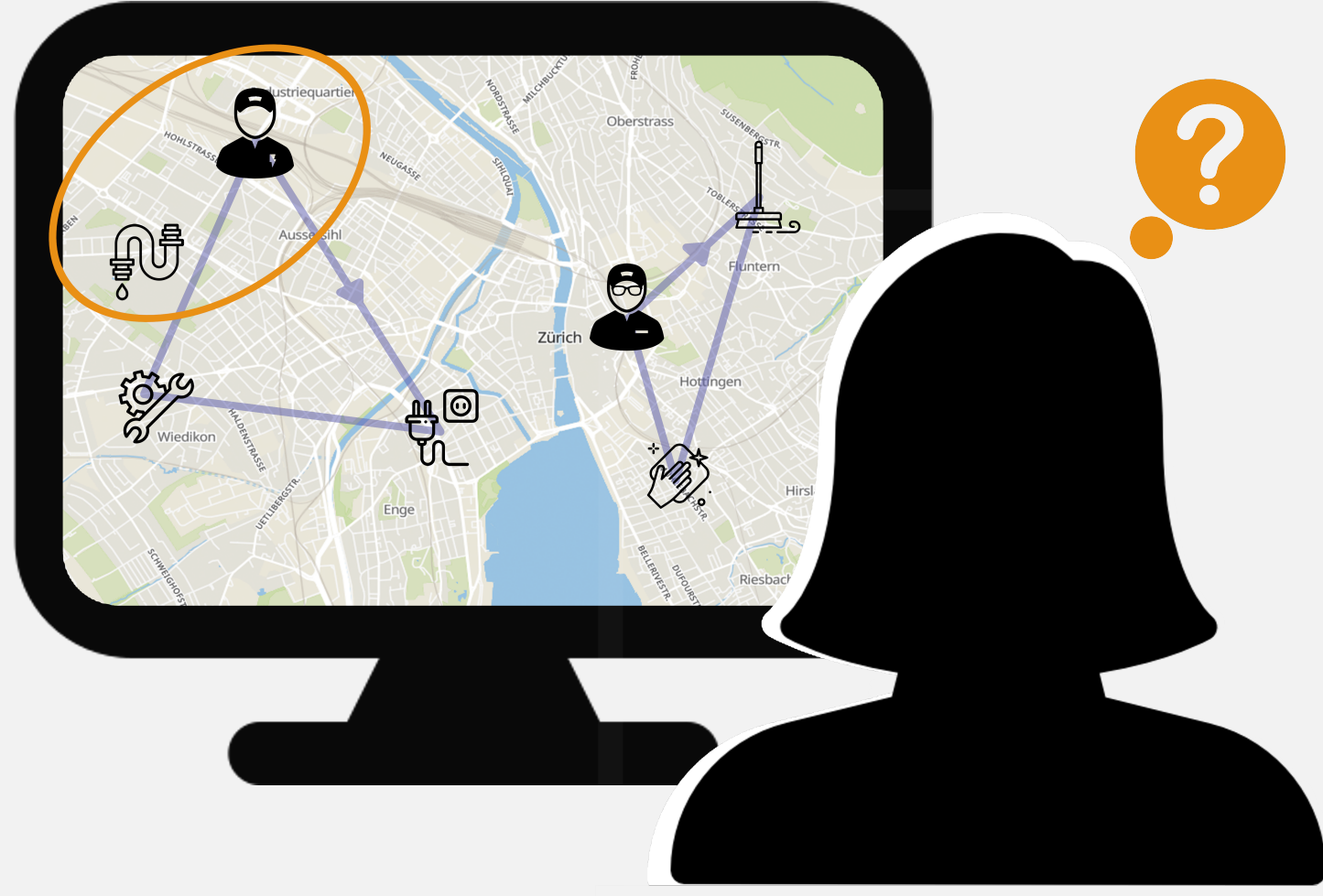


1. Problematic and motivating context



User: "Why is the employee Adam not performing the plumbing task in addition to his two other tasks?"

2. Workforce Scheduling and Routing Problem (WSRP)

Inputs

- $\mathcal{E} = \{\mathcal{E}_i\}_i$ **set of employees** with:
 - skill levels;
 - working time-windows;
 - locations.
- $\mathcal{T} = \{\mathcal{T}_j\}_j$ **set of tasks** with:
 - skill levels;
 - availability time-windows;
 - durations $\{d_j\}_j$;
 - locations.
- $\{\Delta t_{jk}^i\}_{ijk}$ **set of traveling durations** between two locations.

