

# Hybrid approach for the Public Transportation Time Dependent Orienteering Problem with Time Windows

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vicomtech

visual interaction  
communication  
technologies

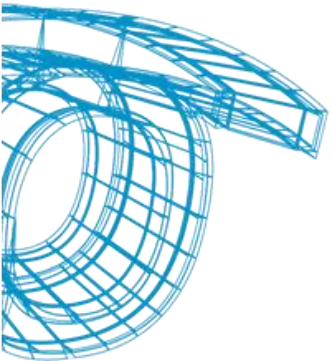
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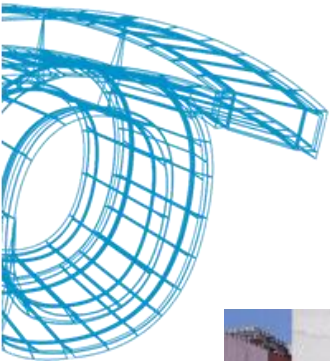
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## Vicomtech

- ★ Applied Research Technology Centre in Computer Graphics, Multimedia and Telecommunications (*non for profit Association*)
- ★ **+ 80 Researchers (17 PhD., engineers, informatics, .... )**
- ★ **Located in** the San Sebastian Technology Park since 2001
- ★ **Founded by**



## Tourist route generation

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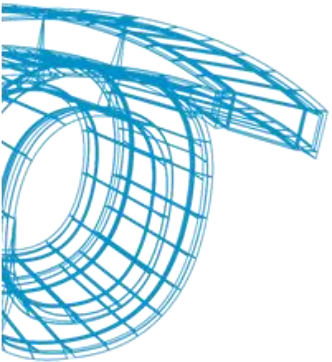


1. Tourists enter the Local Tourist Office (LTO) and talk about their profile and restriction
2. LTO's staff combine this information with their up-to-date knowledge about the local environment to create personalized routes

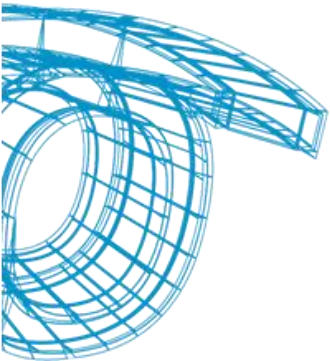
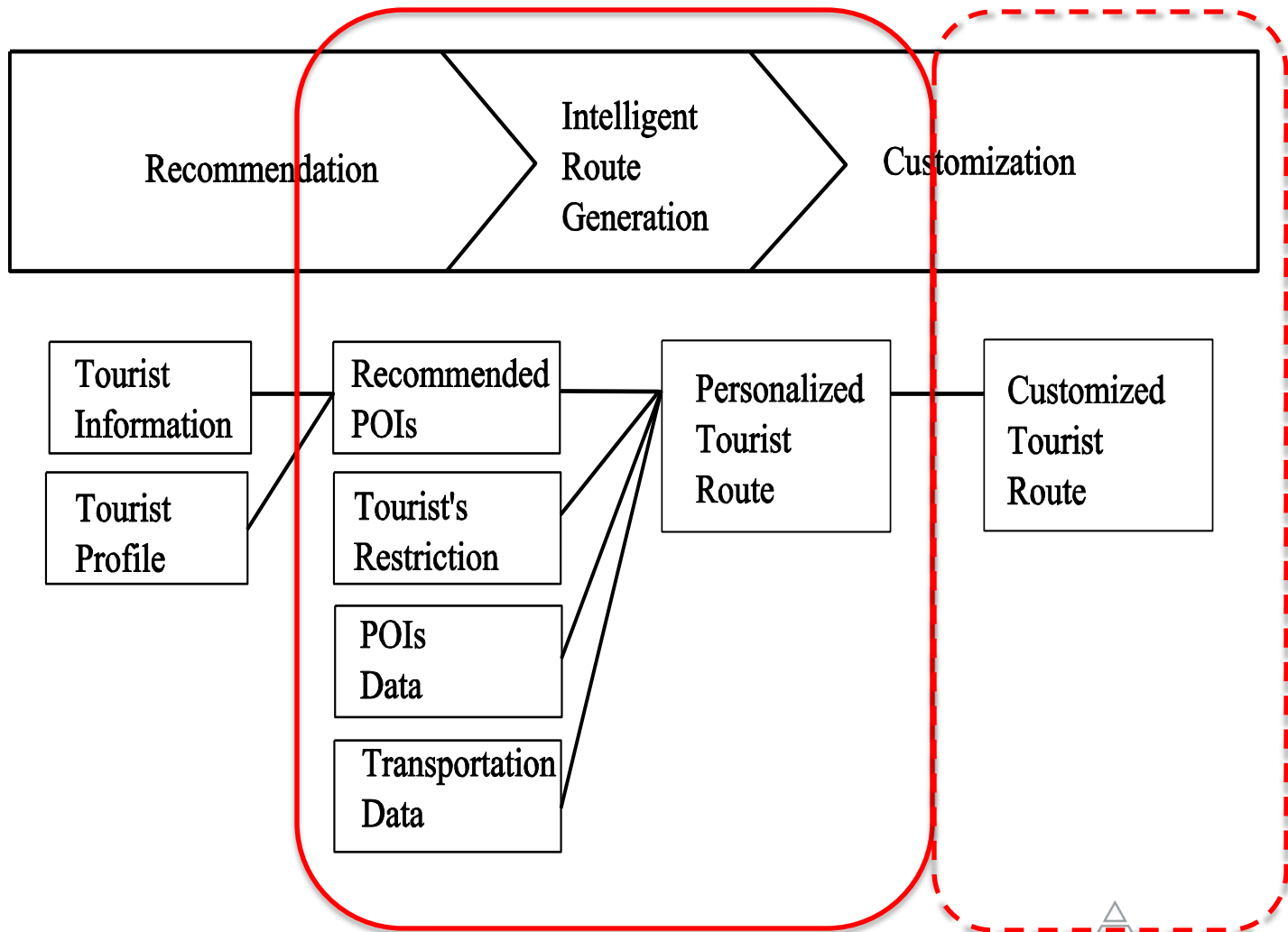
## Tourist route generation

