# Supporting Information of "Route-dependent switch between hierarchical and egalitarian strategies in pigeon flocks"

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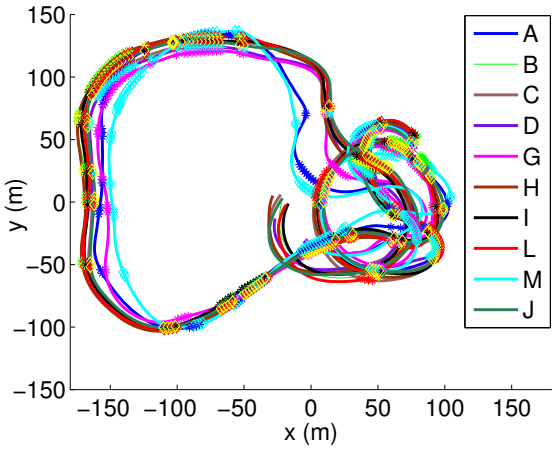


Figure S1: Two-minute trajectories segment from a free flight performed by a flock of ten pigeons. Here, sampling period $T_s = 0.2s$, and the labels $\{A, B, C, D, G, H, I, L, M, J\}$ represent the sequential numbers of all the ten pigeons. The marks along the trajectories denote the sudden turn points with curvatures larger than 0.09.

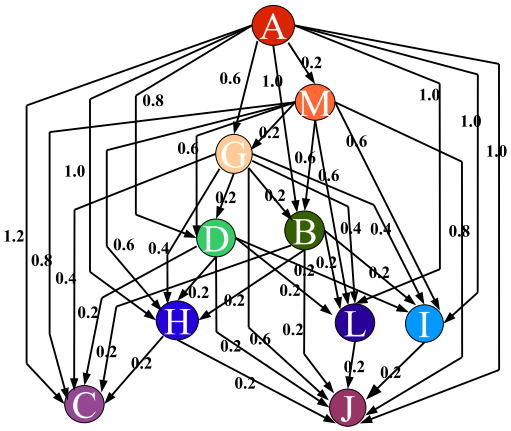


Figure S2: The corresponding HLN topology of the flight shown in Fig. S1. For each pairwise comparison, the directed connection points from the leader to the follower. Numbers associated with links are the corresponding time-delays (in seconds). There is no clear directional relevance for unconnected pigeon pairs.

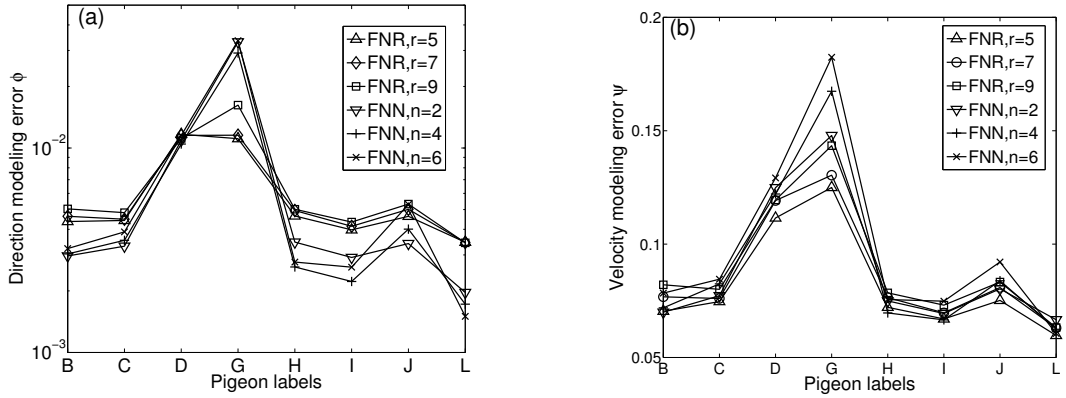


Figure S3: (a) and (b) show the influences of parameters $r$ and $n$ on $\phi_i$ and $\psi_i$, respectively. The observation suggests that the results are insensitive to $r$ and $n$, verifying the robustness of the results presented in Fig. 2 of the main body.

