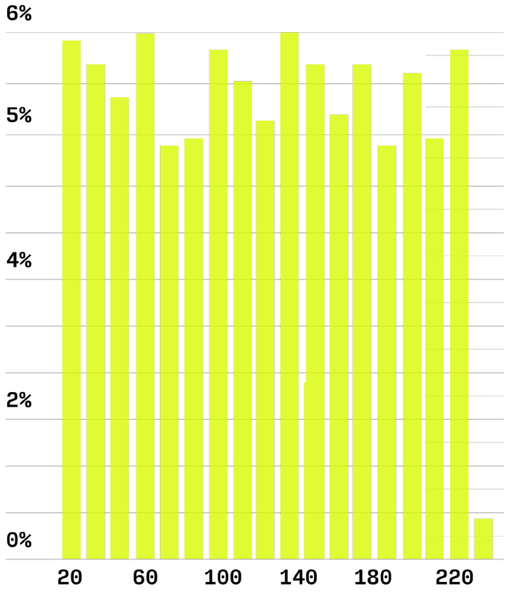


Figure 14 – *West wing Check-in 4th floor Histogram*

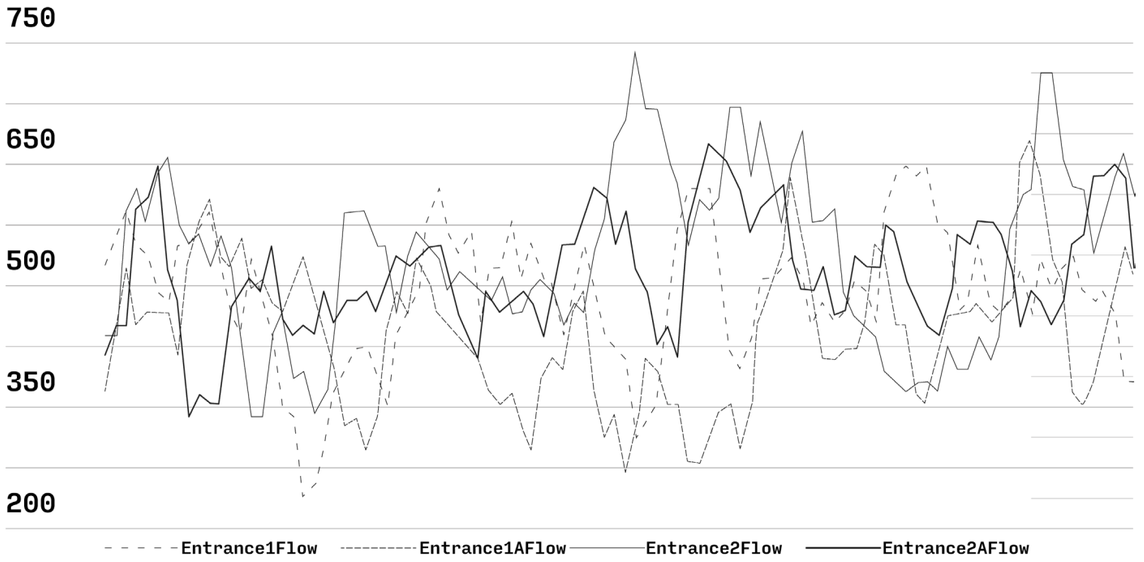


Figure 15 – *4th floor Pedestrian Flow Plot Chart*

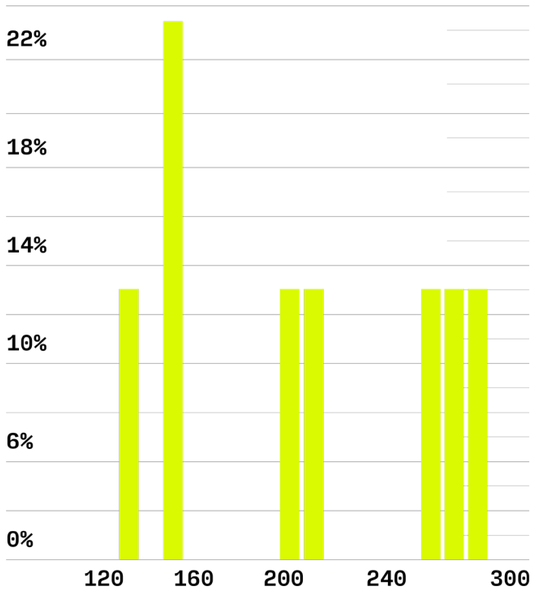


Figure 16 – *East wing Check-in 3rd floor Histogram*

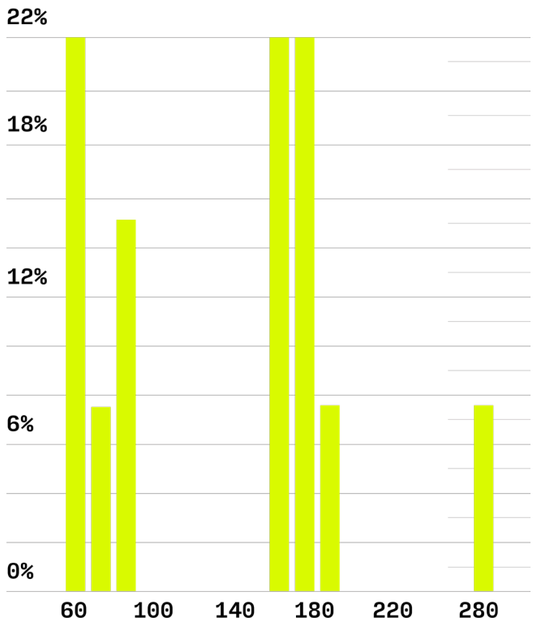


Figure 17 – *West wing Check-in 3rd floor Histogram*

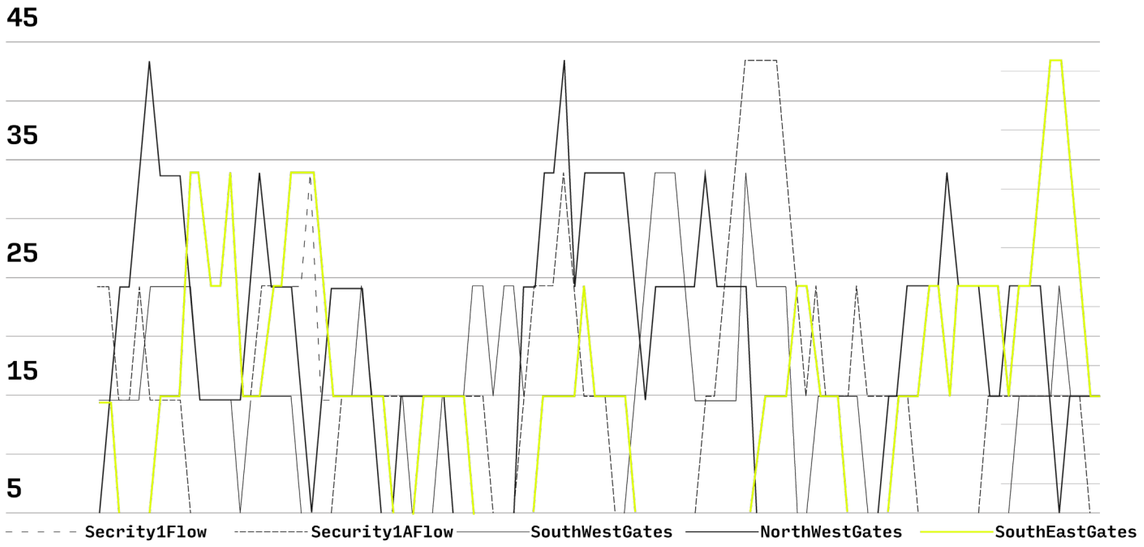


Figure 18 – *3rd floor Pedestrian Flow Plot Chart*

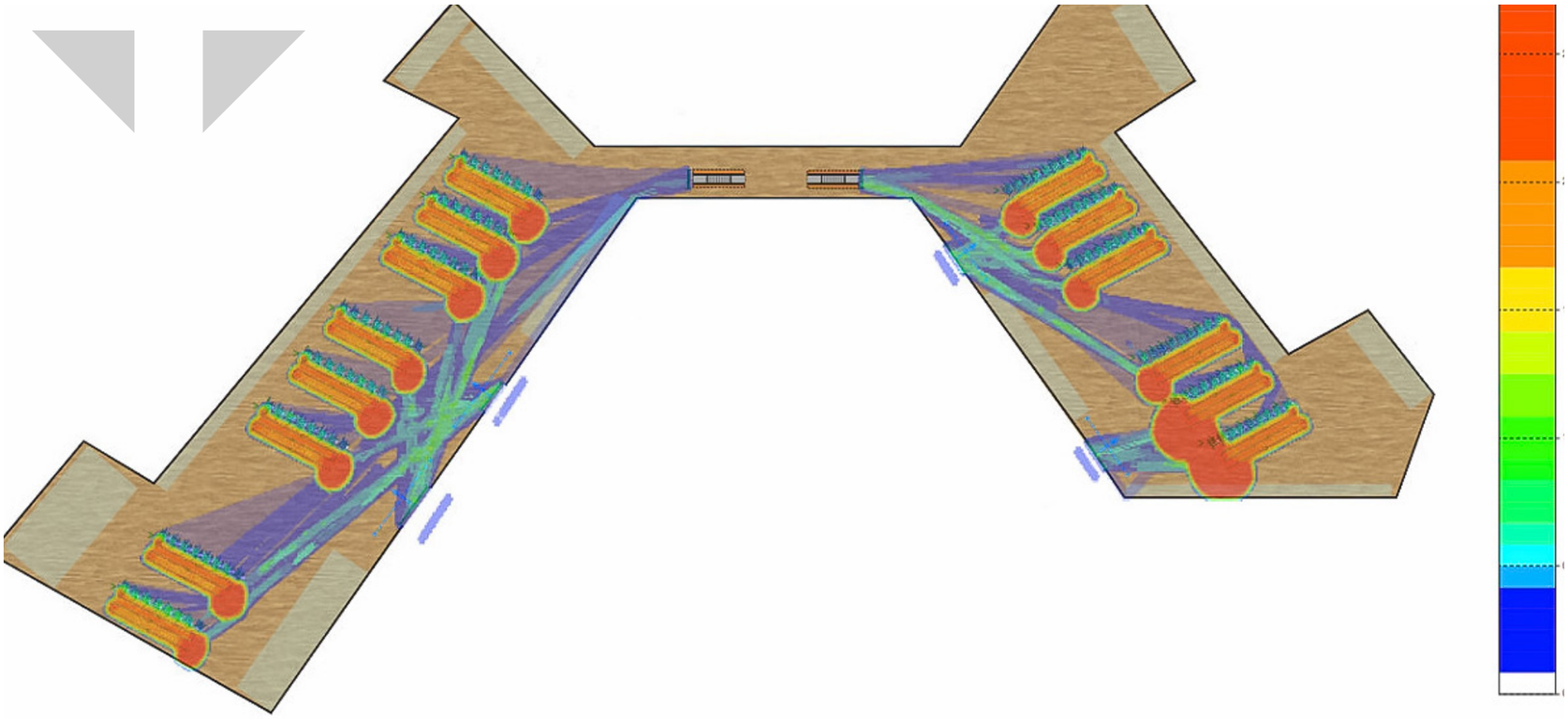


Figure 19 – *4th Floor Pedestrian Density Heatmap*

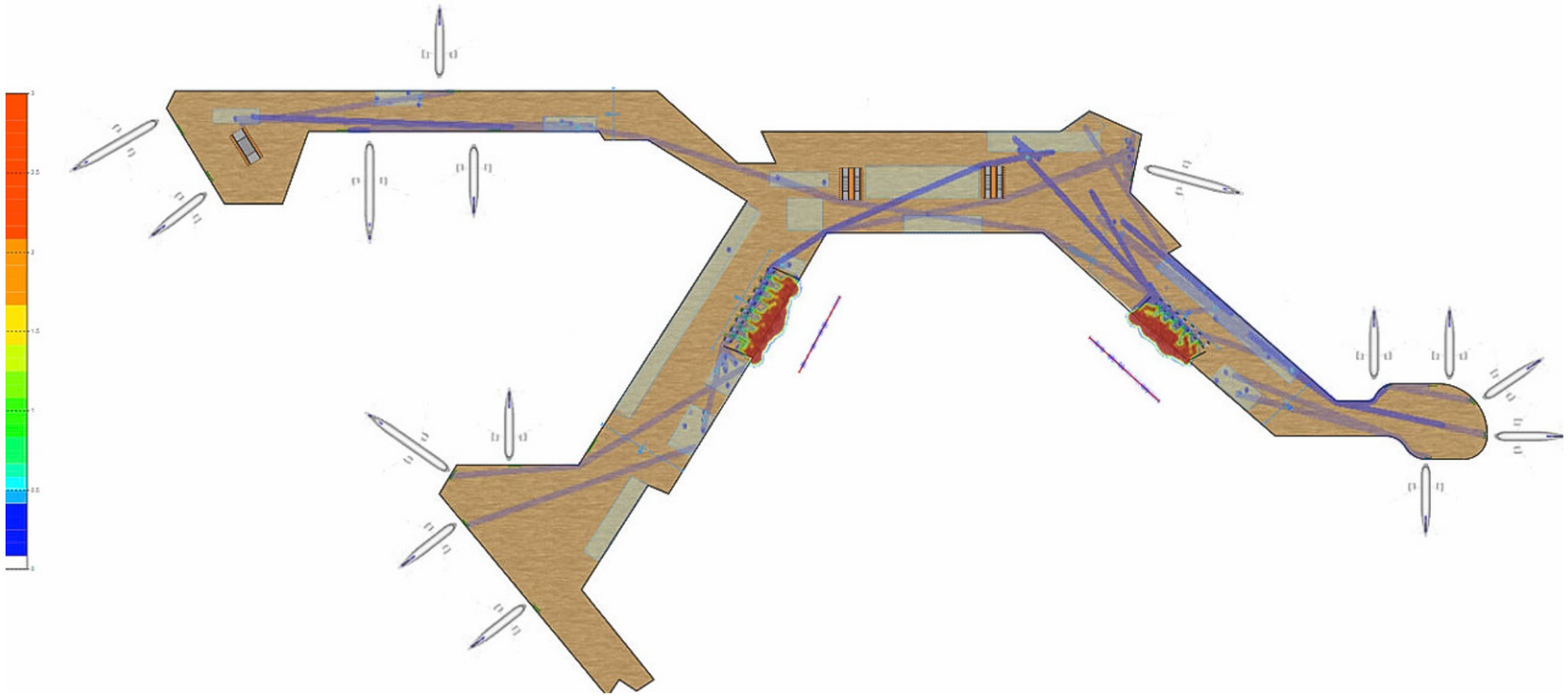