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- ★ **Problems:**
  - ★ **Not updatable**
  - ★ **Human resources**
  - ★ **Restricted by opening hours**



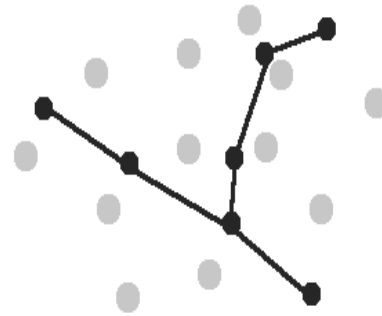
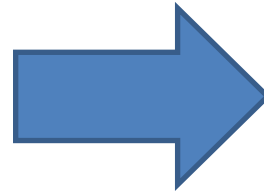
## Tourist route generation



## Tourist route generation



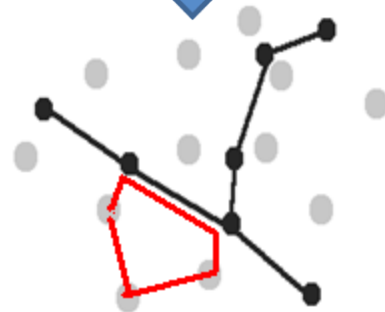
Tourist Profile



Nodes



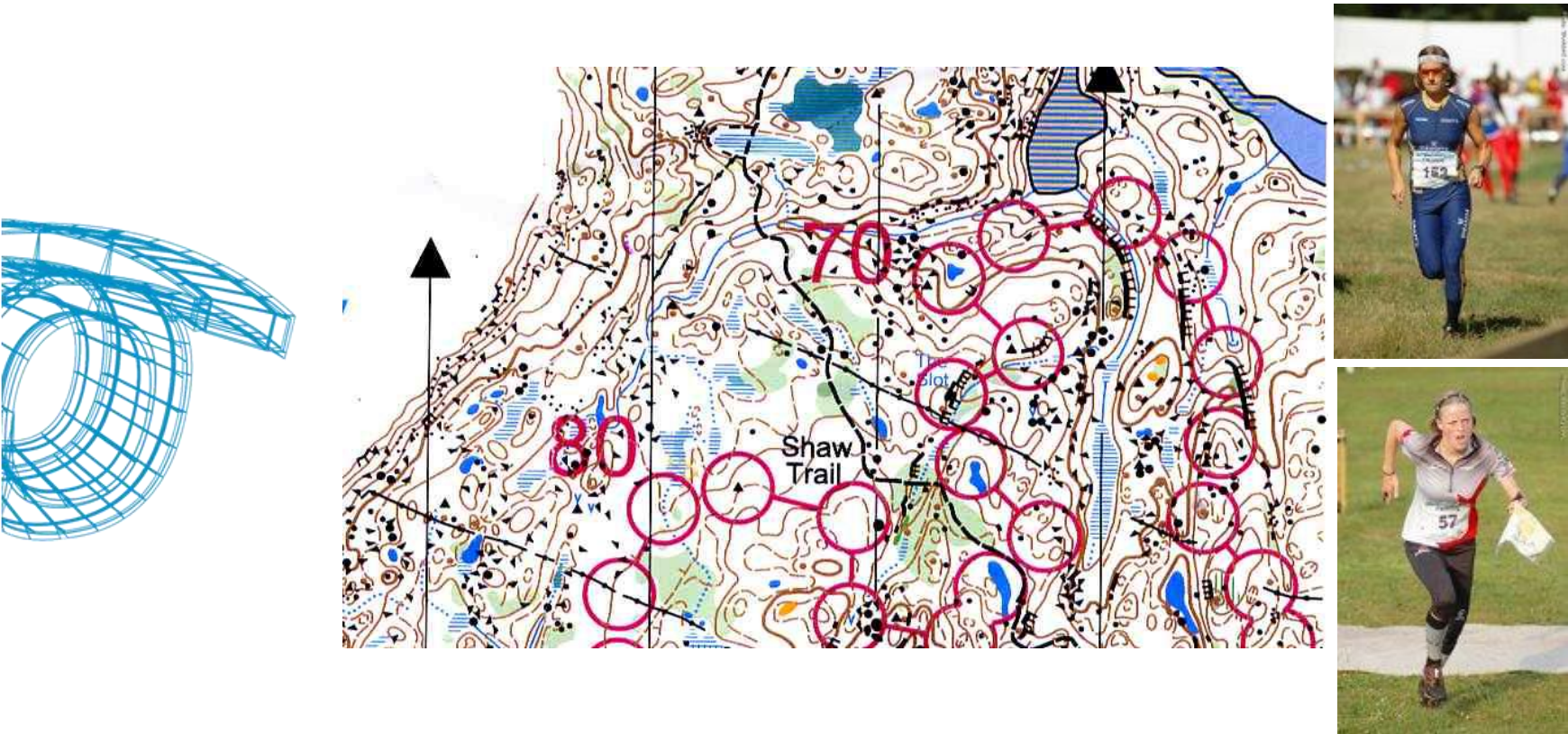
Tourist Attractions



Route



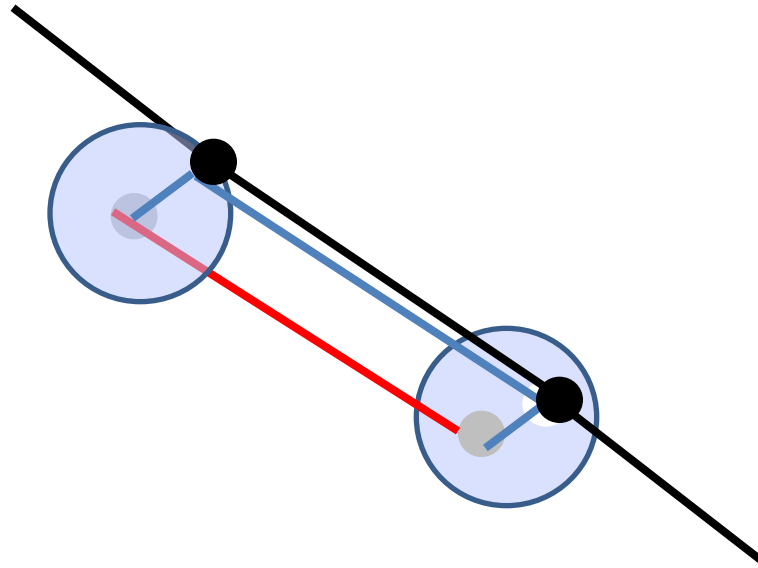
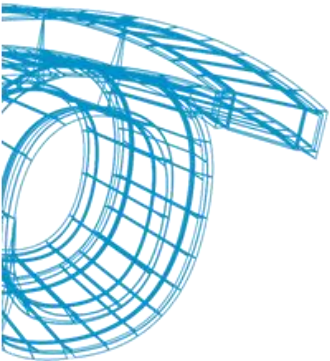
