

Designdocument

Project "TrainVis"

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1 Introduction

The goal for this project was the design and the implementation of an interactive system that can visualize train timetables. Three types of representations will be available:

- Simple text list.
- A visualization using lines as described by E.J. Marey
- Two visualizations using bars. One with absolute and one with relative starting times.

For a more detailed description about the techniques we use please see section 4.

Timetables for trains or airplanes are often represented as textual tables. These contain usually all important information, however it is often not easy to find answers to more specific questions, like for example - „which train should I take to travel from Vienna to Paris as quick as possible without changing the train twice? “-. Humans can process visual information better than text that’s why our application shall facilitate the process of understanding and searching a timetable.

As the primary user for our application we suggest the passenger. That’s the reason why the operability and the user interface design of the tool had an important role in the design.

2 Database model

2.1 Terms:

- **Route:** A route from station A (first) to station Z (last) which cannot be changed and is determined by the data in the database. There can be only one route per database.
- **Connection:** A single connection within a route. A connection leads also from the first station to the last station but also all stopovers in each station are stored. Also the ID of the train and the time of arrival and departure are stored.
- **Station:** Each train can stop in every station. Stations have an order depending on the route.
- **Train:** A train within a connection goes at least from one station to another. If the train goes from the first station to the last station of the route a train change is not necessary. If a train goes for instance from station A to station N and another train from station N to station Z then a train change is necessary within the connection.

2.2 Which data is available?

Since the emphasis of the project is visualization there is only one route per set of data tables. Only one route can be visualized at once but different routes can be loaded into the application by selecting another set of data tables.

2.3 Where and how is the data stored?

The data is stored in four different CSV-Tables:

2.3.1 dates.csv

Dates and days of the week where a given connection is active are saved here. These columns are available:

connectionID: ID of a connection

weekly: A train goes on specific days of the week, 0 = doesn't go, 1 = goes
Begin of the week is Monday!

specialDate: The train is a special train and goes only on specific dates.

notOnDate: The train goes regularly except on this date.

connectionID	weekly	specialDate	notOnDate
Int	Byte(7)	String	String
1	1111100	00.00.0000	00.00.0000
2	0000000	01.01.2007	00.00.0000
3	1111111	00.00.0000	01.01.2007

Mo to Fr, specialDate is always 00.00.0000
Special train, goes only at new year, weekly is always 0000000
Goes daily, except 01.01.2007

The validity of the schedule is stored in the first row of this table. The specialDate column contains the start of the schedule and the notOnDate column the end.

2.3.2 connections.csv

In this file all the trains and their stops in each station within a connection are listed. For each track between two stations there is a row in the table. The right chronological order of the rows is mandatory! The following columns are available:

connectionID: ID of a connection
trainID: ID of the train for this track
from: startstation of the track
fromTime: time of departure
to: endstation of the track
toTime: time of arrival

connectionID	trainID	from	fromTime	to	toTime
Int	Int	Int	String	Int	String
1	1	1	15:00	2	15:05
1	1	2	15:08	5	15:30
1	2	5	15:31	6	16:00

connection 1 using train 1 from station 1 to station 2
connection 1 using train 1 from station 2 to station 5
train does NOT stop in station 3 and 4!
connection 1 using train 2 from station 5 to station 7
trainID has changed, therefore a train change was necessary!

2.3.3 trains.csv

In this table all the trains with their IDs and additional information are stored:

trainID: ID of the train. This is a unique ID that can be used to identify each train.
trainName: Name of the train.
trainInfo: Additional information about the train.

trainID	trainName	trainInfo
Int	String	String
1	REX	Fahradmitnahme begrenzt möglich, nur 2. Klasse
2	ICE	Panoramawagen, Rollstuhlplatz
3	REG	Fahradmitnahme begrenzt möglich, nur 2. Klasse