Figure 20 – *3rd Floor Pedestrian Density Heatmap*

12 Hours

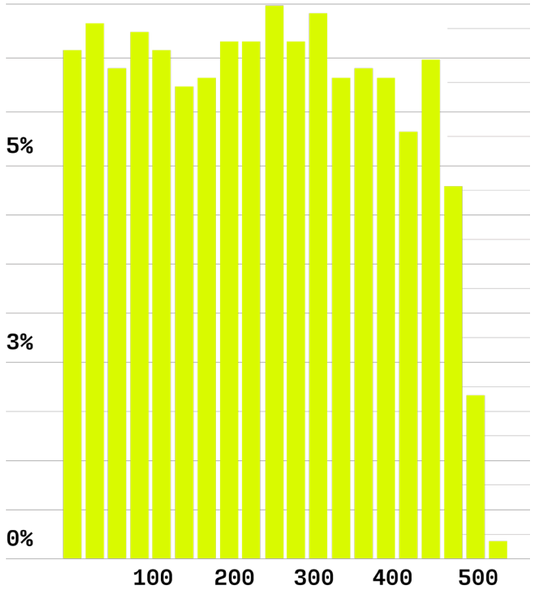


Figure 21 – East wing Check-in 4th floor Histogram

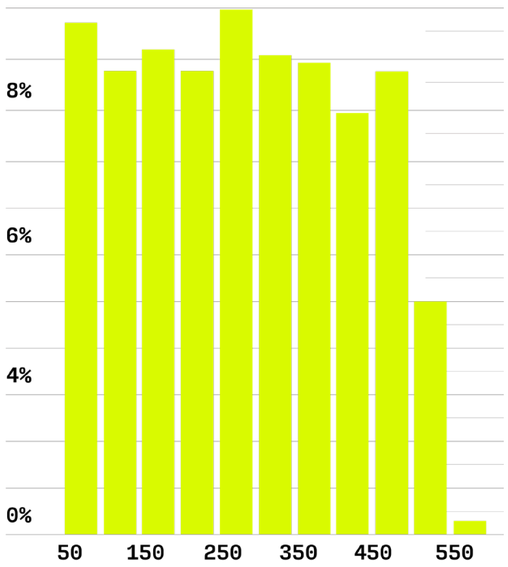


Figure 22 – West wing Check-in 4th floor Histogram

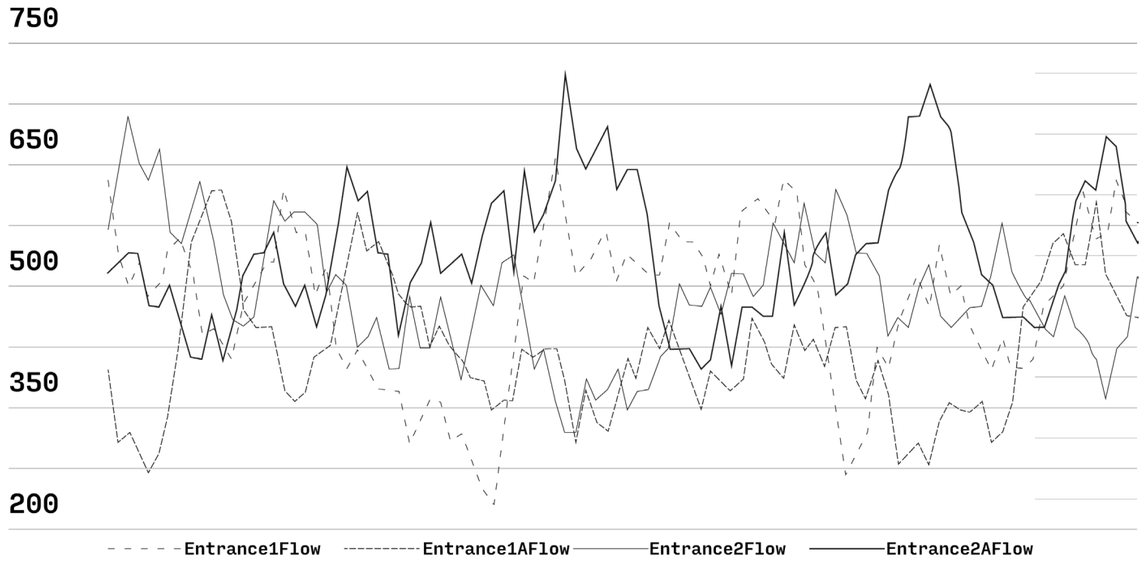


Figure 23 – 4th floor Pedestrian Flow Plot Chart

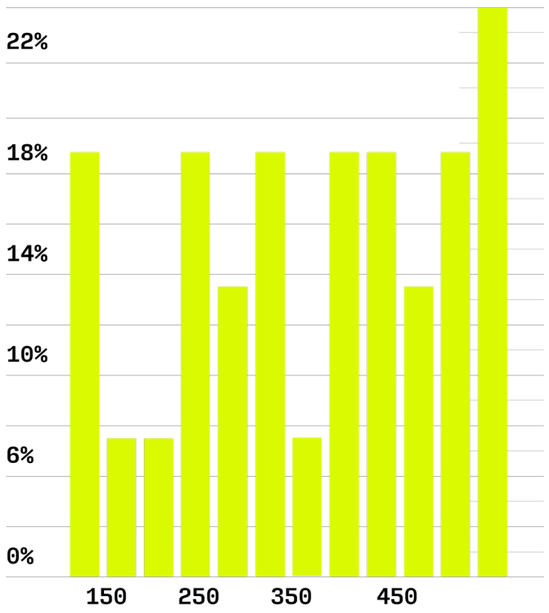


Figure 24 – East wing Check-in 3rd floor Histogram

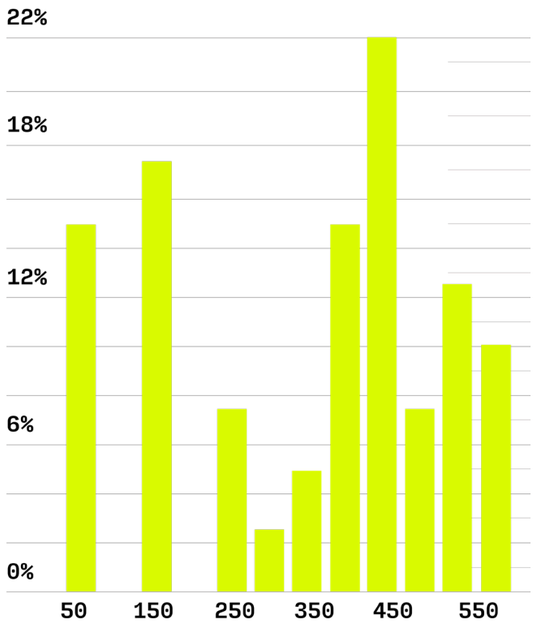


Figure 25 – West wing Check-in 3rd floor Histogram

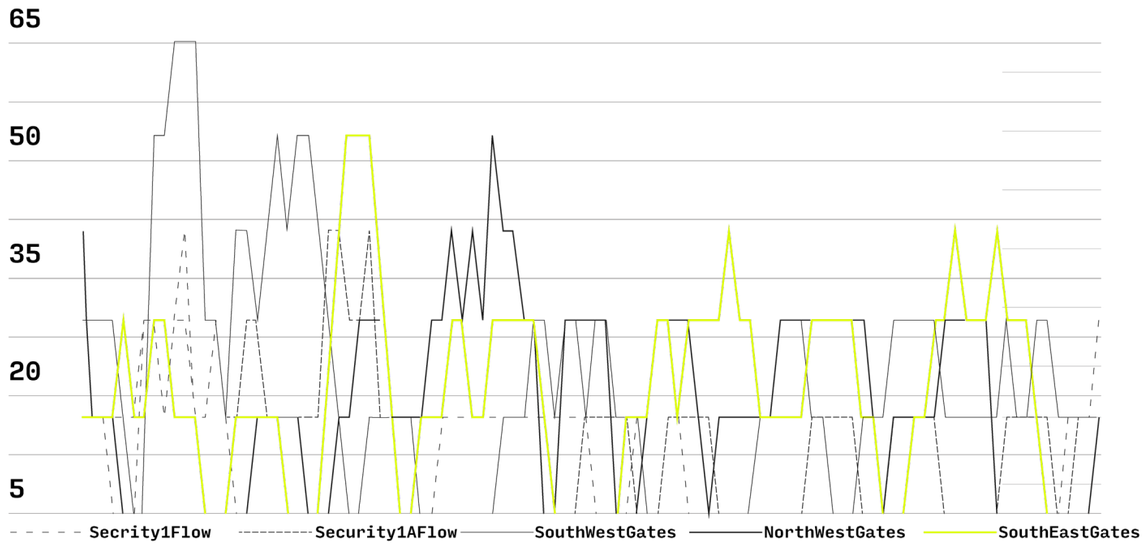


Figure 26 – 3rd floor Pedestrian Flow Histogram