## Tourist route generation





## Tourist route generation

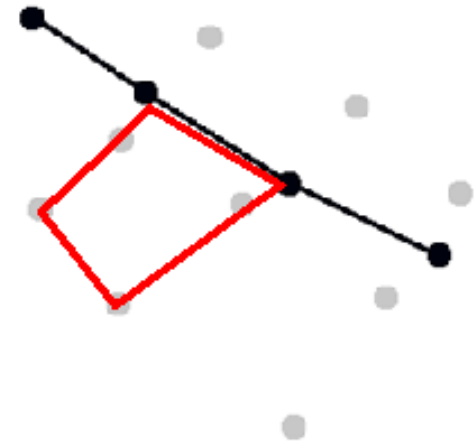
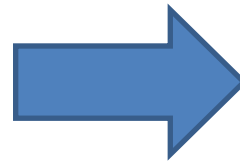
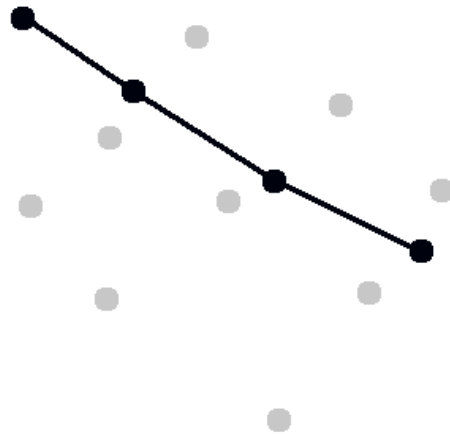
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- WALKING
- AREA NEAR POI
- PUBLIC TRANSPORT

## Time Dependent Orienteering Problem with Time Windows

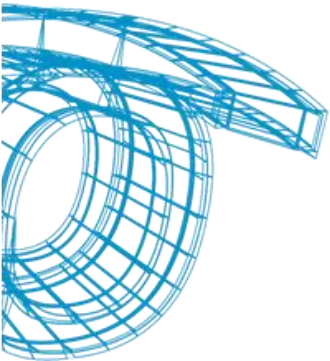
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## **Time Dependent Orienteering Problem with Time Windows**

