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We uploaded three C++ codes and two MATLAB codes. CCmodel.cpp is used for Gillespie simulation of multiple kinesins and dyneins; CCmodel\_ 1v1.cpp is used for Gillespie simulation of single kinesin and single dynein; TOW\_model.cpp is used to simulate the TOW model. The analytical\_approximation.m corresponds to Chapter 3 of SI; The mean\_field\_approximation.m corresponds to Chapter 4 of SI.

If you need to get the data of Fig.2, you should run the CCmodel.cpp and set these parameters: Average\_runlength\_velocity=1, Restart\_from\_the\_origin=0.

If you need to get the data of Fig.3A,B, you should run the CCmodel.cpp and set these parameters: Cooperative=1, Restart\_from\_the\_origin=1.

If you need to get the data of Fig.3C, you should run the CCmodel.cpp and set these parameters: Balance\_probability=1, Restart\_from\_the\_origin=1.

If you need to get the data of Fig.3D, you should run the CCmodel.cpp and set these parameters: Motors\_number=1, Restart\_from\_the\_origin=1, Np\_ini=2, Np\_max=2.

If you need to get the data of Fig.5 Fig.S2 Fig.S3, you should run the CCmodel\_1v1.cpp to get the Simulation data and set these parameters: Fig5=1. Then you need run analytical\_approximation.m or mean\_field\_approximation.m to get the Calculation data.

If you need to get the data of Fig.S1, you should run the CCmodel\_1v1.cpp to get the CC model data and set these parameters: Fig5=1. And you need run the TOW\_model.cpp to get the TOW model data.

If you need to get the data of Fig.S4, you should run the CCmodel\_1v1.cpp to get the Simulation data and set these parameters: FigS4=1-4.

The parameters of code

Max\_time\_of\_gillespie x: the simulation will stop at time x

Max\_cycle\_of\_gillespie x: the simulation will stop after cycling x times

Max\_repeat\_of\_gillespie x: run x times of simulation

Parameter\_is\_random x: 0 means we choose specific parameters; 1 means we choose random parameters.

Restart\_from\_the\_origin x: 0 means when all motors unbind from the microtubule the distance changes to zero; 1 means when all motors unbind from the microtubule the distance do not changes;

Motors\_can\_move\_backwards: 0 means the backward velocity is zero; 1 means the backward velocity is not zero;

Different\_rate x: 0 means that the unbinding rate changes by eqn.2; 1 means that the unbinding rate changes by eqns.S40-S42

Np\_ini: the minimum of

Np\_max: the maximum of

Nm\_ini: the minimum of

Nm\_max: the maximum of

times x: when Parameter\_is\_random=1, the parameters y will change from y/x to y\*x.

Show\_progress\_bar: open the progress bar of the code

Print\_parameters: