



Map Explanation:

The track has been divided into different sections. For each section plus the 'crossing', there's a unique semaphore. For a train to travel on that section it must first acquire its semaphore.

Each section has been marked with a unique colour, one at the start and one at the beginning (which is which depending on the train direction).

The critical sections on the track are 'track_A', 'track_B' and the 'crossing'. Cause they are the parts of the track that only one train can enter at a time. Requiring others to wait until available.

There are 14 sensors placed on the track and there are 4 switches.

Each sensor, switch and the 'crossing' has its coordinates (x,y) written on the track depiction above.

There are 2 possible directions on the track, going from A to B, ('stat_A1' or stat_A2) to ('stat_B1' or stat_B2) or the opposite B to A.

The sensors have been placed in positions considered most effective, some serving multiple purposes so that the number of sensors can be kept as low as possible (shorter track sections only getting one sensor in the middle, and longer getting one each at the track section start and end):

- Sensors (14,3), (14,5), (14,11) and (14,13) are used as the station sensors for stopping.
- Sensors (6,7), (8,5), (12,7) and (12,8) are used for acquiring and releasing the 'crossing' (A critical section). Allowing trains to both stop in time if taken and release as early as possible.
- Sensors (12,7), (12,8), (5,11) and (14,13) are used for both acquiring and releasing semaphores to critical sections 'track_A' and 'track_B'.
- Sensors (9,9) and (9,10) are used for both acquiring and releasing the critical sections 'track_A' and 'track_B'. Which is which depends on the train's direction.
- Sensors (19,8) and (1,10) in critical sections are used for both acquiring and releasing one of the double tracks, which come in both directions of these critical sections.

Train Explanation:

Each train has an:

- id - Unique ID number. Set at initialization.
- speed - Current speed of the train. Set at initialization, updated continuously.
- startStation - Start Station of the train. Set at initialization of train.
- direction - Current direction. Set initially based on Start Station. Updated continuously.
- lastX - The X-pos of the last affected sensor. Updated continuously.
- lastY - The Y-pos of the last affected sensor. Updated continuously.

The trains employ a stop-and-think tactic. Stopping before trying to acquire the semaphore for the next section it's heading into. Thus minimizing any potential for error by allowing the train to first acquire the next section and set the appropriate switches before continuing on. One potential error that is avoided is that the train is on the switch when setting it.

The trains operate by differentiating between single tracks and 'crossing' (critical sections) and multi-tracks (non-critical sections). For:

- Critical sections - Only one train can enter so. If the train acquires the semaphore, it's free to enter. If not then it blocks and waits on the semaphore.
- Non-critical section - Two track sections available. The train first tries to acquire the upper section by default. If not available then acquires the lower section.

The switches are set depending on what section semaphore was acquired, the direction and the last affected sensor positions that the train has saved.

Maximum Speed & Testing:

The Maximum Train Speed observed is 17. Faster than that and eventually the trains move faster than the setting time for the switches. Eventually, there is a train on the switch when setting it. Even though the train stops first and only continues when the switch is set. For the train to move faster than the current maximum speed, the command delay must be taken into further consideration.

The solution for the trains has been tested by running the solution as both single trains (train1 and train2) both trains at all speeds from the maximum. Ran on slow simulation speeds for debugging any errors and higher simulation speeds when searching for the maximum speed.