Collective Dynamics

Evacuation from Cramped Interiors with Aisle Seats: Supplementary Material

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This document contains the supplementary material for the submitted contribution *Evacuation from Cramped Interiors with Aisle Seats: Uncertainty Induced by the Random Choice of Initial Positions*. We provide a clarification on the total number of simulations as well as a brief convergence analysis to show that the estimates of average TET are not burdened by a high degree of uncertainty. Additionally, the following graphs are included to complete the graphs shown in Fig. 2 of this contribution.

- Potential energy – Total evacuation time (TET)
- Interaction energy – Total evacuation time (TET)
- Potential energy – Interaction energy
- Predicted total evacuation time (TET) – Actual total evacuation time (TET)

The total evacuation time (TET) was obtained as an average of 10 simulation runs with the same parameters but randomized initial orientations and priorities. The potential and interaction energy were calculated via Eq. 2 and Eq. 3 of the submitted contribution, respectively. The predicted TETs were obtained separately for each ratio value, using the linear regression model defined by Eq. 4 of the submitted contribution.

The data necessary for reproducing the presented graphs are available in the attached file `data_content.csv` and described in `data_description.txt`. Pathfinder input files containing the simulated geometry and individual occupation configurations can be provided upon request.

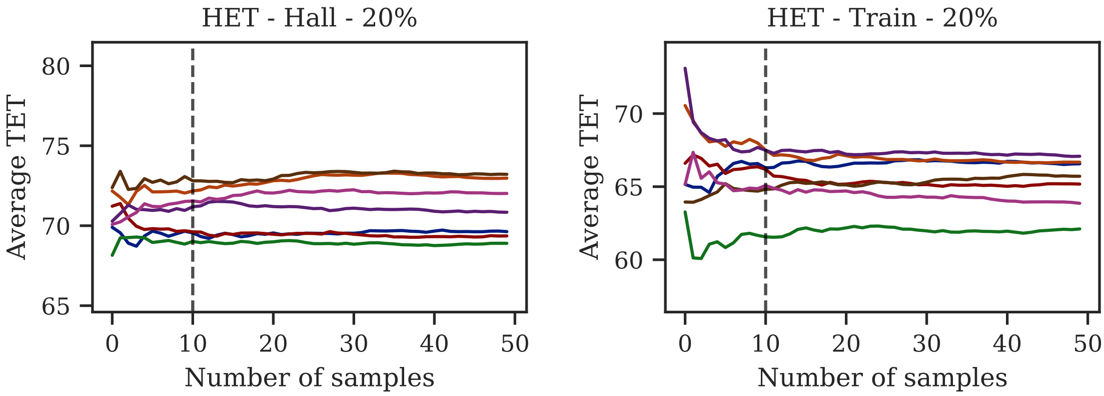
A Note on the Number of Simulations

As was noted in the main article, for each of the two geometries, each of the HOM and HET groups, and each of the three ratios, 92 distinct occupant configurations were generated and simulated 10 times each with different values of initial orientations and occupant priorities. The values were then averaged to obtain an estimate of $\mathbb{E}[\text{TET}]$. This totals to $2 \times 2 \times 3 \times 92 \times 10 = 11\ 040$ simulator evaluations. With an average time of 5 seconds per simulation, the computational time amounts to approximately 15 hours. There was additionally a control group (CTRL), but its simulation time is negligible compared to the other two as there is no variability in the initial positions or ratios.

The number 92 is an artifact from the probabilistic generator of the occupant configurations. To ensure we cover the ranges of both energy variables, we designed a generation process that is parametrized by an "attraction to the exit" coefficient with a $[-1,1]$ range, which makes it favor configurations with higher or lower average distance to the exit of the WL occupants. We used a 9-level grid for this coefficient and sampled 10 configurations at each level, adding up to 90 configurations. We added the two extreme configurations where the WL occupants are as close as possible or as far as possible to the exit to cover the edge cases manually, hence the number 92. Since there were no substantial "gaps" in the ranges of either of the energies, we considered this enough.

