# AI-assisted Schedule Explainer for Nurse Rostering

AAMAS 2020 Demo #8

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(K. Čyras, A. Karamlou, M. Lee, D. Letsios have caried this research while at Imperial, but at the time of publication are no longer affiliated with this institution)
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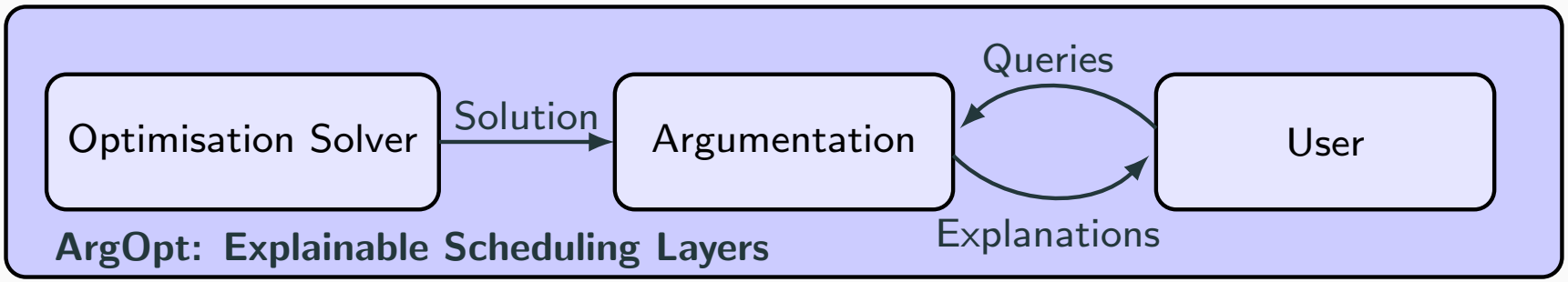
# Argumentation-supported Schedule Explainer

- A tool for explainable makespan scheduling with application to nurse rostering in clinical settings
- Theory (ArgOpt)
  - K. Čyras, D. Letsios, R. Misener, F. Toni: Argumentation for Explainable Scheduling AAAI [Čyras et al., 2019]
- Implementation
  - Stand-alone ArgOpt tool github.com/mylestunglee/aes
  - Interactive Schedule Explainer for Nurse Rostering github.com/AminKaramlou/AESWebApp

# Argumentation for Explainable Scheduling

Argumentation – explainable abstraction paradigm
for reasoning with incomplete and conflicting information

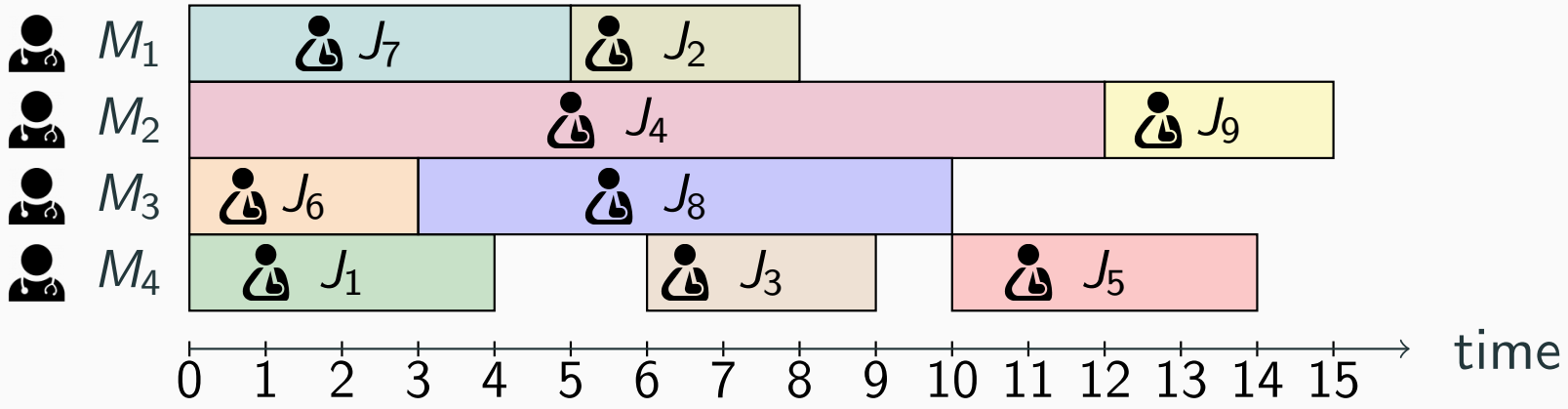



Methodology to explain makespan scheduling

- Mathematical constraints translated into argumentation
- Explanations defined, fulfil formal desiderata
- Actionable explanations presented in natural language

# Optimisation: Makespan Scheduling

**Example**: nurse rostering




**Input**

- Set $\mathcal{J} = \{J_1, J_2, \ldots, J_n\}$ of jobs
- Job $J_j$ has a processing time $p_j$
- Set $\mathcal{M} = \{M_1, M_2, \ldots, M_m\}$ of machines
- Machine-dependent deadlines, user decisions etc.

