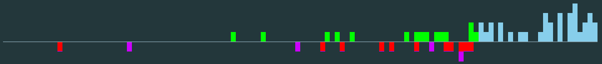
C: Coherency

Problem author: Thore Husfeldt



Problem: Given n models on a gaming board, represented as non-overlapping disks with diameter between 25 and 165 mm. Check coherency.

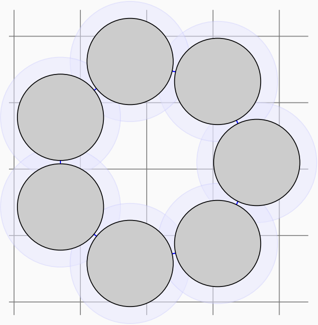


Figure 1: Example board configuration (example 4)

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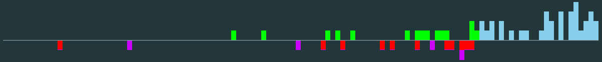

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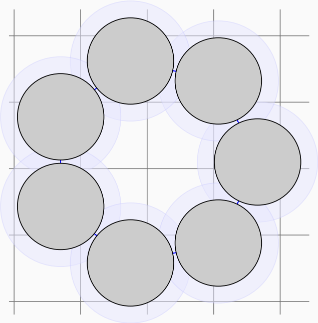
Models are *coherent* if they can reach each other. Models are adjacent when ≤ 2 inches apart. For $n \geq 7$, each model must have at least two neighbors, for coherency.



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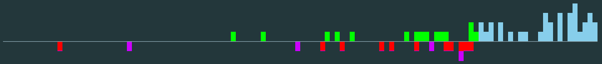

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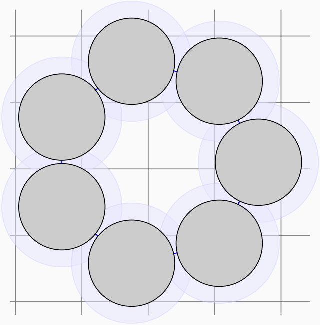
Naive solution: Check adjacency for all pairs of models in $\mathcal{O}(n^2)$.



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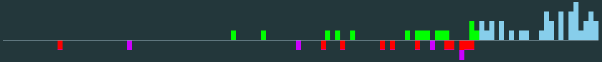

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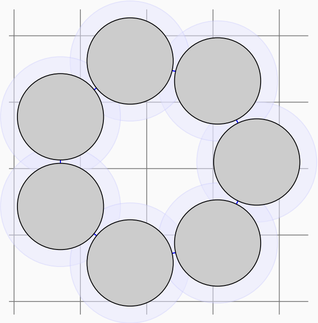
Make a graph of n nodes, and represent adjacency as undirected edges.



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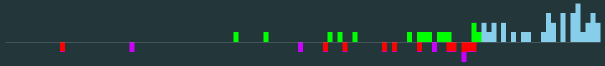

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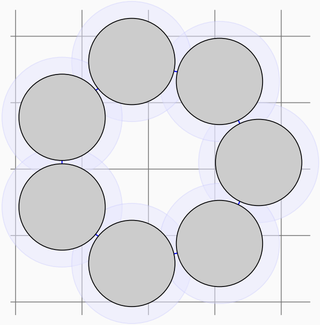
Run your favourite algorithm for finding connected components, and check degrees, for $n \geq 7$.



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In total, $\mathcal{O}(n^2)$. This is too slow, as $n \leq 200000$.

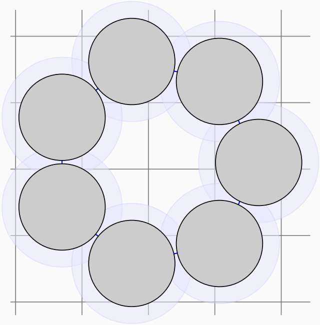


Figure 1: Example board configuration (example 4)

Idea: Use a grid of cells of 211 x 211 mm.

