Exercise 1

Consider the entity relationship model of a train connection system (below). Note: The connects relationship models a direct connection between two stations. For example, the train starting (start) in Munich and ending (end) in Hamburg passes through several stations. Each of these route-sections (e.g., Munich → Nürnberg or Nürnberg → Würzburg) has an entry in the connects relation. Further, the train entity models a train line: The train line going from Munich to Hamburg, becomes a different train line (different trainNo) when returning.

Task: Add functionalities to the shown ER diagram.

Solution:
Exercise 2

For now, ignore the functionalities in the diagram and answer the following questions:

- How many partial functions \( A \times B \rightarrow C \) are possible in a ternary relationship (ignore permutation on the left side of the partial function when counting).
- List all possible partial functions of the „offers“ relationship.
- For each partial function, try to describe in natural language which constraints it would enforce (not all of them make sense in the real world).

Now, considering the functionalities:

- Which partial function actually hold?
- What does the absence of the other partial functions allow for? (no need to create an exhaustive list).

Solution:
There are three possible partial functions:

\[
\begin{align*}
\text{Instructor} \times \text{Year} & \rightarrow \text{Course} \\
\text{Instructor} \times \text{Course} & \rightarrow \text{Year} \\
\text{Course} \times \text{Year} & \rightarrow \text{Instructor}
\end{align*}
\]
• (1) would imply that a given instructor may only offer one (or zero) course(s) per year. I.e., an instructor can not do two courses in one year.

• (2) would imply that a given instructor may offer a course only in one year (or not at all). I.e., an instructor can not offer a course twice.

• (3) would imply that a given course is only offered by one (or no) instructor in a certain year. I.e., a course can not be offered twice in one year.

Now, considering the functionalities:

• The functionalities shown in the figure only enforce 3.

• Not having the other two partial functions allows an instructor to offer multiple courses per year and also reuse a course multiple times (in different years).