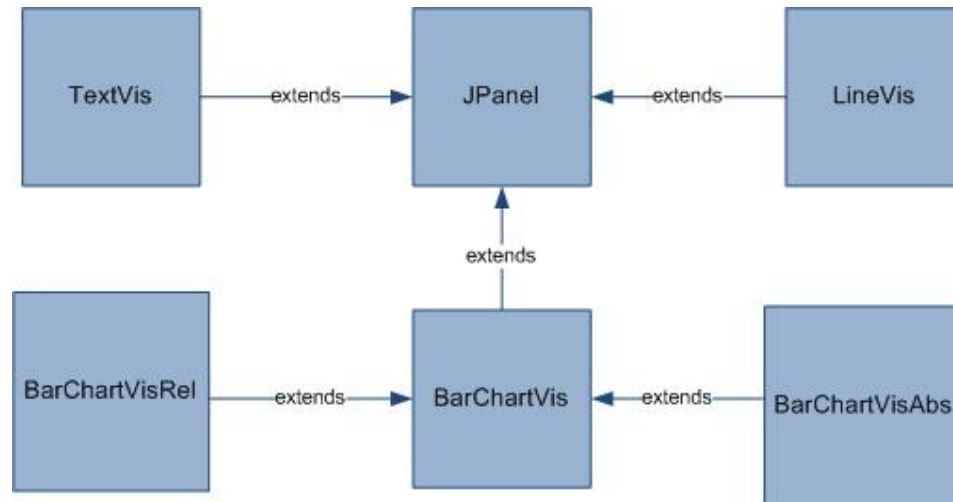
2.3.4 stations.csv

In this table all stations of the route are stored. The following columns are available:

stationID: The unique ID of the station
stationName: Name of the station.
stationInfo: Additional information about the station.
stationKM: Number of kilometers that the stations is away from the first station of the route.

stationID	stationName	stationInfo	stationKM
Int	String	String	Int
1	Wien Westbahnhof	Behindertengerecht, VIP-Lounge, WC	10
2	Krems/Donau	WC	15

3 Class diagram



The four main classes of the project are *TextVis*, *LineVis*, *BarChartVisRel*, and *BarChartVisAbs*. All of them derive from the Java-Swing class *JPanel*. Each of them encapsulates one form of visualization. You only have to pass consistent data tables to the constructor of these classes and everything will be displayed in the panel.

3.1 LineVis

This class accomplishes the Marey train-visualization.

3.2 BarChartVis

This class is an abstract class for both bar chart visualizations.

3.3 BarChartRel

This class displays a duration bar chart. The start of every bar lies in the origin of the x-axis. For further information see chapter 3.

