Data Generation for Resource Allocation - Details

We simulated device-to-device (D2D) and cellular user equipment (CUE) communications within a specified area. I am mentioning the details below:

1. ***Initialization of Transmitter and Receiver Locations***

The simulation area was defined as a square of specified dimensions, where random locations for D2D transmitters were generated. For each D2D transmitter, a corresponding receiver location was determined within a maximum allowable distance (Dist_TX_RX) to ensure realistic communication constraints. The Cellular User Equipment (CUE) transmitters were similarly placed within the area. The location initialization was performed using the loc_init function, which made sure that the receivers were within communication range of their respective transmitters while maintaining the constraints of the simulation area.

2. ***Feasibility Check for Receiver Locations***

The feasibility of each receiver's location was validated using the Feasible_Loc_Init function. This function ensured that each receiver was within the bounds of the simulation area and maintained the maximum distance constraint from its corresponding transmitter. If the generated location did not meet these criteria, a new location was iteratively generated until a feasible one was found.

3. ***Channel Generation and Path Loss Calculation***

For each simulation sample, channels between transmitters and receivers were generated. The channels were characterized by path loss and multi-path fading effects. Path loss was calculated using the log-distance path loss model, incorporating a path loss exponent (PL_alpha) and constant (PL_const). Multi-path fading was simulated using a Rayleigh distribution, which was applied to each transmitter-receiver pair to account for realistic channel conditions.
The generated channel gains were constrained to avoid unrealistically small values using a lower bound threshold. The ch_gen function was used to create the channel matrices, incorporating path loss and multi-path fading effects. For each channel, the following data was stored:

- ***Channel Gain Matrices****: Representing the channel gains with fading effects for each transmitter-receiver pair.*
- ***Receiver and Transmitter Locations****: The spatial coordinates of D2D and CUE transmitters and their corresponding receivers.*

4. ***Data Generation***

0.1 million samples were generated for the training dataset. Each sample contained channel matrices and corresponding transmitter and receiver locations for multiple channels and D2D users. The dataset was then normalized by taking the logarithm of the channel matrices, followed by standardization using the mean and standard deviation of the logarithmic values.

5. Resource Allocation and Power Configuration

All possible transmission power configurations were generated for D2D users across the specified number of channels using the all_possible_tx_power function. The power configurations were constrained to ensure that no user exceeded the maximum transmission power and that only one user was active at any given time, simulating exclusive channel access.

6. Optimal Power Allocation for LLM Guidance

The channel gains dataset was utilized to find optimal power allocations for maximizing either Spectral Efficiency (SE) or Energy Efficiency (EE) using a pre-trained large language model (LLM).

7. Simulation Parameters

The following parameters were used in the simulation:

- ***Simulation Area**: Square area of size 20 to 70 units.*
- ***D2D Distance Constraint**: Maximum distance between D2D transmitters and receivers, ranging from 15 to 20 units.*
- ***Transmission Power**: Maximum allowable transmission power of 10^2 units.*
- ***Path Loss Exponent (PL_alpha)**: 38.*
- ***Path Loss Constant (PL_const)**: 34.5.*
- ***Noise Level**: Calculated based on the bandwidth and thermal noise density, with a default noise level of noise = BW*10**-17.4.*