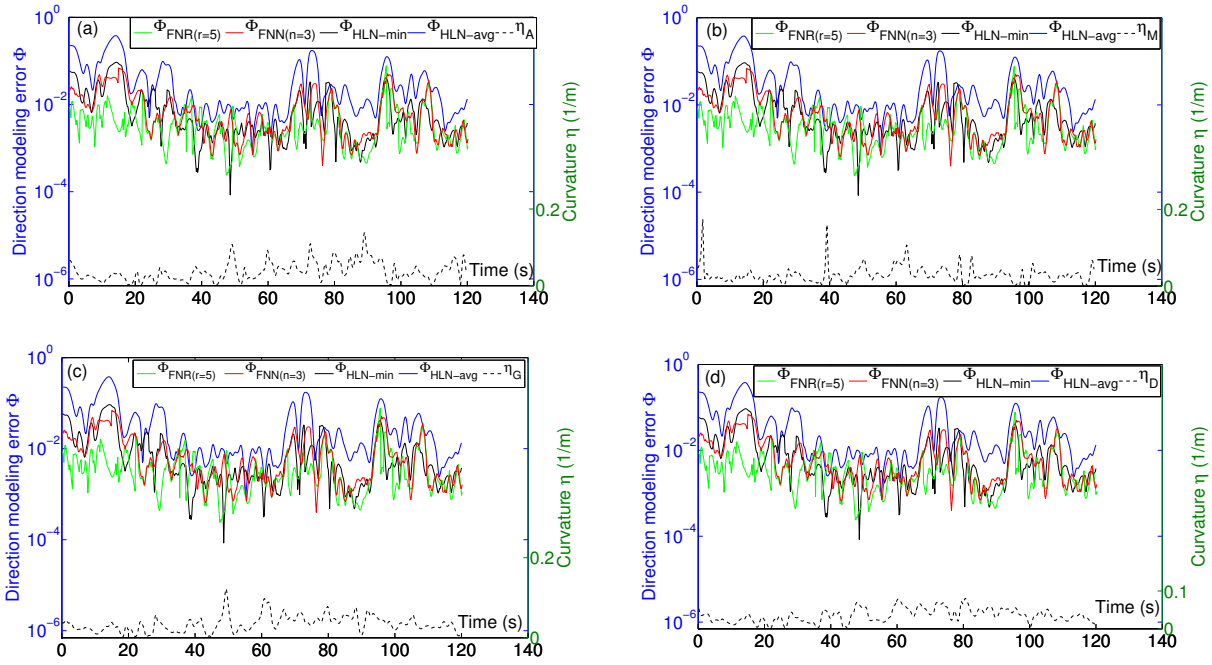


Figure S4: Temporal evolutions of modeling errors $\phi$ under the FNR/FNN and the HLN patterns, respectively. Evidently, some HLN-dominating temporal segments match the peak values of the curvature curves $\eta_A$ (subfigure(a)), $\eta_M$ (subfigure(b)), $\eta_G$ (subfigure(c)) and $\eta_D$ (subfigure(d)) nicely, supporting the conclusion that pigeons tend to follow their leaders instead of neighbors when suffering sudden turns.