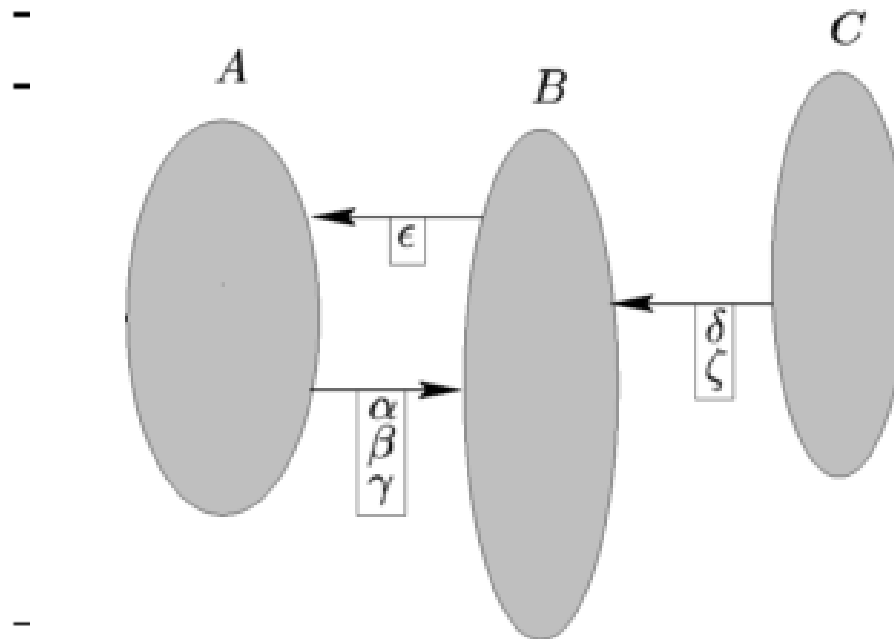
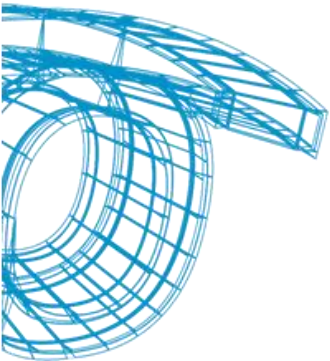
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- \* Includes public transportation**
- \* Hybrid approach to solve it in real time:**
  - \* Offline:**
    - \* Time Dependency:**
      - \* Precalculation of transportation time**
  - \* Real time**
    - \* Orienteering Problem with Time Windows**



## Time Dependent Orienteering Problem with Time Windows

- ★ Offline
- ★ Time Dependent Dijkstra's Shortest Path

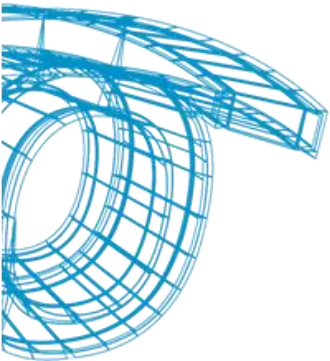


algorithm

## **Time Dependent Orienteering Problem with Time Windows**

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- \* Offline**
- \* We calculate the travel time between all the possible pairs of POIs with leave time steps of 1 minute**
- \* We calculate the average travel time for each pair of POIs**
- \* We store the travel time**
- \* 90 minutes on a PC Intel Core 2 Quad with 2.40 GHz processors and 2 GB Ram**

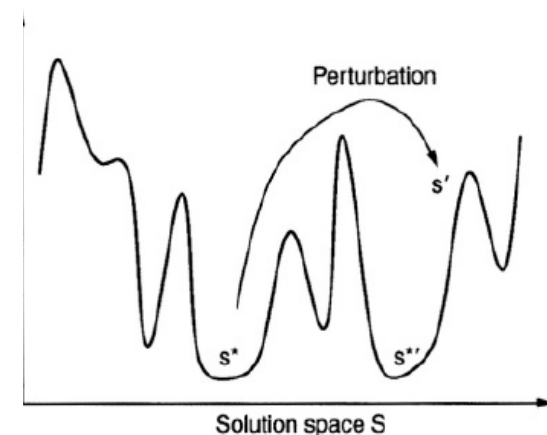


## Time Dependent Orienteering Problem with Time Windows

- ★ Real Time
- ★ Based on Vansteenwegen et al. [3].
- ★ We use the average travel times



```
procedure Iterated Local Search  
  ← GenerateInitialSolution  
  ← LocalSearch  
repeat  
  ← Perturbation  
  ← LocalSearch  
  ← AcceptanceCriterion  
until termination condition met  
end
```



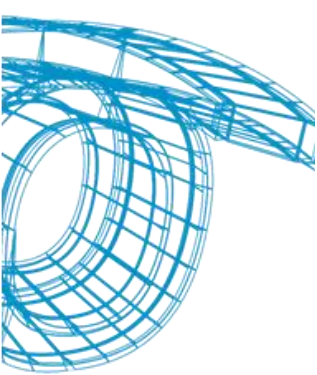
## Time Dependent Orienteering Problem with Time Windows

