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Problem Statement

The task was to implement an algorithm that places PCB components (USB connector, Microcontroller, Crystal, MikroBus 1 & 2) on a **50×50 unit board** while satisfying multiple **hard constraints** and optimizing layout compactness.

Algorithm

Our solution follows a **constraint-aware placement algorithm**:

1. **Pre-Placement Phase**
    - Place edge-constrained components first (USB, MB1, MB2).
    - Ensure **MB1 and MB2** are placed on **opposite edges** and remain **parallel**.
2. **Microcontroller Placement**
    - Place the Microcontroller near the board center to balance the layout.
    - This helps meet the **global balance constraint**.
3. **Crystal Placement**
    - Place the Crystal within **10 units** of the Microcontroller.
    - Verify **keep-out zone** so its connection line does not cross USB interference.
4. **Validation Phase**
    - Check **no overlaps**, **inside boundary**, and **edge rules**.
    - Compute **center of mass** to ensure it lies within the 2-unit tolerance.
5. **Scoring & Optimization**
    - Compute **compactness score** (minimize bounding box area).
    - Compute **centrality score** (uC close to center).
    - Total score = Compactness + Centrality (lower is better).

3. Results

- All **hard constraints passed** (boundary, no overlap, parallel, edge, proximity, CoM, keep-out zone).

- Validation executed in under **0.006 seconds** (fast enough).
- Scoring showed a **compact and balanced placement**.

4. Key Features

- Purely **algorithmic solution** (no hardcoded coordinates).
- Uses **matplotlib** for visualization of board & components.
- Self-check validation with provided Python script.
- Final output includes both **plot visualization** and **JSON placement file**.