Optimization model

$$\max \left(\underbrace{\sum_{i \in \mathcal{E}} \sum_{j \in \mathcal{T}} \sum_{k \in \mathcal{T}} U_{ijk} d_j}_{\text{total working duration}}, - \underbrace{\sum_{i \in \mathcal{E}} \sum_{j \in \mathcal{T}} \sum_{k \in \mathcal{T}} U_{ijk} \Delta t_{jk}^i}_{\text{total traveling duration}} \right)$$

s.t.

- employees must work within their time windows;
- tasks must be performed within their time windows;
- employees must be skilled enough to perform the tasks;
- ...

$U_{ijk} \in \{0, 1\}$ whether or not \mathcal{E}_i goes from \mathcal{T}_j to \mathcal{T}_k

$T_j \in \mathbb{N}$ performing time of \mathcal{T}_j

3. Question & explanation in the literature

Questions types

- **Contrastive** (see [1]):
 "Why this current decision rather than that other one?"
 fact foil (often implicit)
- ...

Explanation reasoning types

- **Counterfactual** (see [2]):
 "To get that decision, the input should have been this way."
 suggested changes in the input
- ...

4. Related work

Article	Domain		Questions		Explanations		User interaction	
	AI	OR ¹	CT ²	Number	CF ³	Dependence on the SA ⁴	Process	GUI ⁵
[3] [4]	-	Scheduling	-	Single template	No	Content-wise: explanation based on data stored during the SA execution	Sequence of independent (question, explanation)	Yes
[5] [6] [7]	Planning	-	Yes	Multiple templates	No	Computation-wise: re-execution of the SA on an altered input		Yes
[2]	-	Selection problems (Knapsack)	Yes	Single template	Yes	Computation-wise: re-executions of the SA on altered inputs		No

1. OR: Operations Research; 2. CT: Contrastive; 3. CF: Counterfactual; 4. SA: Solving Algorithm(s); 5. GUI: Graphic User Interface

5. Our proposals

- **Domain:**
 - explainability in OR, similarly to XAI;
 - tackling real-world problems (WSRP).
- **Questions:**
 - multiple templates of contrastive questions.
- **Explanations:**
 - not depending on the solving algorithm;
 - include counterfactual explanation reasoning.
- **User interaction:**
 - dialectical process;
 - solutions and instances spaces exploration;
 - graphic user interface prototype.

6. Typology of (question, explanation) in our WSRP explanation tool

Type	Contrastive questions		Explanations		
	Templates	Condition	CF ¹	SS ²	CM ³
(QE ₁)	<ul style="list-style-type: none"> • Why is the employee $\langle \mathcal{E}_i \rangle$ not performing the task $\langle \mathcal{T}_k \rangle$ in addition to the activities of his/her planning? ↪ While keeping the same order of his/her other activities. • ... 	-	No	Small	Linear algorithm based on time slacks
(QE ₂)	<ul style="list-style-type: none"> • Why is the employee $\langle \mathcal{E}_i \rangle$ not performing the task $\langle \mathcal{T}_k \rangle$ in addition to the activities of his/her planning? ↪ Even if it means changing the order of his/her activities. • ... 	No feasible solution brought out in the explanation of (QE ₁) question	No	Medium	ILP⁴ restricted to \mathcal{E}_i 's planning
(QE ₃)	<ul style="list-style-type: none"> • Why is it not possible for the employee $\langle \mathcal{E}_i \rangle$ to perform the task $\langle \mathcal{T}_k \rangle$ in addition to the activities of his/her planning? • ... 	No feasible solution brought out in the explanation of (QE ₂) question	Yes	Large	ILP⁴ restricted to \mathcal{E}_i 's planning

1. CF: Counterfactual 2. SS: Solution Set to exam 3. CM: Computation Method 4. ILP: Integer Linear Programming

7. Graphic User Interface of our WSRP explanation tool



8. References

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- [3] J. Ludwig *et al.*, "Explaining Complex Scheduling Decisions", IUI Workshops, 2018
- [4] J. Agrawal *et al.*, "Using Explainable Scheduling for the Mars 2020 Rover Mission, ICAPS Workshop XAIP, 2020
- [5] B. Krarup *et al.*, "Towards Model-Based Contrastive Explanations for Explainable Planning", ICAPS Workshop XAIP, 2019
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