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# Math Modeling Contest: Optimized Plan to Leave the Louvre

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# Introduction

The Louvre Museum, with five levels of extraordinary art work, hosts thousands of people on a daily bases. In the case of an emergency, the workers need to know the fastest way to get the visitors out of the Louvre.



# Evacuating the Louvre

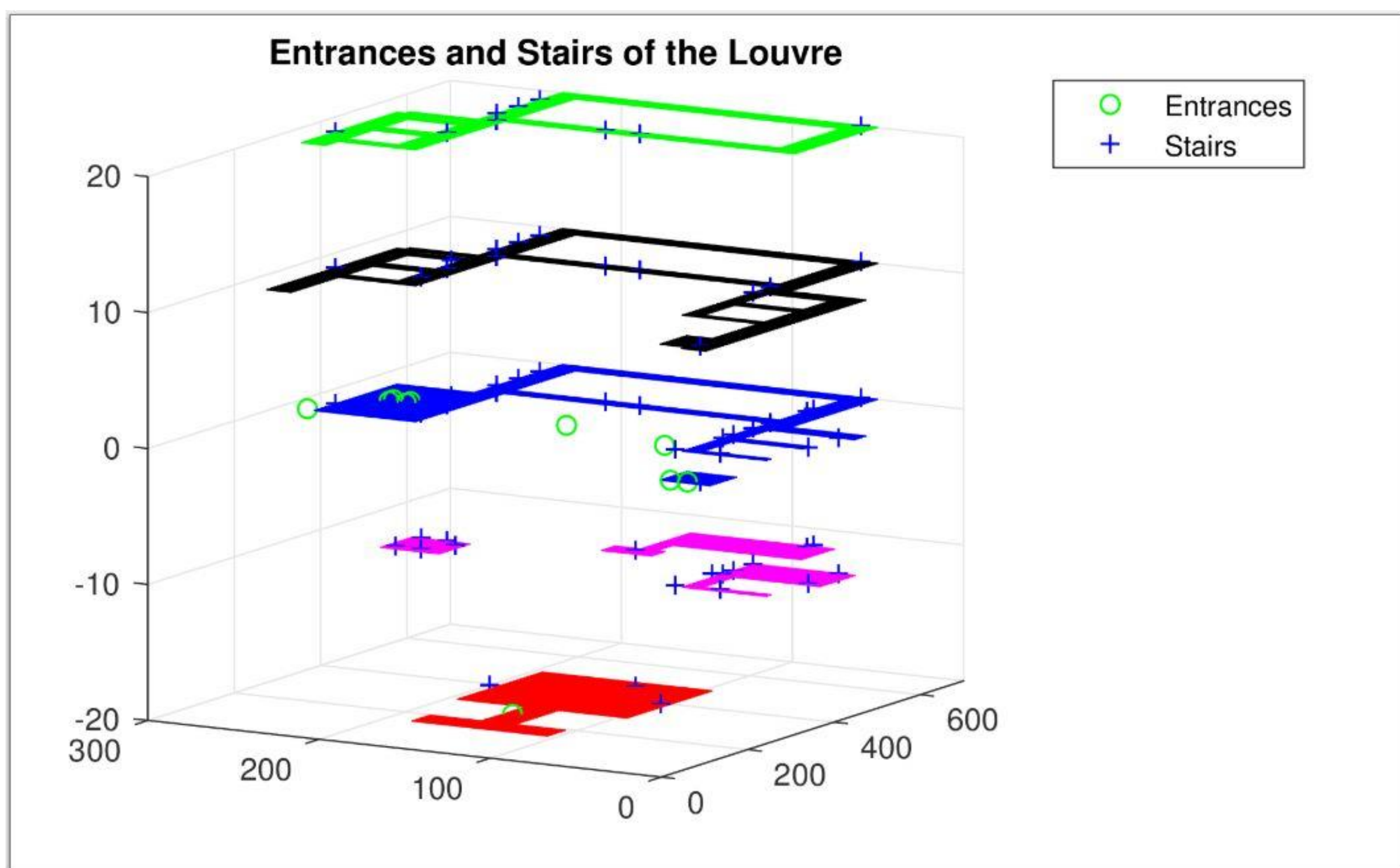
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## Results

- Broke the Louvre up into different nodes
- Found equations connecting the nodes
- Walking speeds were found
- Three models were made with slight variations



**Model 3:** Fastest model as it reduces the bottlenecks at high density nodes by rerouting half of the guests in Mona Lisa's node through a different exit pathway. Total time 20 minutes