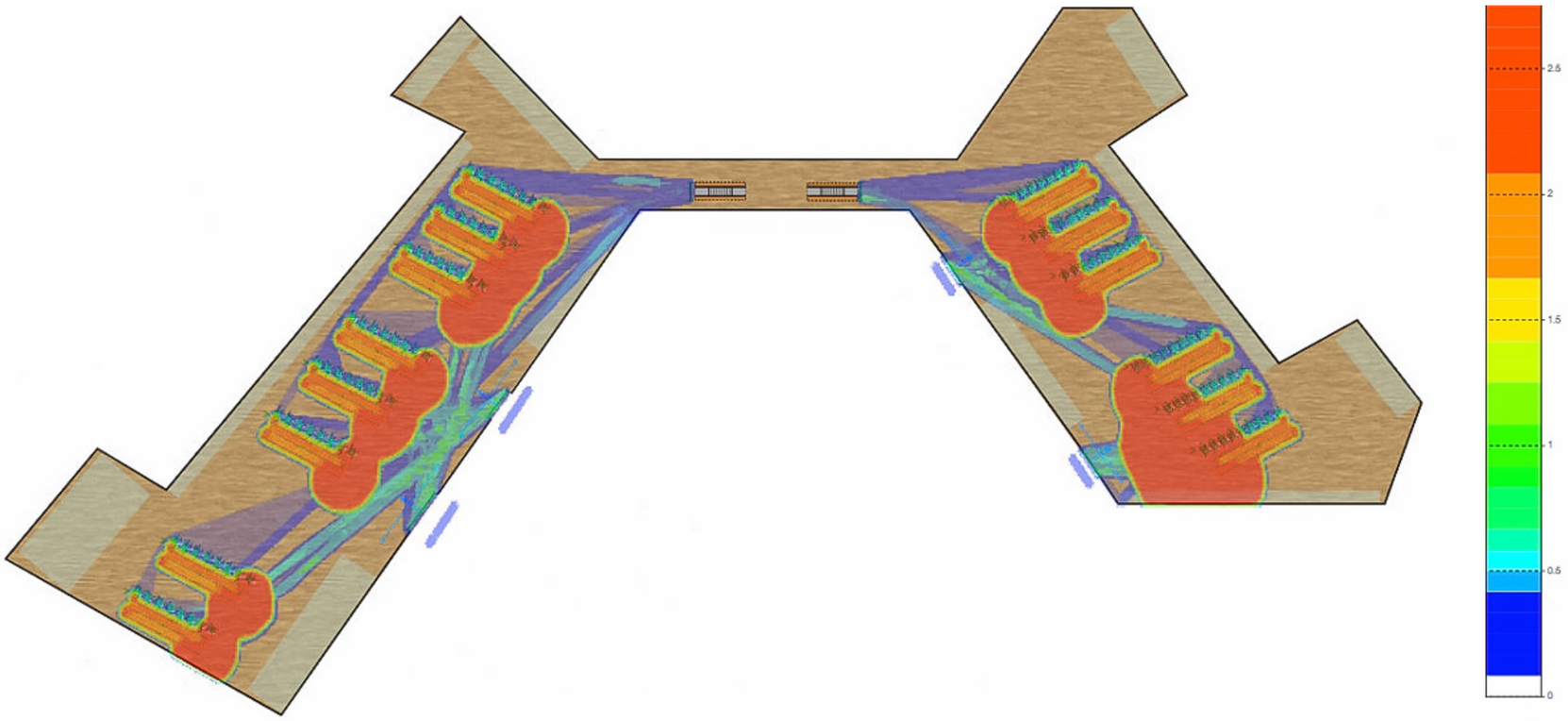


Figure 27 – *4th Floor Pedestrian Density Heatmap*

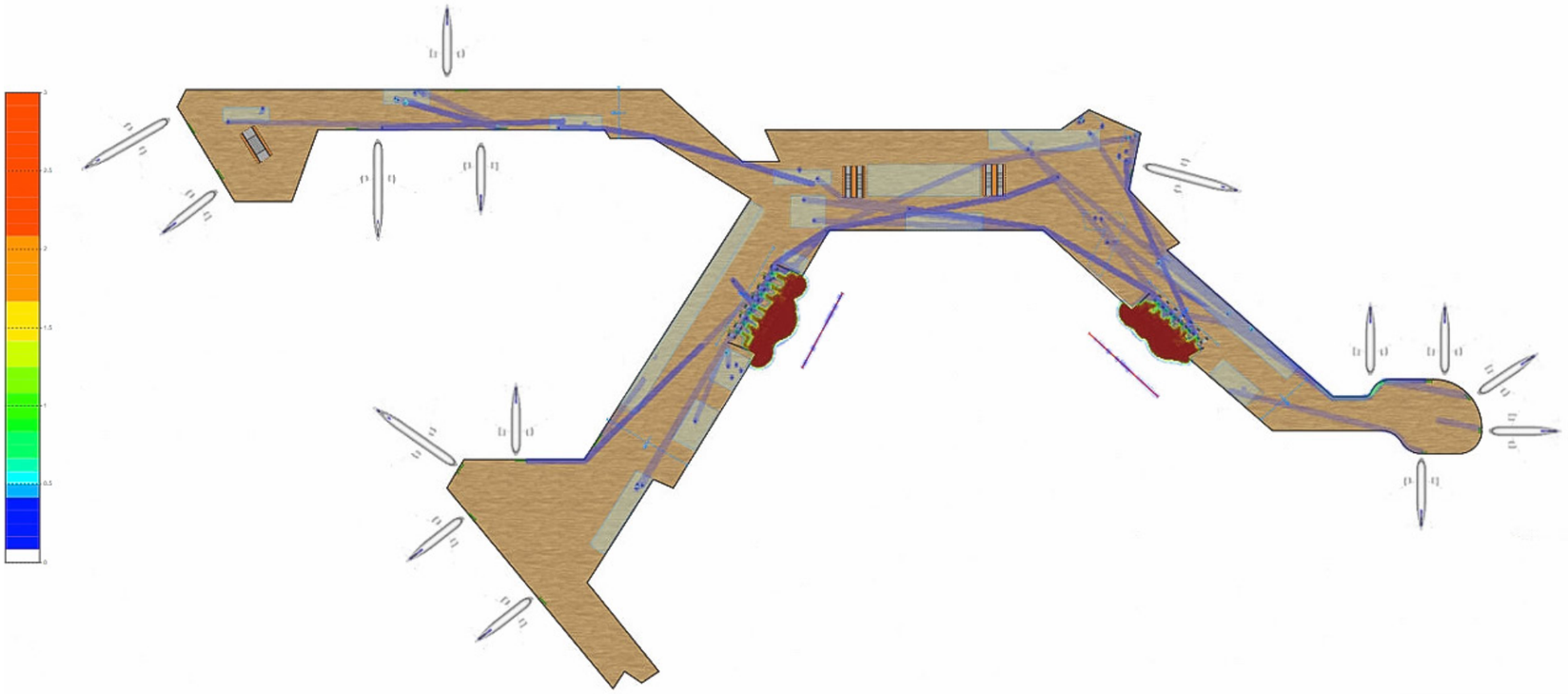


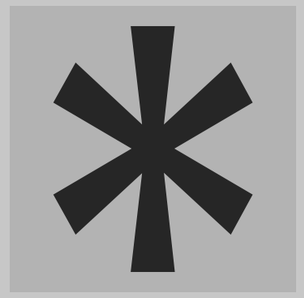
Figure 28 – *3rd Floor Pedestrian Density Heatmap*

Analysis

/* Looking at Narita Airport’s schematic layout, it is clear that Narita Airport wants to separate its function into different levels.

The advantage is that it creates much space for that specific program to function well and not interfere with each other.

However, this could be confusing from a typical passenger’s perspective. The distance from one checkpoint to another seems far and hard to reach.