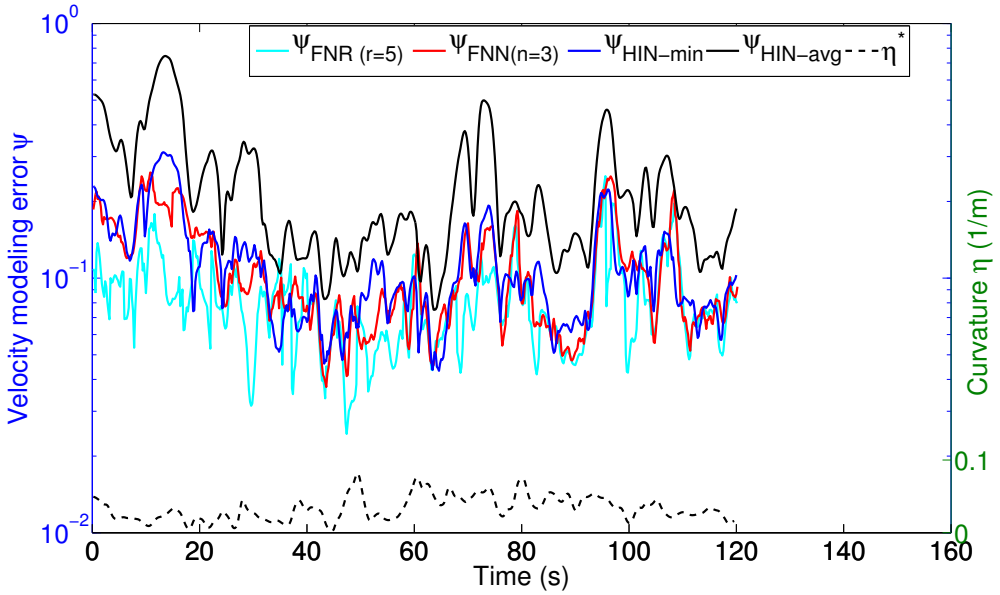


Figure S5: Temporal evolutions of modeling errors $\psi$ under the FNR/FNN and the HLN patterns, respectively. Here, $\psi = \frac{1}{8}\sum_{i\in\{B,C,D,G,H,I,J,L\}}\psi_i$. There is no clear relationship between the performance of HLN and the average curvature $\eta^*$ of all the follower pigeons under investigation. The reason is that the HLN is not suitable to characterize the velocity modulus evolution. Moreover, FNR/FNN generally outperform HLN in modeling velocity evolution. Results for individual pigeons are similar. These results support our conclusion that each pigeon should consider the speeds of its neighbor(s) when deciding how fast it should fly.

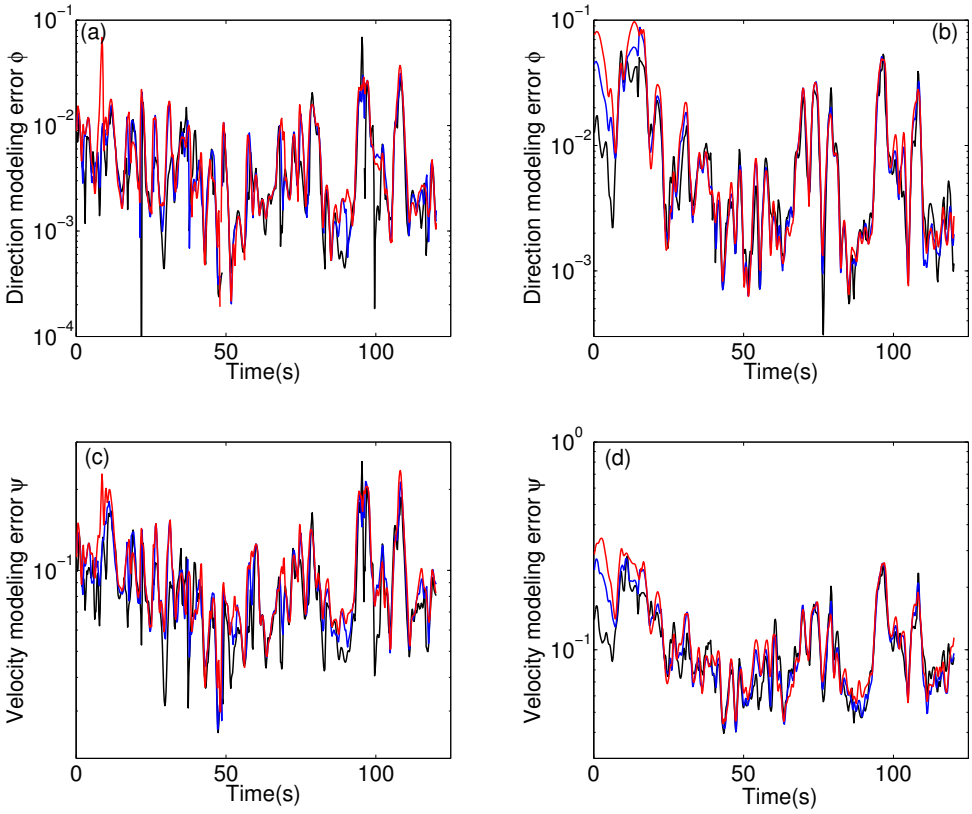


Figure S6: Temporal evolutions of modeling errors of FNR/FNN with different parameters. In (a) and (c), black, blue and red curves denote $r = 5, 7, 9$, respectively; in (b) and (d), black, blue and red curves denote $n = 2, 4, 6$, respectively. The profiles of the curves do not change much under different parameters, indicating the robustness of our results.