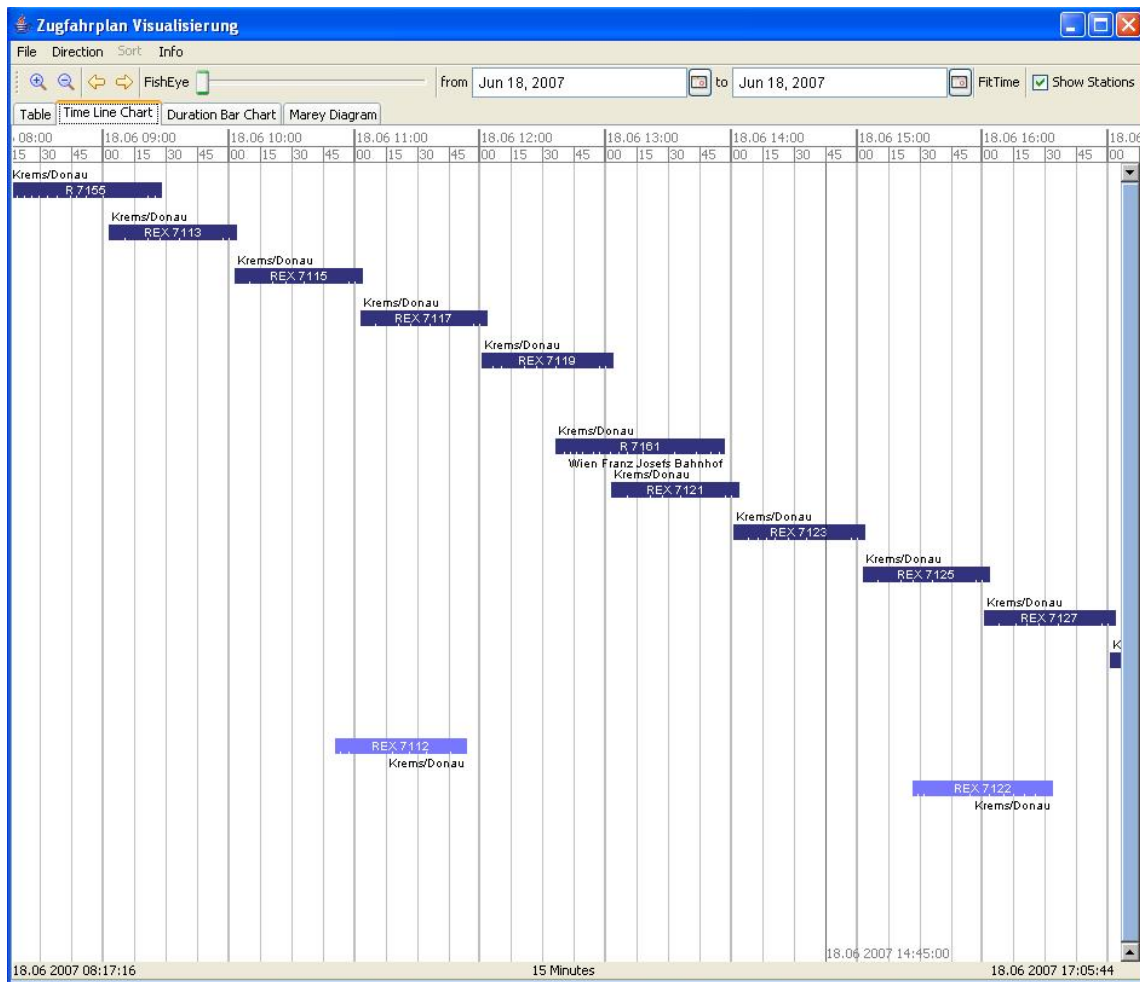
3.4 BarChartAbs

Here all the trains are displayed in a time line chart.

3.5 TextVis

Here the data is just displayed as a normal text table.

4 Features



4.1 The Menu

4.1.1 File:

- **Load zip:**

This option provides the opportunity to load different train routes. The .zip file will be checked and if no error occurs during loading the application will work with the loaded train routes.

- **Exit:**

This option provides the opportunity to exit the application immediately.

4.1.2 Direction:

Here you can set which directions shall be displayed. This affects the “Time Line Chart”, the “Duration Bar Chart”, and the “Marey Diagram”-tab of the application.

4.1.3 Sort:

This option is only available for the Marey Diagramm. You can specify how the train stations are being sorted.

4.1.4 Info:

- **About:**

Provides information about the authors.

- **Help:**

Displays the help file.

4.1.5 Buttons:

- **Zoom in & Zoom out:**

Provides functionality to zoom in or out.

- **Move left or right:**

Moves the time bar to the left or to the right.

- **Fisheye range slider:**

Provides fish eye functionality. The date in the middle of the time bar will be better visible.

- **Date from-to:**

When the program invokes for the first time the current date is specified. Furthermore if you load a run off timetable, the application will not display anything. In this case you have to search for available dates. Enter your dates for the search. Dates can be entered manually or with the tool right to the date field.