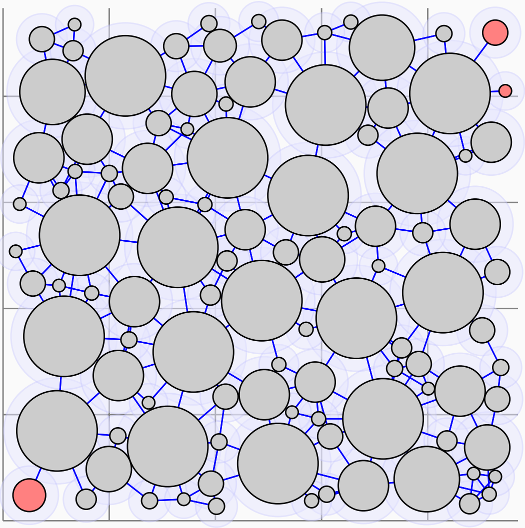
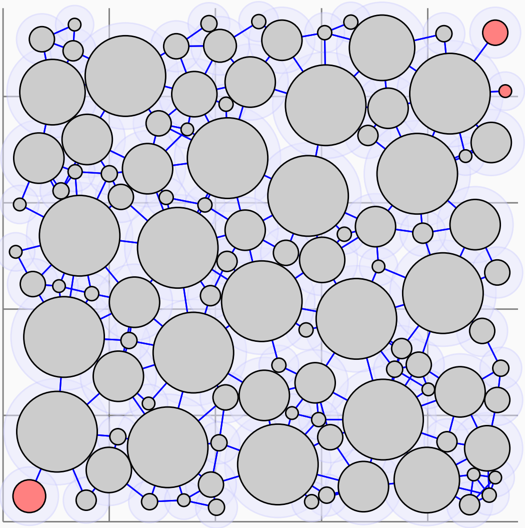


Figure 2: Secret testcase

Idea: Use a grid of cells of 211 x 211 mm.

Centres of disks are placed into corresponding cell. This can be done with a map / dictionary, in $\mathcal{O}(n \log n)$ or $\mathcal{O}(n)$.



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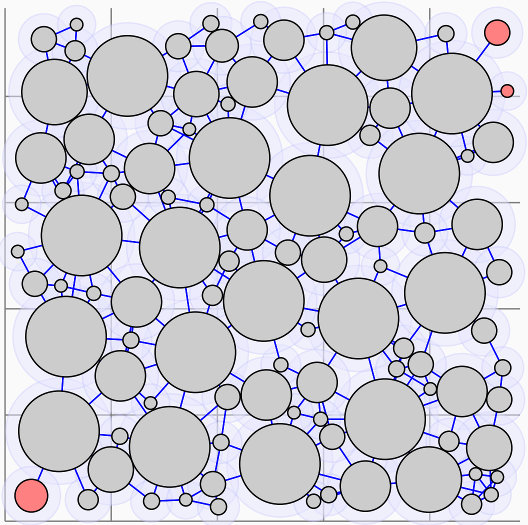

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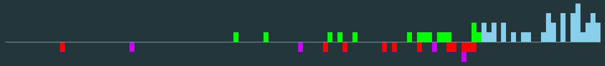

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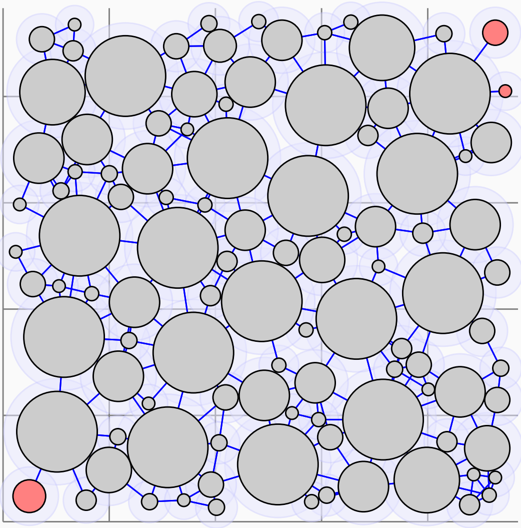
Algorithm: For each disk, loop through all 8 adjacent cells, and its own cell, and check all candidate disks for adjacency.
DFS, BFS or DSU can be used to find the connected components.



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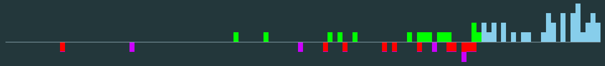

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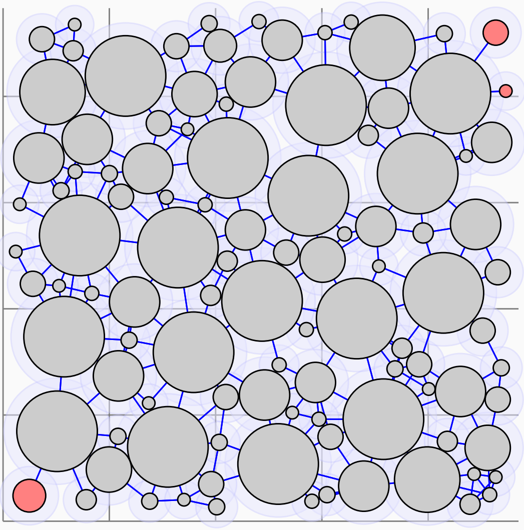

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Time complexity?