**Figure 1** The general layout of the Louvre along with the locations of stairwells and exits.

Nodes	Floor	Wing
A	Neapolitan Hall	NA
B	Lower Ground Floor	Denon
C	Lower Ground Floor	Sully
D	Lower Ground Floor	Richelieu
E	Ground Floor	Denon
F	Ground Floor	Denon
G	Ground Floor	Richelieu
H	Ground Floor	Sully
I	First Floor	Richelieu
J	First Floor	Denon
K	First Floor	Sully
L	2 <sup>nd</sup> Floor	Richelieu
M	2 <sup>nd</sup> Floor	Sully

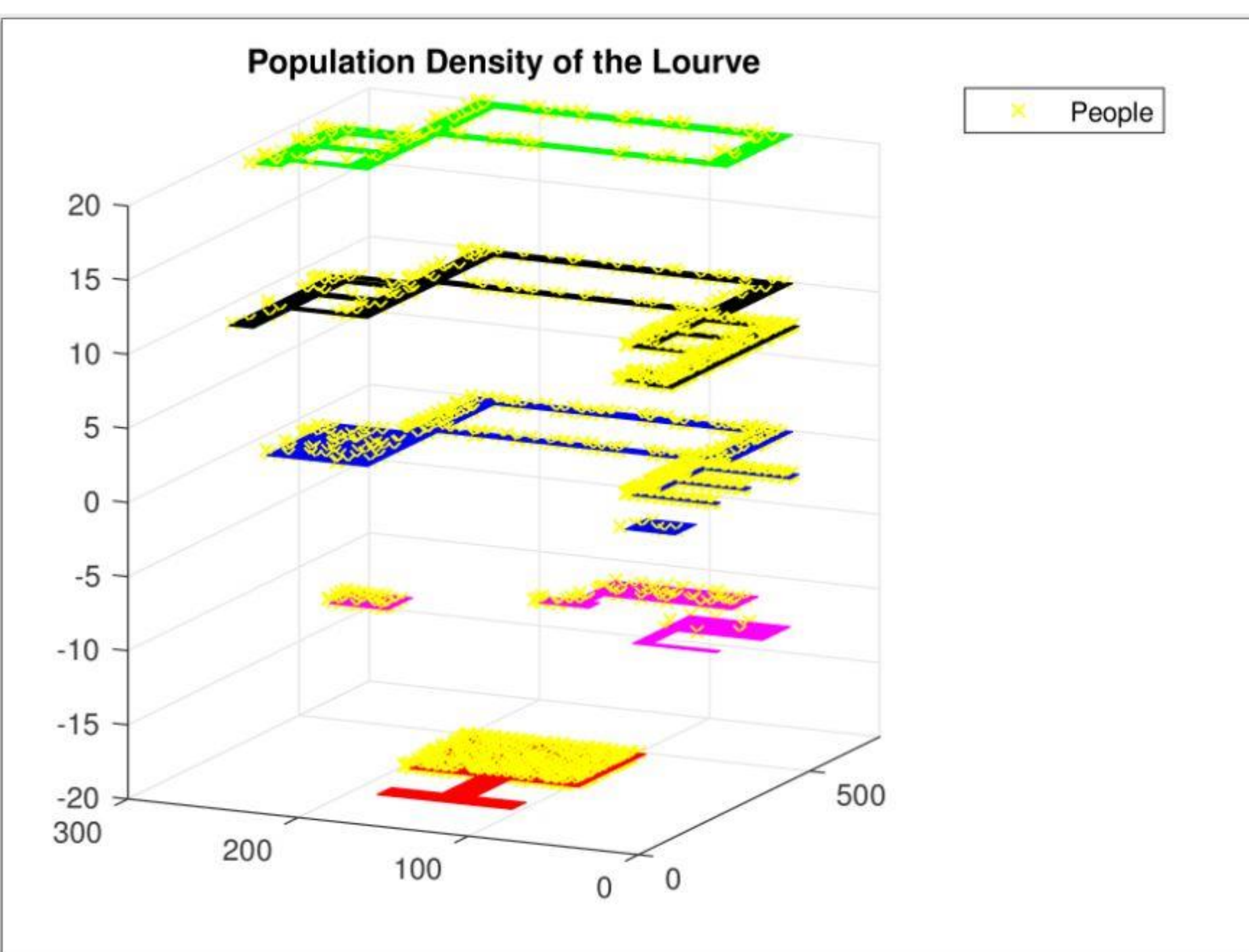
**Table 1:** The location of each node given the floor and wing.

