

H: Hasty Hiker

Problem author: Jeroen Op de Beek



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- **Problem:** Count the number of beautiful trails.
- **Naive solution:** Loop over all 4-tuples and check if they are beautiful trails.

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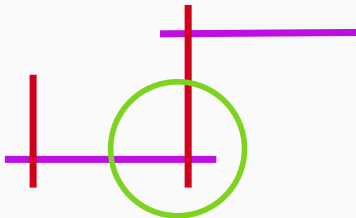
- **Problem:** Count the number of beautiful trails.
- **Naive solution:** Loop over all 4-tuples and check if they are beautiful trails.
- **Complexity:** $\mathcal{O}(n^4)$, too slow!

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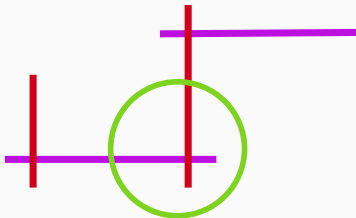
- **Faster solution:**
 - Let's loop over the two roads in the middle of the trail.

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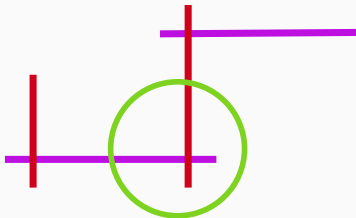
- **Faster solution:**
 - Let's loop over the two roads in the middle of the trail.
 - First check whether they intersect.

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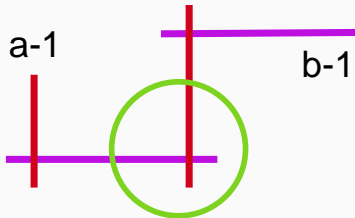
- **Faster solution:**
 - Let's loop over the two roads in the middle of the trail.
 - First check whether they intersect.
 - Count how many roads intersect these two roads. Let's call these counts a and b , respectively.

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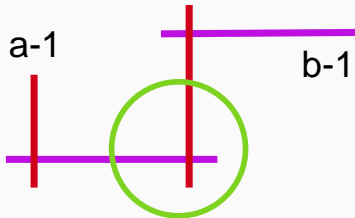
- **Problem:** Count the number of beautiful trails.



- **Faster solution:**
 - Let's loop over the two roads in the middle of the trail.
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 - Then add $(a - 1) \times (b - 1)$ to the answer.



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- **Faster solution:**
 - Let's loop over the two roads in the middle of the trail.
 - First check whether they intersect.
 - Count how many roads intersect these two roads. Let's call these counts a and b , respectively.
 - Then add $(a - 1) \times (b - 1)$ to the answer.
- **Complexity:** $\mathcal{O}(n)$ per intersection, so $\mathcal{O}(n^3)$ in total. Still too slow.

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- **Problem:** Count the number of beautiful trails.
- **Optimization:** Precompute the number of other roads each road intersects.

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- **Problem:** Count the number of beautiful trails.
- **Optimization:** Precompute the number of other roads each road intersects.
- **Complexity:** $\mathcal{O}(n^2)$, fast enough!

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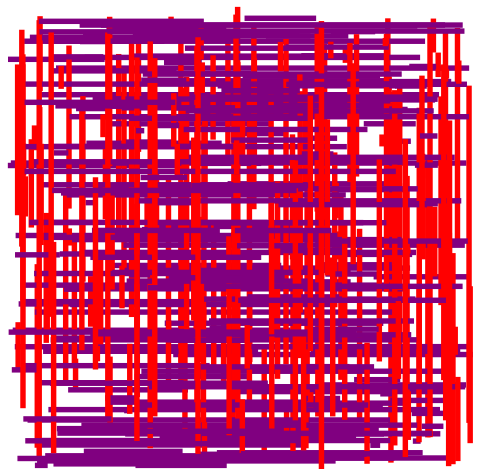
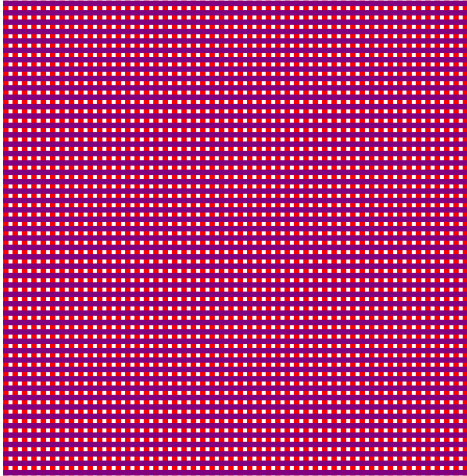
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- **Problem:** Count the number of beautiful trails.
- **Optimization:** Precompute the number of other roads each road intersects.
- **Complexity:** $\mathcal{O}(n^2)$, fast enough!
- **Bonus:** It is possible to solve this problem in $\mathcal{O}(n \log(n))$ using Fenwick tree + sweepline.

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Statistics: 12 submissions, 4 accepted, 7 unknown