Convergence of Average TET

As mentioned above, to filter out the inherent randomness we simulated each occupant configuration 10 times and averaged. To investigate whether an average of 10 samples is close enough to convergence, we did a smaller-scale comparison between the estimates obtained by averaging 10 runs and 50 runs for different occupant seating configurations. Below are the graphs that illustrate the estimate of average TET based on the number of samples used to compute it for the HET group with 20 % of WL occupants. Computing the average absolute difference $\left|\overline{\mathrm{TET}}_{10} - \overline{\mathrm{TET}}_{50}\right|$ of the estimate obtained by 10 samples and the estimate obtained by 50 samples we obtain the value (0.37 ± 0.28) s for the lecture hall geometry and (0.41 ± 0.31) s for the train geometry, which we deemed small enough for the purpose of this contribution.



(a) (b)

Figure 1 Scatter plots of Potential Energy – Total Evacuation Time relation.

Potential Energy – Total Evacuation Time (TET)

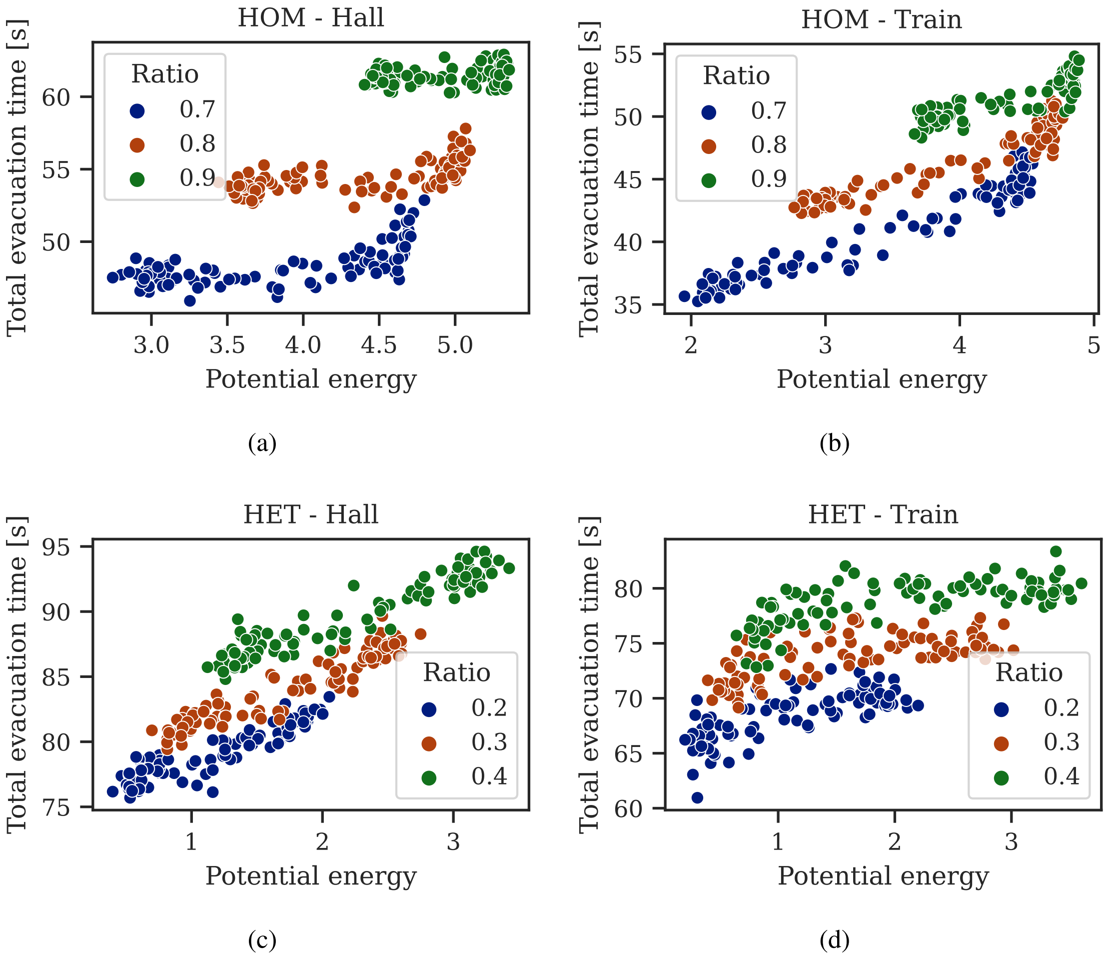


Figure 2 Scatter plots of Potential Energy – Total Evacuation Time relation.

Interaction Energy – Total Evacuation Time (TET)

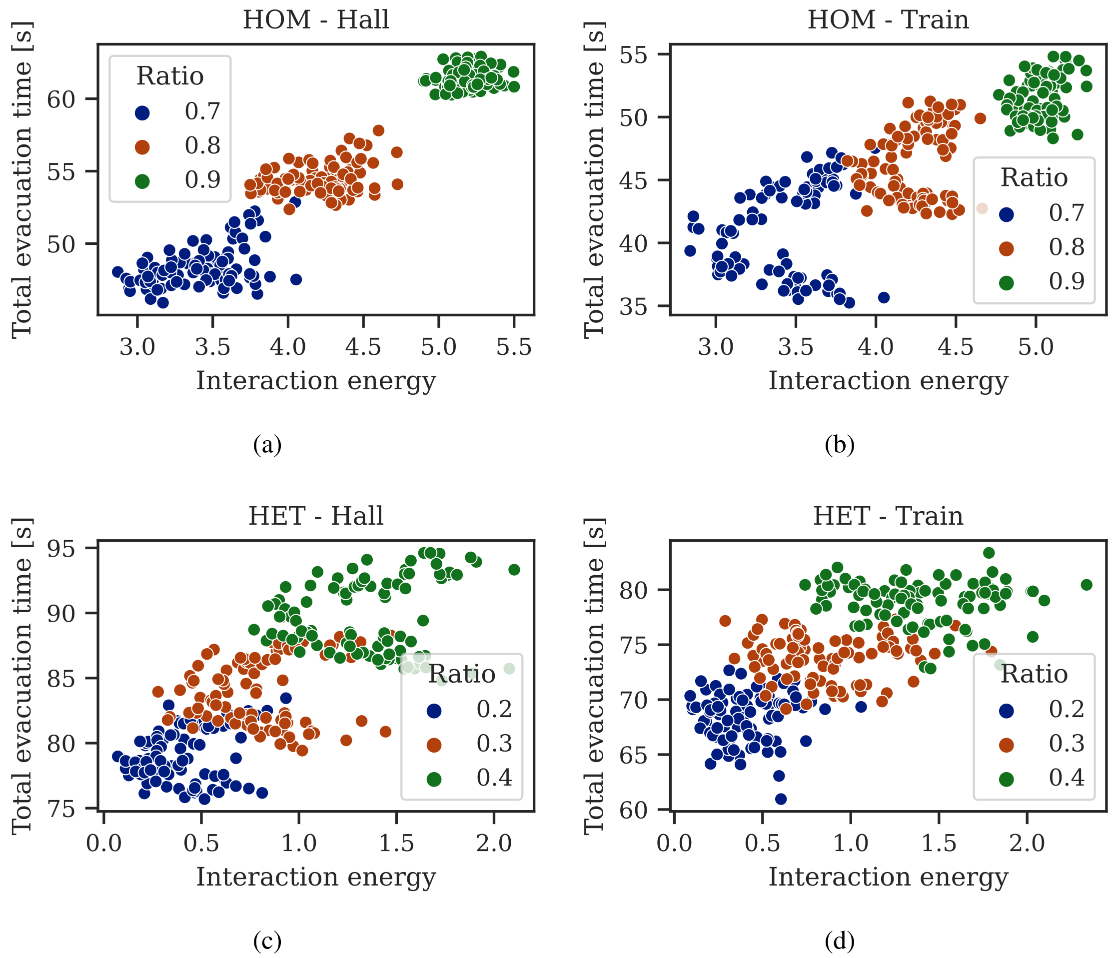


Figure 3 Scatter plots of Interaction Energy – Total Evacuation Time relation.