Nodes	A	B	C	D	E	F	G	H	I	J	K	L	M
Value of $P$	0.67	0.45	0.50	0.83	1	1	1	0.37	0.97	0.28	0.36	0.83	0.90
Value of $P'$	0.56	0.25	0.18	0.56	1	1	1	0.37	0.66	0.09	0.36	0.56	0.61

**Table 2:** The general walking speed of people in high density populations for each node.

**Model 1:** Visitors exit according to the shortest distance. This is the simplest model. Total time 43 minutes

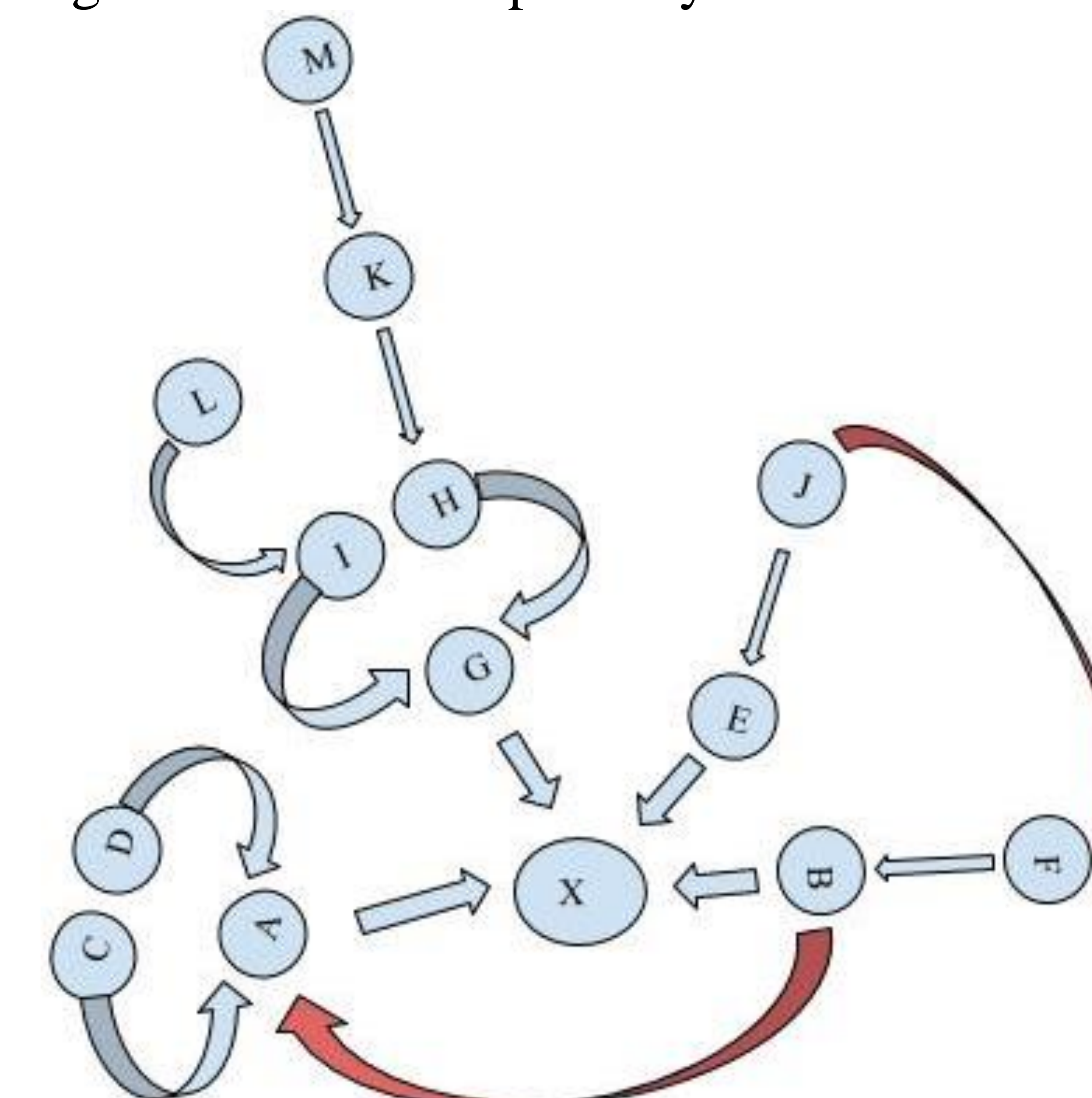
**Model 2:** Accounts for the high density of guests that surround the *Mona Lisa* and reroutes the guests outside of this node around it. Total time 38 minutes