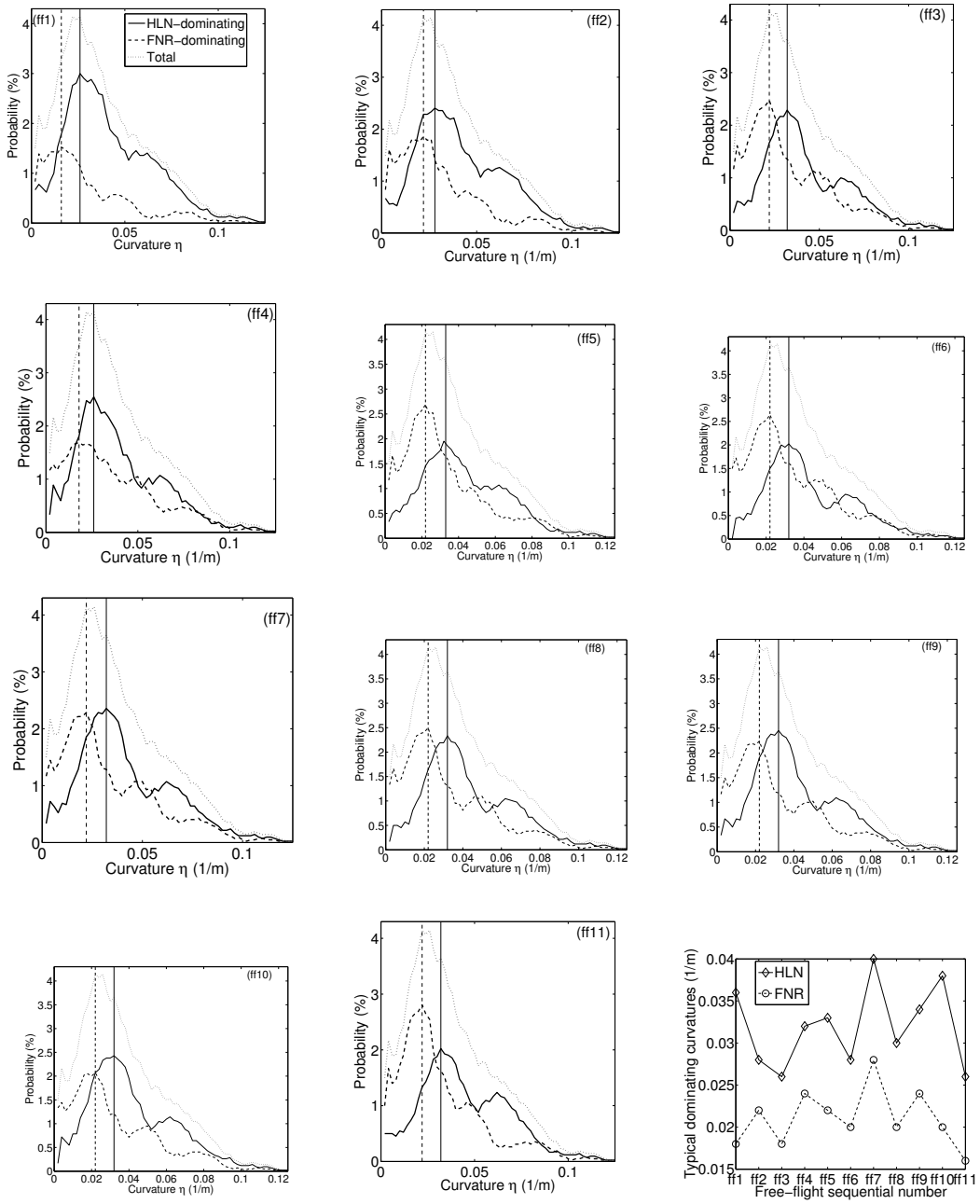


Figure S7: Each of the first 11 plots displays probability density function of curvatures (dotted line) as well as the fractions of HLN-dominating cases (solid line) and FNR-dominating cases (dashed line), with the same organization to that of Fig. 5. The 11 plots correspond to 11 experiments for free flights (ff) of pigeons, and thus are labeled from ff1 to ff11. The peaks of HLN-dominating and FNR-dominating curves are emphasized by a solid vertical line and a dashed vertical line, respectively. These two values are named as typical dominating curvatures for HLN and FNR, respectively. The last plot summarizes the typical dominating curvatures for all 11 experiments, showing a strong evidence that FNR typically works better for small-curvature cases while HLN does better for large-curvature cases.