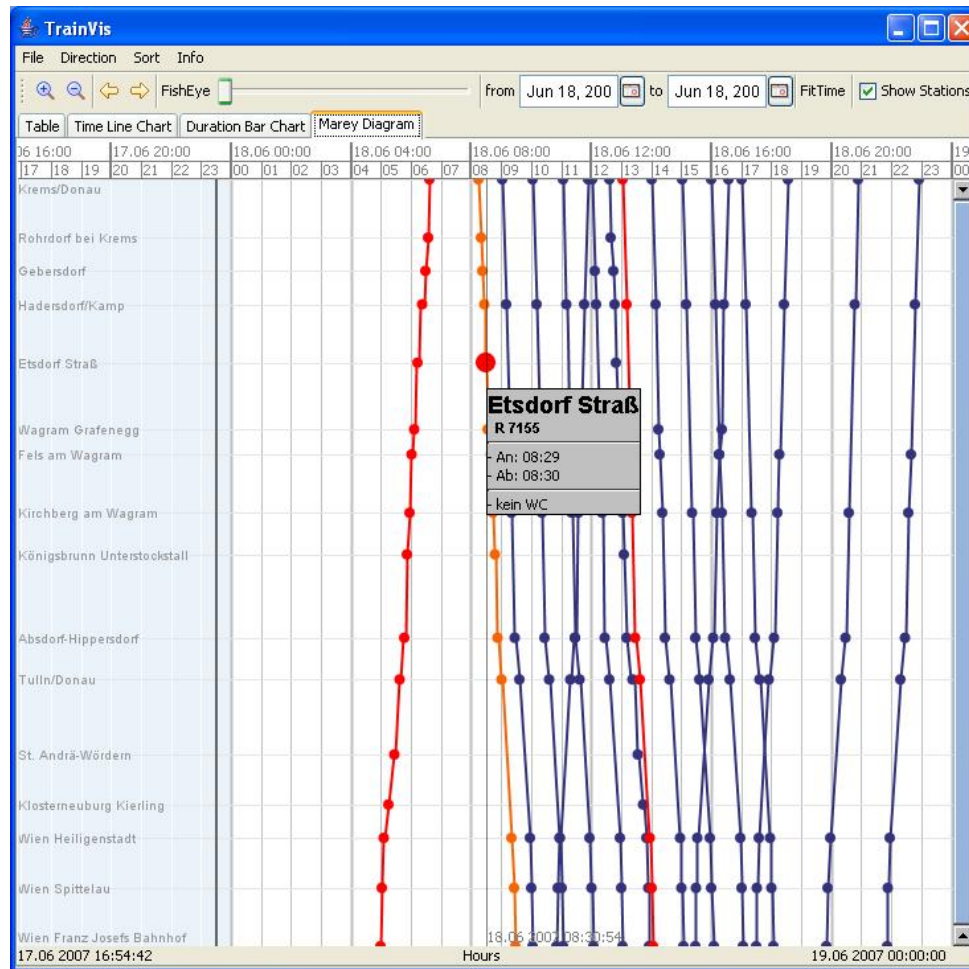
- **FitTime:**

Our application displays days from midnight to midnight, but the earliest train leaves about 07:00. This button cuts off the time if no train is on the road.

- **Show Stations:**

This shows the stations of a route. It is not available in the table view.

4.2 Visualization with lines (EJ. Marey)



The “Marey Diagram”-tab of the application.

4.2.1 Description

All stations are listed on the vertical axis. The distance between the stations depends on the stationKM-column of the stationstable. The horizontal axis represents time. The direction of a line implies the direction of the train it stands for: Lines that run from left to right stand for trains that go from the lower station (in the figure for example “Wien Franz Josefs Bahnhof”) to the upper station (“Krems/Donau”). Lines that run from right to left symbolize trains that have the opposite direction. The gradient of each line stands for the speed of the represented train. Stopovers that take longer than one minute are symbolized by horizontal lines at the corresponding station.

4.2.2 Features

- **Mouseover train**
When the mouse is moved over a train its color changes to orange and a tooltip-box with information about that train is displayed. Furthermore all stations of this train are displayed.

- **Mouseover station**

When the mouse is moved over a station this specific station is highlighted and a tooltip-box with information about this station is displayed.

- **Mouseclick train**

When you click on a train its color changes to red and this train is marked as selected. This selection affects also both the time line chart and the duration bar chart.

