Traffic Flow in Railway Systems

Contents

Aim and Materials

The aim of the learning game is to simulate and experience the driving dynamics of trains in the context of block division. This requires:

- two trains with different driving dynamics
- a track consisting of spaces
- train berths
- signals for block division
- if necessary, turnouts

Real continuous dimensions time (t) and distance (s) are assigned to discrete units of rounds (t) and spaces (s). Thus, the simulation is round-based in order to imitate the steps of a computer.

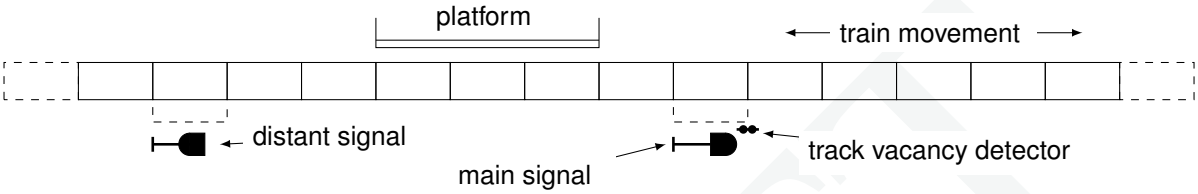
Version 0.4 from 2018-11-16

Part I.

Manual

1. Setup of a Line

The line consists of any number of spaces. Signals or platforms can be arranged along the line.



2. Signal Aspects

The main signal may only show the proceed aspect if there is no train in the following block section (from track vacancy detector to track vacancy detector). The distant signal is located in front of the main signal in braking distance and reflects the signal aspect of the main signal.

	halt	proceed
main signal		
distant signal		

3. Simulation of Driving Dynamics

The simulation is based on rounds.
Each round consists of at least two consecutive steps:

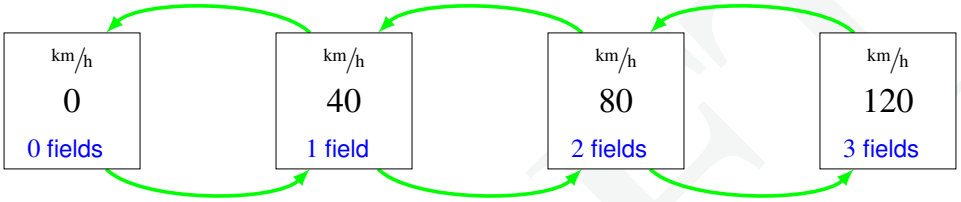
1. The train makes the movement set in the previous round.
2. All signals are set according to the track occupancy.

3. (optional) A new shift lever position can be chosen.

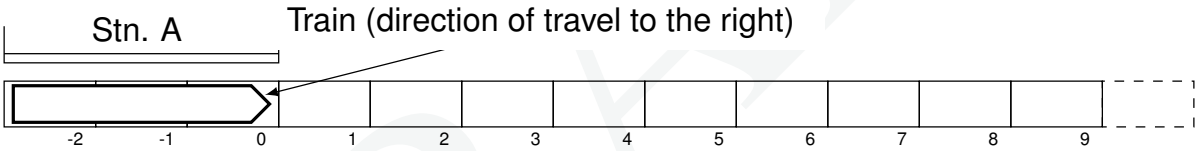
At the start of the game, the train stands still. Shift lever positions start at the “0” field. The different train dynamics are depicted by different possible movements of the shift lever.

4. Example

The shift lever is moved along the green arrows. Shift lever positions for a passenger train:

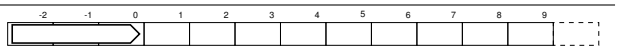
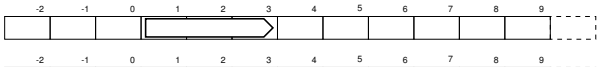
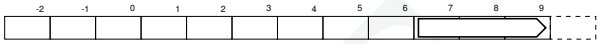


A train is supposed to accelerate on the following track:



For the course of the learning game, we start with the first round and follow the process from the previous section *Simulation of Driving Dynamics*. In the first round, the train from the initial condition stands still. In the example there are no signals that can be set. We can move the shift lever by one position to 40 km/h forward. The round is over.

The second round begins with the execution of the movement one field to the right. The shift lever can be moved on and the round is over. The third round begins with the execution of the movement by *two* fields to the right. The shift lever can be moved on again and the round is over. Continue until the position of 120 km/h is reached and the train moves evenly with three fields per round.

Round	current speed	1.Step Move	2.Step shift lever on	
1	0 km/h	0 fields	40 km/h	
2	40 km/h	1 field	80 km/h	
3	80 km/h	2 fields	120 km/h	
4	120 km/h	3 fields	120 km/h	
5	120 km/h	3 fields	120 km/h	
etc.				

Part II.

Challenges

5. First Stage

5.1. Introduction to Driving Dynamics

Setup

- A single train,
- Line with fields -2 to 37,
- Platform A at field -2 to 0,
- Platform B at field 14 to 16,
- Platform C at field 35 to 37.

Task 1

The train (on field 0 towards 37) stands still and has its shift lever at $0\,^{\mathrm{km}}/_{\mathrm{h}}$.

a) If the train accelerates as much as possible, which field can it get to in *nine* rounds?

b) How many rounds are minimally needed, if the train stops at every station?

Note the solution steps in a protocol!

Example for a protocol:

Round	curent speed	(1. Step) Move by	current position head of train	(2. Step) shift lever at
1	$0\,^{\mathrm{km}}/_{\mathrm{h}}$	0 fields	field 0	$40\,^{\mathrm{km}}/_{\mathrm{h}}$
2	$\cdots$			
$\vdots$				

Task 2

The train (on field 0 towards 37) just passes through the first station and has its shift lever on maximum speed.

a) How many fields does the train need to come to a stop?

a) How many rounds are needed if the train shall leave the track completely without stopping?

5.2. Sight and Braking Distance

Setup

Unknown line with different visibility conditions:

Visibility	Sight in fields
Very good	3
Normal	2
Bad	1

Task 3

a) What is the maximum speed for the train with very good visibility in order to stop in front of an obstacle in time?

b) How many rounds are minimally needed, to arrive safely with normal visibility in a 14 fields away station?

c) How many fields far would you have to be able to see in order to drive 160 $^{km}/_{h}$?

6. Second Stage

6.1. Block Segmentation

Setup

One train and any length of line, with at least 3 complete blocks. A block consists of: visual point, distant signal, main signal, signal clearing point and clearing distance.

Task 4

a) Place the distant and main signals so that 160 $^{km}/_{h}$ can be driven and bad visibility does not lead to impairment!

b) How many rounds is a block occupied with a train running (complete blocking time)?

6.2. Traffic Flow

Setup

- Two different trains with different train dynamics.
- Any length of the track, with at least 3 complete blocks.
- At the beginning and the end of the track, a station with switches can be arranged or the track can be lead in a circle.

Task 5

a) How many rounds are needed if both trains shall run unimpeded and the fast train runs in front of the slow train?

b) How many rounds are needed if both trains shall run unimpeded and the slow train runs in front of the fast train?

Revision History

Revision	Date	Author(s)	Description
0.1	2018-04-17	MS, FN, LG	First prototype created with driving dynamics
0.2	2018-05-15	MS, LG	Educational game with block logic extended
0.3	2018-09-03	MS	Handbook created
0.3.1	2018-10-17	MS	Handbook with neutral design
0.4	2018-11-16	MS, SZ	Translation into english

Felix Nebel (FN), Lukas Gruber (LG), Martin Scheidt (MS), Stephan Zieger (SZ)