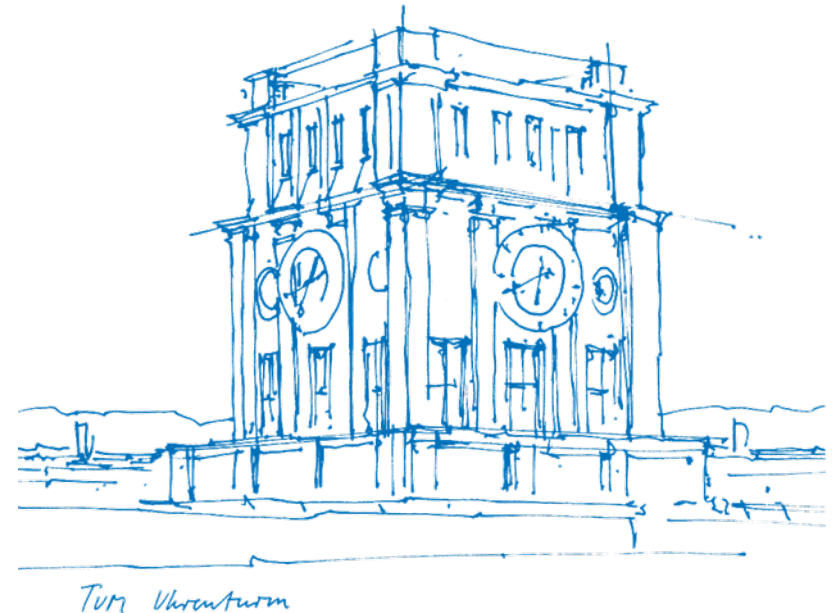


Interactive Front-End for EV Traffic Simulation in Highways

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Smart scheduling approach for EVs

- **paper:** “Smart Charging Schedules for Highway Travel with Electric Vehicles”
 - authors: Victor del Razo and Hans-Arno Jacobsen
- **idea:** EVs determine their charging stops during a highway trip
- **goal:** reduce the total travel time for each EV
- **summary:** shortest path problem
 - A* search algorithm
 - extended with verification of constraints
- **software:** Python based simulation framework that provides
 - generated trip data
 - time-dependent parameters

Smart scheduling approach for EVs

- **simulation model**

- electric vehicles (EVs)
- charging stations (CSs)
- highway

- **scheduling design**

- local to the EV
- communication with charging stations
- highway-related information system

- **scheduling process**

- calculate set of charging stops and times
- submit bookings to the charging stations
- proceed trip as planned unless an update event is received

Interactive Front-Ends

Our task was to design and implement two front-ends for the simulation framework.

- **Simulation Manager Interface**
 - show current states of EVs and CSs
- **EV Driver Interface**
 - show relevant vehicle information
 - display travel-related information

Research question

What is the most suitable form of presentation for the data that is most relevant during the simulation and while driving respectively?

- **Simulation Manager Interface**
 - data-heavy application
 - structured data access
 - relation between EVs and CSs
 - schedule changes
 - aggregated metrics
- **EV Driver Interface**
 - limited user attention
 - separation of information
 - time-relevant data

Which tools, libraries, frameworks or APIs can be used to implement the two front-ends?

Which are most suitable for our purpose?

Google Maps JavaScript API



config.js

```
var config = {  
  mapID: "map",  
  mapCenter: "Germany",  
  mapZoom: 7,  
  markers: {  
    car: {  
      url: "img/markers/car.png",  
      anchor: new google.maps.Point(24, 18)  
    },  
    battery: {  
      url: "img/markers/battery.png",  
      anchor: new google.maps.Point(20, 36)  
    }  
  }  
};
```