4.3 TextVis

Spezifizieren Sie ein Datum oder einen Zeitraum

Fahrplan für den: 18.06.2007

Zugname:	Abfahrt:	Abfahrtsort:	-Nach-	Ankunftsart:	Ankunft:
R 7155	07 8:15:00 AM	Krems/Donau		Wien Franz Josefs Bahnhof	07 9:28:00 AM
REX 7113	07 9:03:00 AM	Krems/Donau		Wien Franz Josefs Bahnhof	07 10:04:00 AM
REX 7115	07 10:03:00 AM	Krems/Donau		Wien Franz Josefs Bahnhof	07 11:04:00 AM
REX 7117	07 11:03:00 AM	Krems/Donau		Wien Franz Josefs Bahnhof	07 12:04:00 PM
REX 7119	07 12:01:00 PM	Krems/Donau		Wien Franz Josefs Bahnhof	07 1:04:00 PM
R 7161	07 12:36:00 PM	Krems/Donau		Wien Franz Josefs Bahnhof	07 1:57:00 PM
REX 7121	07 1:03:00 PM	Krems/Donau		Wien Franz Josefs Bahnhof	07 2:04:00 PM
REX 7123	07 2:01:00 PM	Krems/Donau		Wien Franz Josefs Bahnhof	07 3:04:00 PM
REX 7125	07 3:03:00 PM	Krems/Donau		Wien Franz Josefs Bahnhof	07 4:04:00 PM
REX 7127	07 4:01:00 PM	Krems/Donau		Wien Franz Josefs Bahnhof	07 5:04:00 PM
REX 7129	07 5:01:00 PM	Krems/Donau		Wien Franz Josefs Bahnhof	07 6:04:00 PM
R 7152	07 5:00:00 AM	Wien Franz Josefs Bahnhof	Krems/Donau		07 6:37:00 AM
REX 7112	07 10:51:00 AM	Wien Franz Josefs Bahnhof	Krems/Donau		07 11:54:00 AM
REX 7122	07 3:27:00 PM	Wien Franz Josefs Bahnhof	Krems/Donau		07 4:34:00 PM
REX 7130	07 5:29:00 PM	Wien Franz Josefs Bahnhof	Krems/Donau		07 6:33:00 PM
REX 7138	07 7:51:00 PM	Wien Franz Josefs Bahnhof	Krems/Donau		07 8:54:00 PM
REX 7142	07 9:51:00 PM	Wien Franz Josefs Bahnhof	Krems/Donau		07 10:56:00 PM

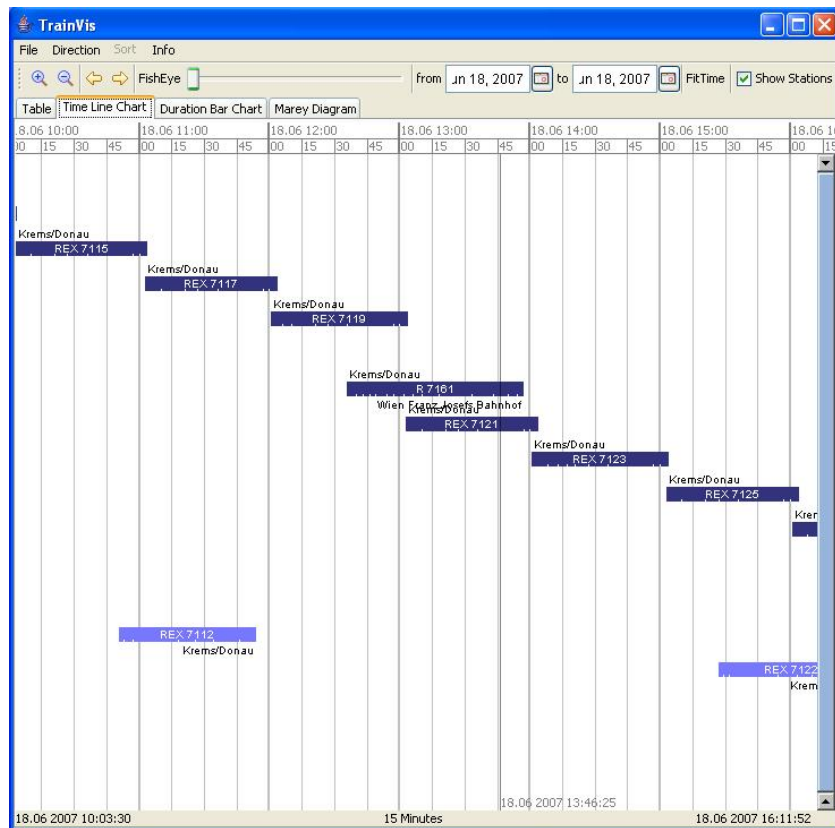
Sie haben folgenden Zeitraum ausgewählt: 18.06.2007 - 18.06.2007

