Happened-Before Relation

Ordered events

\[ p_1 \text{ precedes } q_4 \]
\[ q_4 \text{ precedes } q_2 \]
\[ q_2 \text{ precedes } q_1 \]
\[ p_0 \text{ precedes } q_1 \]

Unordered (Concurrent) events

\[ q_0 \text{ is concurrent with } p_0 - p_4, r_0 - r_1 \]
\[ q_2 \text{ is concurrent with } p_0 - p_4, r_1 \]
\[ q_4 \text{ is concurrent with } p_2 - p_4, r_1 - r_2 \]
\[ q_5 \text{ is concurrent with } p_2 - p_4, r_2 - r_3 \]
Happened-Before Relation

Ordered events
- \( p_1 \) precedes \( p_2 \) \( \rightarrow q_5 \rightarrow q_3 \rightarrow r_2 \)
- \( q_4 \) precedes \( q_5 \rightarrow r_3 \)
- \( q_2 \) precedes \( q_3 \rightarrow q_5 \rightarrow r_2 \rightarrow r_3 \)
- \( p_0 \) precedes \( p_1 \) \( \rightarrow q_1 \rightarrow q_3 \rightarrow q_5 \rightarrow r_3 \)

Unordered (Concurrent) events
- \( q_0 \) is concurrent with \( p_0 \) \( \rightarrow p_4 \rightarrow r_0 \), \( r_0 \)
- \( q_2 \) is concurrent with \( p_0 \) \( \rightarrow p_4 \), \( r_1 \)
- \( q_4 \) is concurrent with \( p_2 \) \( \rightarrow p_4 \), \( r_1 \rightarrow r_2 \)
- \( q_5 \) is concurrent with \( p_2 \) \( \rightarrow p_4 \), \( r_2 \rightarrow r_3 \)