/* The result from the simulation re-ensured the problem that it has. Passenger, when they enter entrances, crosses each other paths. When the density is not high, it does not cause many problems. However, when passenger density is high, people start to bump into each other and cause inconvenience.

/* The other problem that can be seen is the passenger density at the check-in counter on the 4th floor and the security screening on the 3rd floor. At the time of the research, Narita airport does not imply a wide use of automation machines for this procedure. As a result, the manual labour involved in these processes is still quite high. One needs to interact and exchange when checking in and getting tickets at the counters through the long serpentine line.

/* The security screening process is constricted in a relatively small area compared to the airport's size.
This confined space makes the security screening process difficult and lengthy.
As reflected on the passenger density heatmap (Figures 19-20, 27-28) and the plateau on the flow statistic plot chart (Figures 18, 26), the queue for this process is lengthy and not smooth.

SUMMARY

/* In summary, Narita International Airport proved why it is one of the top airports in the world. The number of annual passengers it serves makes it very efficient and laid out. Nevertheless, with that being said, it still has some kinks within the system.

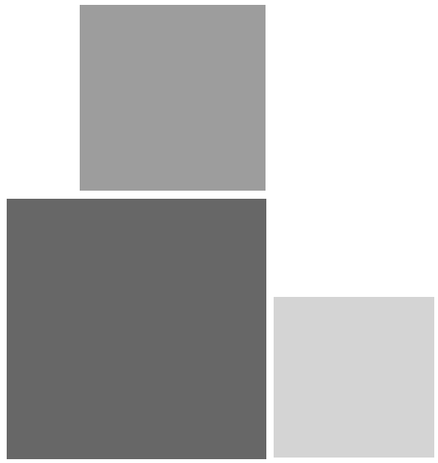
It needs more transparency for airline passengers travelling. The fact that passengers must travel from floor to floor to get to another checkpoint causes confusion and anxiety in travelling.

Areas such as check-in counters and security screening are common choke points for that floor. With human labour still in charge of most of the process, it takes much space to do it well.

Automation can be used to optimize this process and bring more efficiency into the process chain. Security screenings are the biggest problem, according to this simulation data. In addition, the queue and process time are lengthy, slowing the experience for a typical passenger. These areas need to increase in size and open up to keep up with the demands. However, an increase in size would not solve the problem when it happens again down the road.

Again, automation can help out this process and make this more efficient. A change in the operating system can also improve this, such as screening via cameras and pre-check-in for domestic passengers.

Implication



These simulation data are not guaranteed 100% accuracy, but it informs what is working and what is not.

These are the important key ideas when looking at this research.

Heading into the thesis design project, armed with this knowledge and data, would not only help inform better design choices. For example, floor plans can be quickly formed and re-created within the software. In addition, the system performance can be simulated and tweaked on the spot.

The more understanding one can get from the data, better design choices can be made down the road.