Potential Energy – Interaction Energy

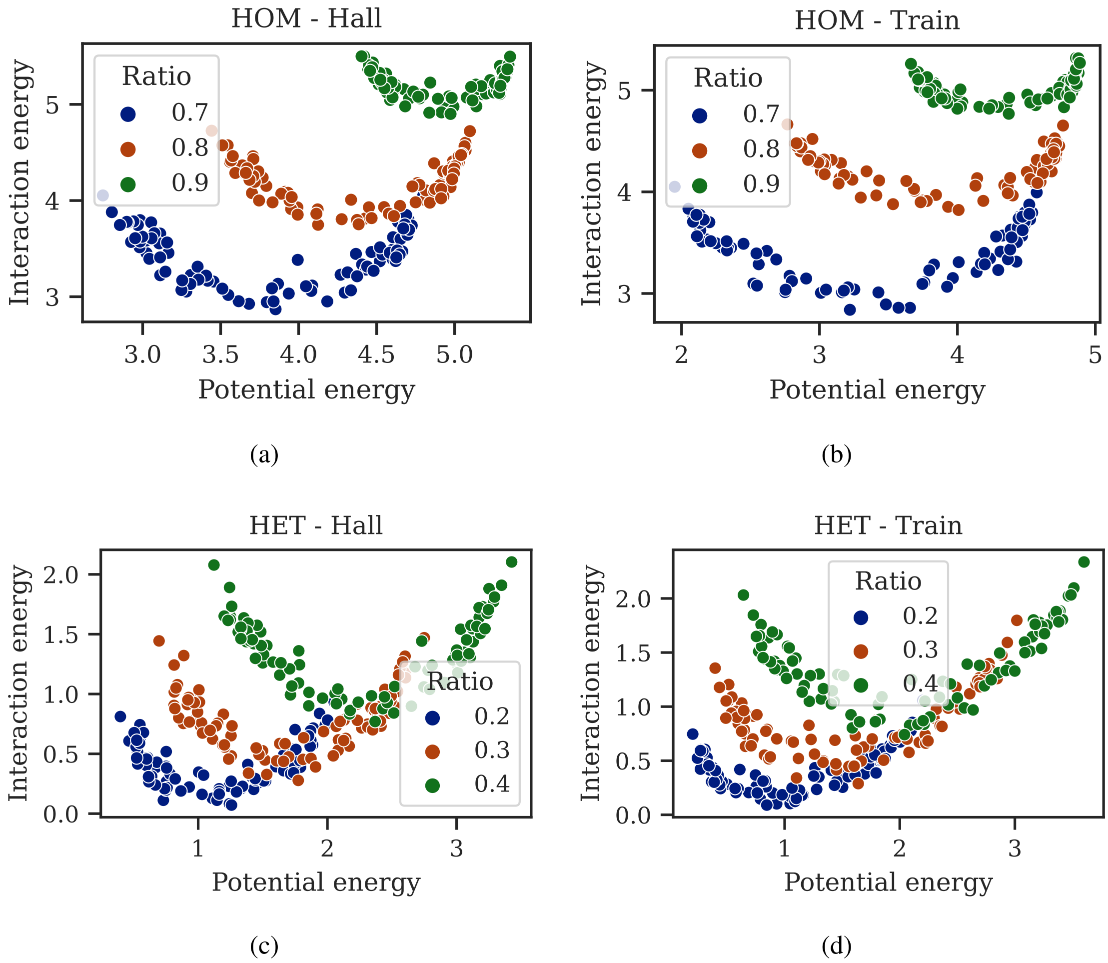


Figure 4 Scatter plots of Potential Energy – Interaction Energy relation.