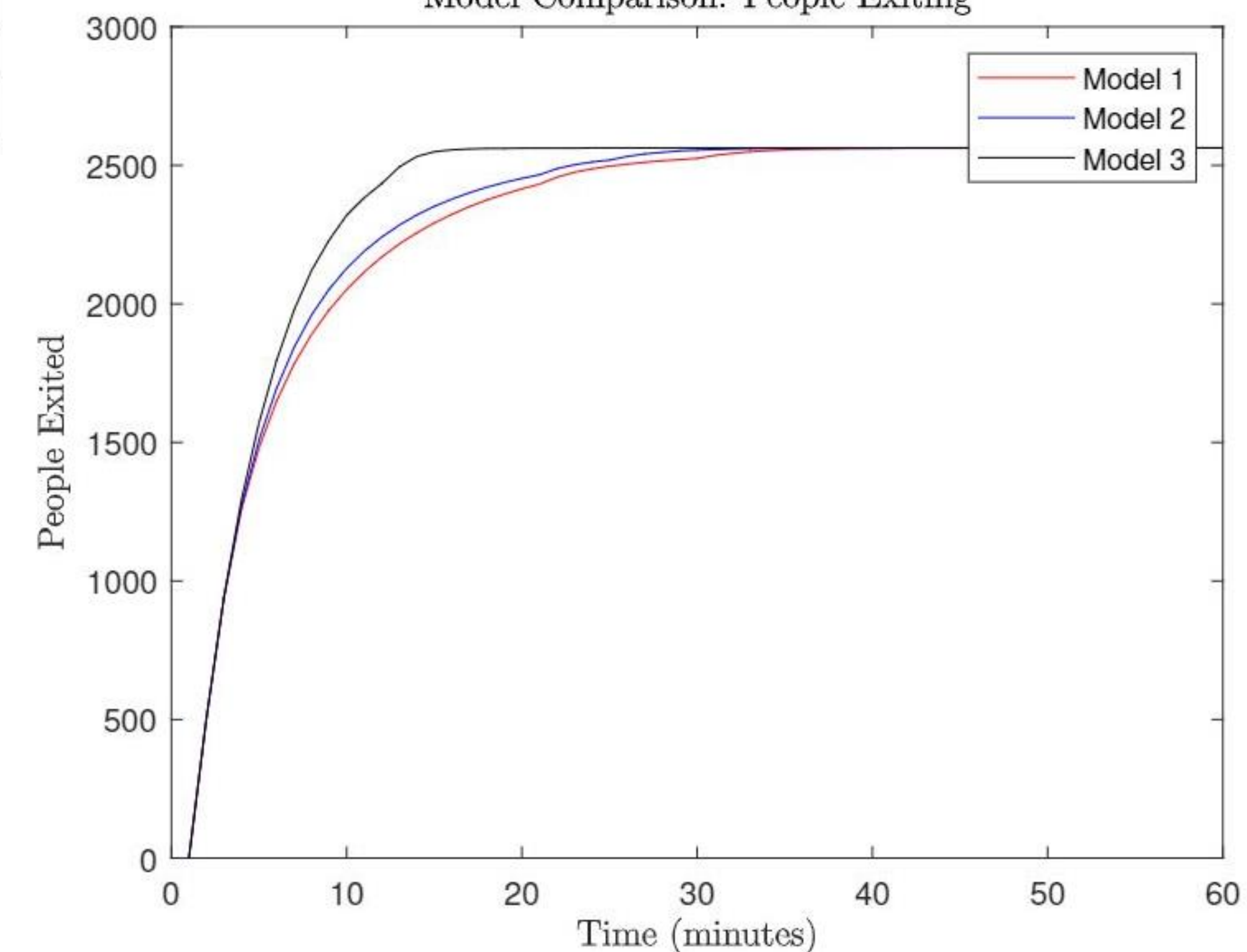
**Figure 2:** The general layout of the Louvre along with the general distribution of the visitors.

## Goals

- Come up with an evacuation plan
- Identify bottlenecks
- Find a way around bottlenecks
- Identify the fastest escape route for visitors
- Come up with a way to break through the language barrier



Model Comparison: People Exiting



## Conclusion

- There were bottlenecks on nodes B, J, and K
- Model 3 if the fastest with a time of 20 minutes
- Use the Louvre app to help get through the language barrier