main.js

```
$(document).ready(function () {  
  
    // Init map  
    var map = new Map();  
  
    // Electric vehicles traveling from A to B  
    var ev = [];  
  
    ev.push(new EV(map.map, 1, 0, "Munich", "Berlin"));  
    ev.push(new EV(map.map, 2, 10, "Munich", "Berlin"));  
    ev.push(new EV(map.map, 3, 25, "Berlin", "Munich"));  
  
    // Charging stations at location C  
    var cs = [];  
  
    cs.push(new CS(map.map, 1, "Ingolstadt"));  
    cs.push(new CS(map.map, 2, "Nuremberg"));  
    cs.push(new CS(map.map, 3, "Bayreuth"));  
    cs.push(new CS(map.map, 4, "Osterfeld"));  
});
```


map.js

```
function Map() {
    this.init = function () {

        // Create new Google Map
        this.map = new google.maps.Map(document.getElementById(config.mapID), {
            mapTypeId: google.maps.MapTypeId.ROADMAP
        });

        // Center and fit country in viewport
        var geocoder = new google.maps.Geocoder();
        var map = this.map;

        geocoder.geocode({'address': config.mapCenter}, function (results, status) {
            if (status == google.maps.GeocoderStatus.OK) {
                map.setCenter(results[0].geometry.location);
                map.fitBounds(results[0].geometry.viewport);
            }
        });
    };
}
```

cs.js

```
function CS(map, id, location) {  
    var CS = this;  
  
    var stats = {  
        id: id,  
        time: '',  
        queue_length: '',  
        busy_poles_fc: '',  
        busy_poles_tsc: '',  
        arrived_cars: '',  
        leaving_cars: '',  
        queued_cars: '',  
        plugged_cars: '',  
        energy_consumed: '',  
        energy_produced: '',  
        energy_stored: '',  
        energy_bought: '',  
        queue_prediction_fc: '',  
        queue_prediction_tsc: ''  
    };  
};
```

cs.js

```
this.init = function () {  
    var marker = new google.maps.Marker({  
        map: map,  
        icon: config.markers.battery  
    });  
  
    CS.setPosition(marker);  
  
    var panel = new google.maps.InfoWindow({  
        content: CS.getStats()  
    });  
  
    CS.initStats(panel, marker);  
};
```

cs.js

```
this.getStats = function () {  
    var info = '';  
  
    for (var key in stats) {  
        info += key + ': ' + stats[key] + '<br>';  
    }  
  
    return info;  
};
```

ev.js

```
function EV(map, id, start_time, origin, destination) {  
    var EV = this;  
  
    var stats = {  
        id: id,  
        time: '',  
        position: '',  
        geo_position: '',  
        distance_travelled: '',  
        time_travelled: '',  
        time_waited: '',  
        time_charged: '',  
        time_driven: '',  
        battery_level: '',  
        speed: '',  
        driving_flag: '',  
        schedule_status: ''  
    };  
};
```

ev.js

```
this.start = function () {  
    var directions = new google.maps.DirectionsService();  
  
    var request = {  
        origin: origin,  
        destination: destination,  
        travelMode: google.maps.TravelMode.DRIVING  
    };  
  
    setTimeout(function () {  
        directions.route(request, function (result, status) {  
            if (status == google.maps.DirectionsStatus.OK) {  
                EV.autoUpdate(map, result.routes[0].legs);  
            }  
        });  
    }, start_time * 1000);  
};
```

ev.js

```
this.autoUpdate = function (map, legs) {  
    var route, marker, panel;  
  
    route = new google.maps.Polyline({  
        path: [],  
        geodesic: true,  
        strokeColor: '#000000',  
        strokeOpacity: 0.8,  
        strokeWeight: 2,  
        editable: false,  
        map: map  
    });  
  
    marker = new google.maps.Marker({  
        map: map,  
        icon: config.markers.car  
    });  
  
    ...  
}
```

ev.js

```
...

var timeUnit = 0;

for (var i = 0; i < legs.length; i++) {
  for (var j = 0; j < legs[i].steps.length; j++) {
    for (var k = 0; k < legs[i].steps[j].path.length; k++) {
      setTimeout(function (coords) {

        route.getPath().push(coords);
        EV.moveMarker(map, marker, coords);
        EV.updateStats(panel);

      }, 50 * timeUnit++, legs[i].steps[j].path[k]);
    }
  }
}
```