The „Table“-tab of the application

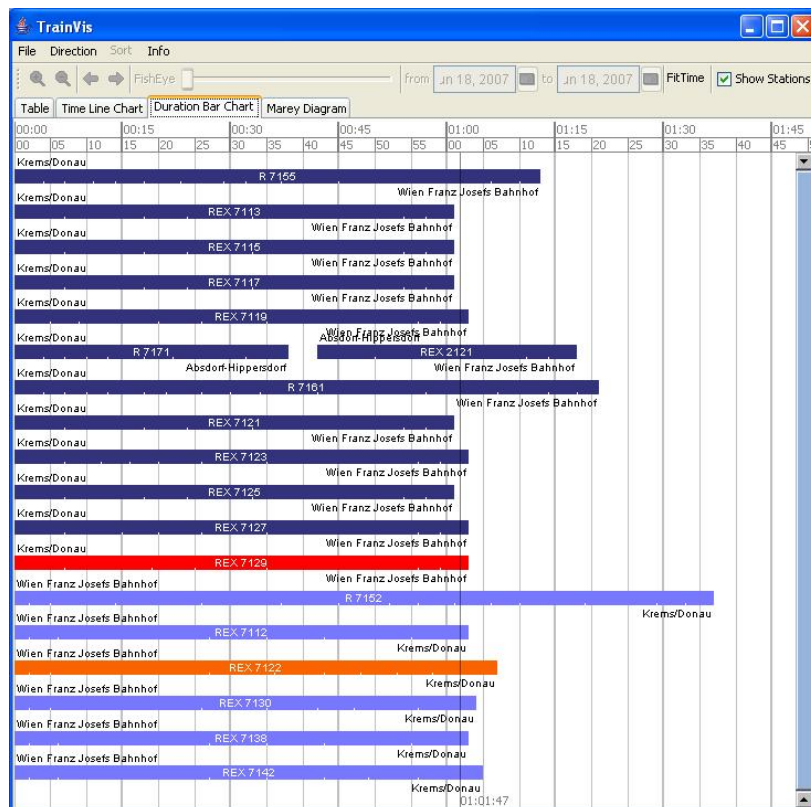
4.3.1 Description

This is the classic view as a simple table containing all the available information about the currently selected timerange. The displayed columns are trainname, time of departure, place of departure, place of arrival and time of arrival.

4.4 Barchart visualization



The „Time Line Chart“-tab of the application



The „Duration Bar Chart“-tab of the application

4.4.1 Description

There are two different visualizations using bars: The first is the time line chart where time is represented by the horizontal axis. Every bar in this view corresponds to a train. The names of the start- and endstations are drawn at the left and right side of each bar. In this view all connections over the valid schedule can be shown and it can be panned and zoomed as pleased. If two trains have the same vertical coordinate they belong to the same connection. Also the vertical order of both visualizations is the same. To make the direction of a train better visible there are two different shades of blue for each direction of the route.

The second view is called duration bar chart. Here the horizontal axis also stands for time but every bar starts at the origin. With this view it is easy to compare the duration of different trains. Each train has one bar so if a connection consists of more than one train there are two bars at the same vertical position and a gap in between that corresponds to the time one has to wait at the station.

In both views the name of the train is displayed at the middle of the corresponding bar.

4.4.2 Features

- **Mouseover train**
When the mouse is moved over a train its color changes to orange and a tooltip-box with information about that train is displayed.
- **Mouseclick train**
When you click on a train its color changes to red and this train is marked as selected. This selection affects both bar chart views and the Marey diagram.

5 Future Work

There is still plenty of room for enhancement for this application. Here are a few points that we have found important:

5.1 Performance

The biggest deficiency of the application as it is is its performance. In our opinion this comes mainly from huge data tables that have to be used to store all the temporal information. At the moment when the selected time-range is altered the horizontal coordinates of ALL items is changed and that takes time obviously. To solve this problem a reorganization of the internal data organization could be necessary. Also the table-based approach of the prefuse-toolkit might not be optimal for this manner.

5.2 Query functionality

Query functionality to find a specific connection or to modify the displayed amount of trains could make the application more interactive and useful.

5.3 Sorting

Interactive sorting for both bar chart visualizations would improve their functionality very much.

5.4 A real Table for the "Table"-tab

At the moment the "Table"-tab is only a textbox that cannot be edited. A real table would look much better.

5.5 Multiple Views

It would be nice to be able to see all four tabs at once. At the moment this would bring a horrible performance loss because all data tables would have to be edited simultaneously.

5.6 Bar height

When the database holds a large quantity of connections the bars of the duration bar chart and the time line chart overlap each other depending of the height of the application window. Therefore it would be a good thing to adapt the height of the bars to the amount of available horizontal pixels. The labels and the current state of the range slider would also have to be taken into consideration for an optimal appearance of both bar charts.