Predicted Total Evacuation Time (TET) – Actual Total Evacuation Time (TET)

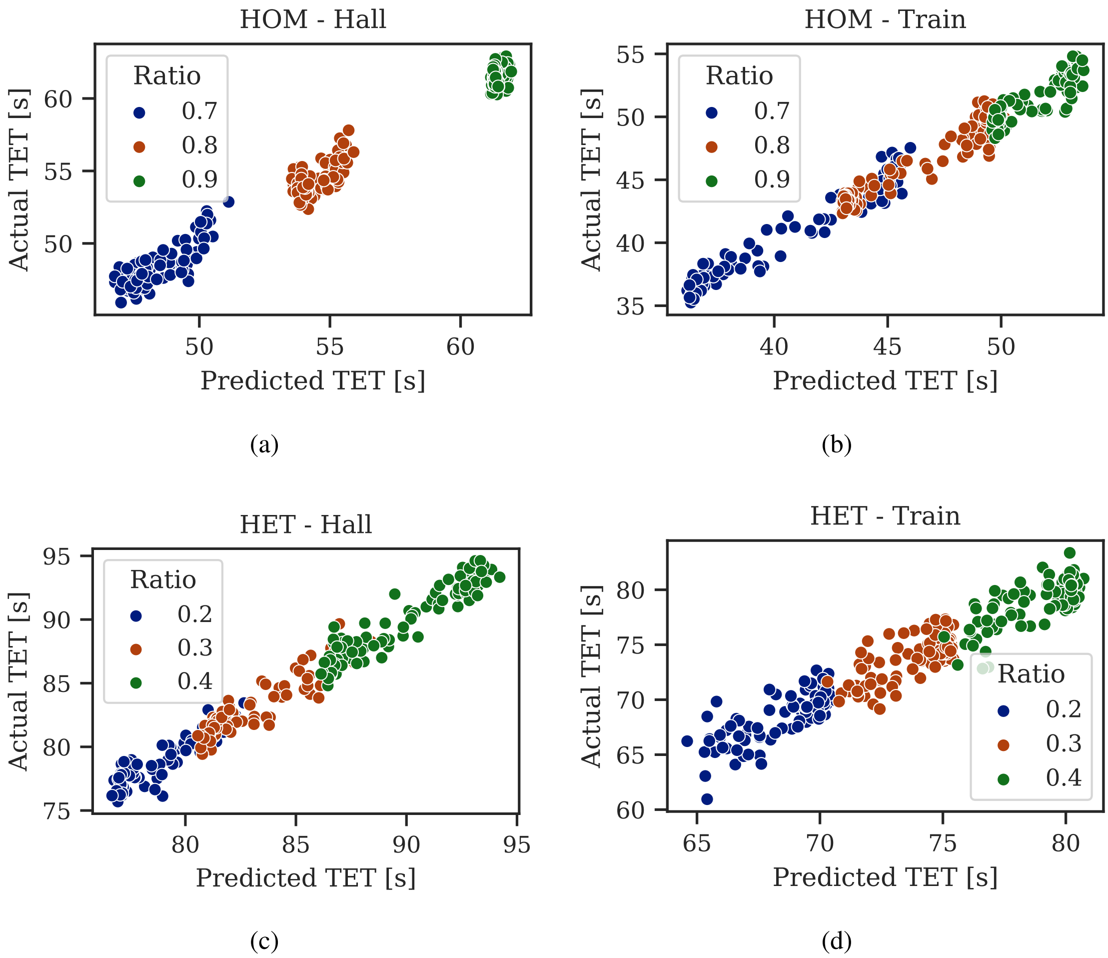


Figure 5 Scatter plots of Predicted TET – Actual TET relation.