- ★ Real Time
- ★ Repair procedure to include the real travel time between the POIs of the route

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### Algorithm 2: Diagram of the repair procedure

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```
for  $i = 1$  to  $routeLength$  do
     $averageDistance = averageDistance(i - 1, i)$ ;
     $realDistance = realDistance(i - 1, i, l_{i-1})$ ;
     $a_i = l_{i-1} + realDistance$ ;
    if ( $averageDistance < realDistance$ ) and ( $visit\ i\ unfeasible$ ) then
        | remove  $i$  from route;
    else
        |  $Wait_i = max(0, Open - a_i)$ ;
        |  $l_i = a_i + Wait_i + T_i$ ;
```

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## Validation

startId	2 hours			4 hours			6 hours			8 hours		
	score	#	CPU(s)	score	#	CPU(s)	score	#	CPU(s)	score	#	CPU(s)
1	235	3	0.0	1035	14	0.1	1415	19	0.1	1745	23	0.2
2	530	7	0.0	1070	14	0.1	1485	20	0.1	1795	24	0.2
3	600	8	0.0	1115	15	0.1	1485	20	0.1	1715	23	0.2
4	605	8	0.0	1145	15	0.1	1485	20	0.1	1800	24	0.2
5	530	7	0.0	1070	14	0.1	1470	20	0.1	1810	24	0.2
6	750	10	0.0	1195	16	0.1	1485	20	0.1	1790	24	0.2
7	500	7	0.0	1035	14	0.1	1455	20	0.1	1770	24	0.2
8	650	9	0.0	1115	15	0.1	1485	20	0.1	1775	24	0.2





## Validation

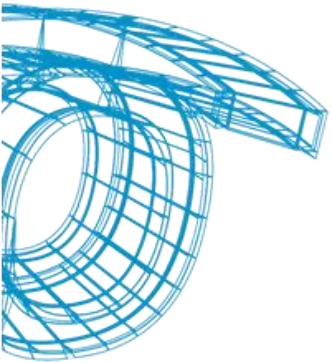


Around 70 minutes of walking time, 20 minutes of bus time and 8 minutes of waiting time for the bus

## Validation

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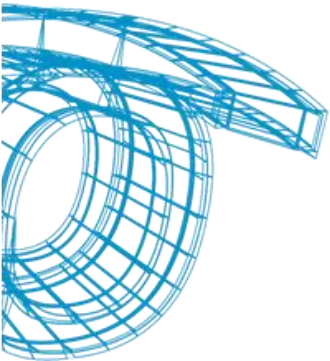
- ★ **Planned within Summer 2010**
- ★ **Demo: video**



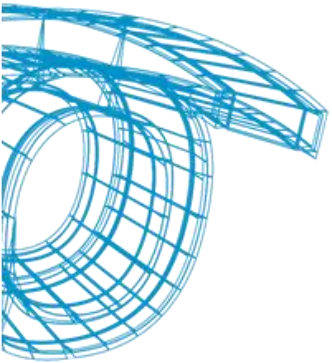
## Conclusions

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- \* **Hybrid approach for the TDOPTW**
  - \* **Offline:**
    - \* **Time Dependency:**
      - \* **Precalculation of transportation time**
  - \* **Real time**
    - \* **Orienteering Problem with Time Windows**
- \* **Future steps:**
  - \* **Test the approach in Time Dependent scenarios:**
    - \* **Multimodal freight transportation**
  - \* **Optimize offline algorithm**

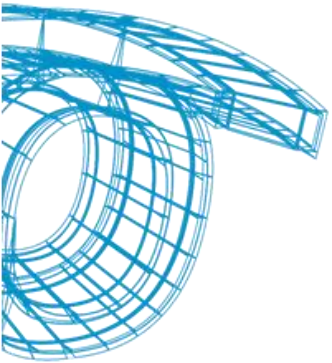


# QUESTIONS



**ESKERRIK ASKO**

**MUCHAS GRACIAS**





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