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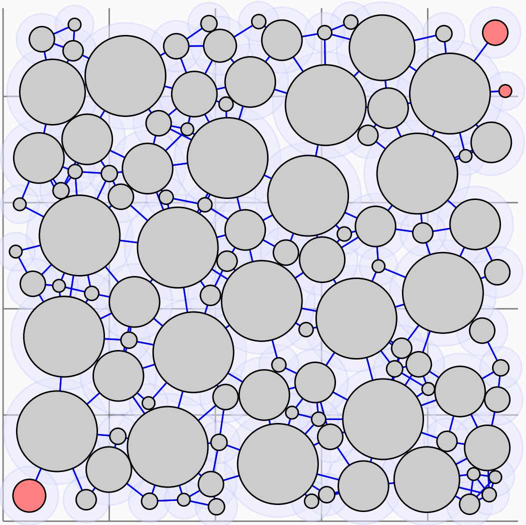

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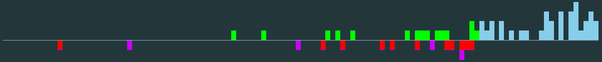

Time complexity: Time complexity is

$$\mathcal{O}(n \times 9 \times \text{Max number of disks in one cell})$$

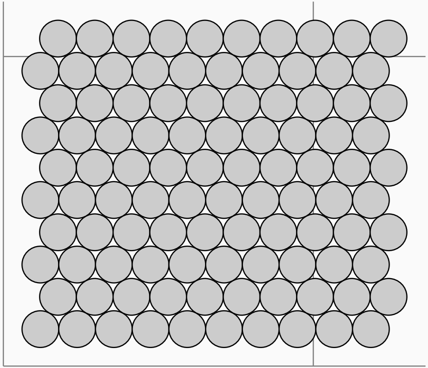

Figure 3: Worst case triangular packing with smallest diameter.

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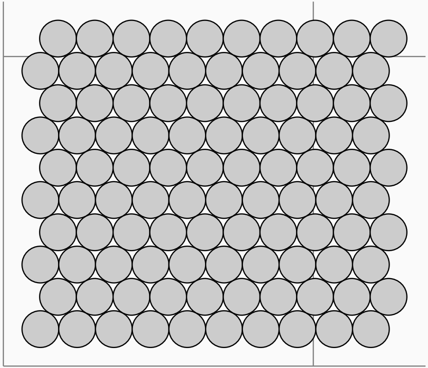
Roughly $\mathcal{O}(900 \times n)$



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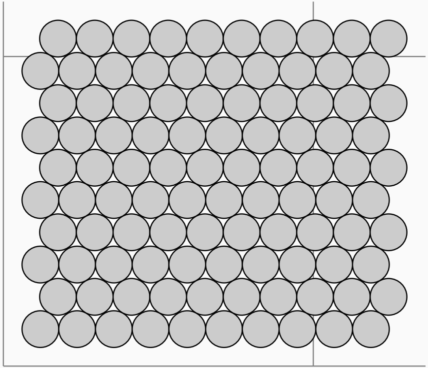
More precise: Cells need to be $\Omega(D_{\text{max}})$ mm big, so $\mathcal{O}(\left(\frac{D_{\text{max}}}{D_{\text{min}}}\right)^2)$ disks of the minimum diameter fit inside one cell



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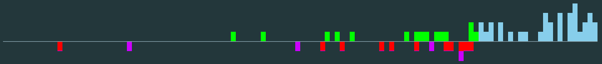

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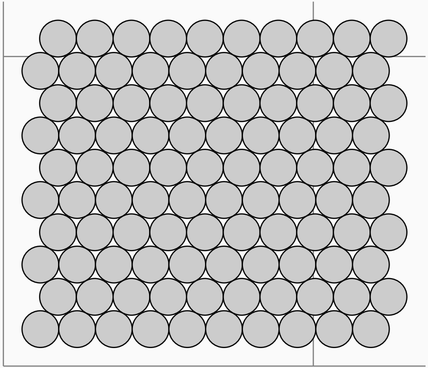

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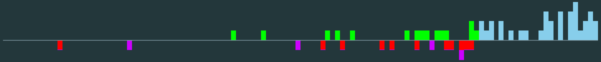

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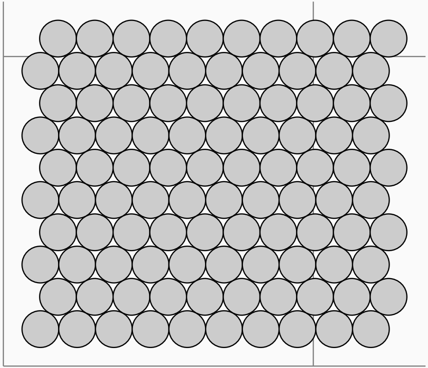

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Statistics: 64 submissions, 9 accepted, 34 unknown