**Objective**: Construct a schedule $S$ with minimum makespan

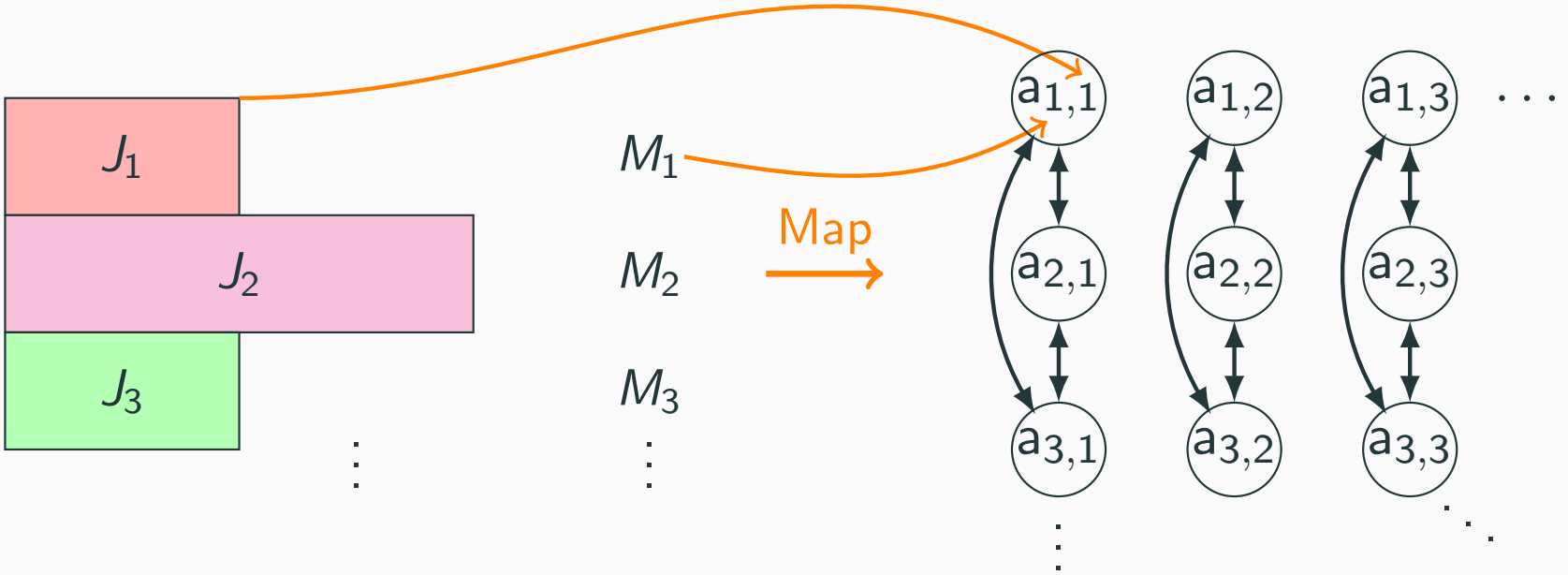
# Challenge: Explain and Make Interactive

$$
\begin{aligned}
& C_i \leq T_i && M_i \in \mathcal{M} \\
& \textstyle\sum_{M_i \in \mathcal{M}} x_{i,j} = 1 && J_j \in \mathcal{J} \\
& \textstyle\sum_{J_j \in \mathcal{J}} x_{i,j} \cdot p_j \leqslant C_i && M_i \in \mathcal{M} \\
& x_{i,j} = 1 && (i,j) \in D \\
& x_{i,j} \in \{0,1\} && J_j \in \mathcal{J},\ M_i \in \mathcal{M}
\end{aligned}
$$

- How about nurse $M_i$ takes care of $J_\ell$ instead of $J_j$?
  - Is it feasible, efficient? (Optimisation properties)
  - If enacted, what are the repercussions? (Improving solution)

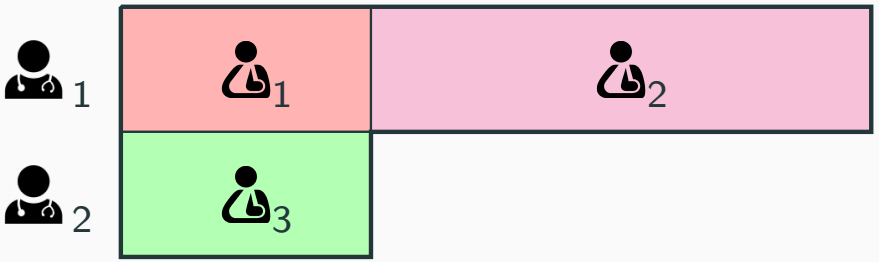
# Mapping Scheduling Problems to Argumentation Frameworks

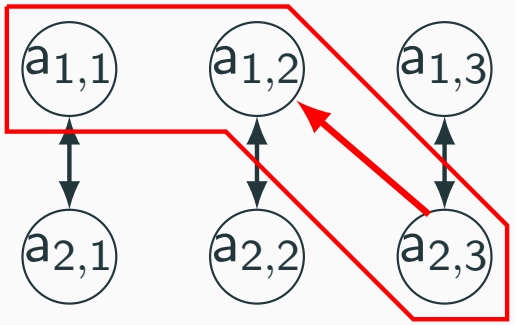
An abstract argumentation framework models decisions with arguments, and incompatibilities with attacks:




- Assignments $x_{i,j}$ become arguments $a_{i,j}$
- $a_{i,j}$ attacks $a_{k,l}$ iff $i \neq k$ and $j = l$
  - Different machines compete for the same job
- Stable extensions are 'good' schedules

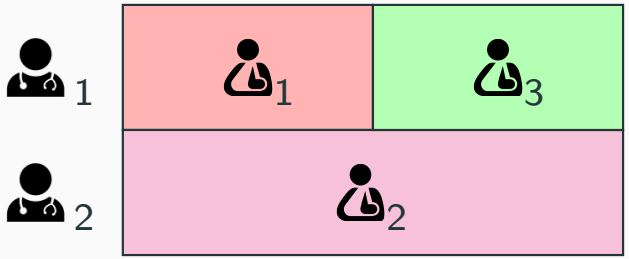
# Nurse: Can I Do This?



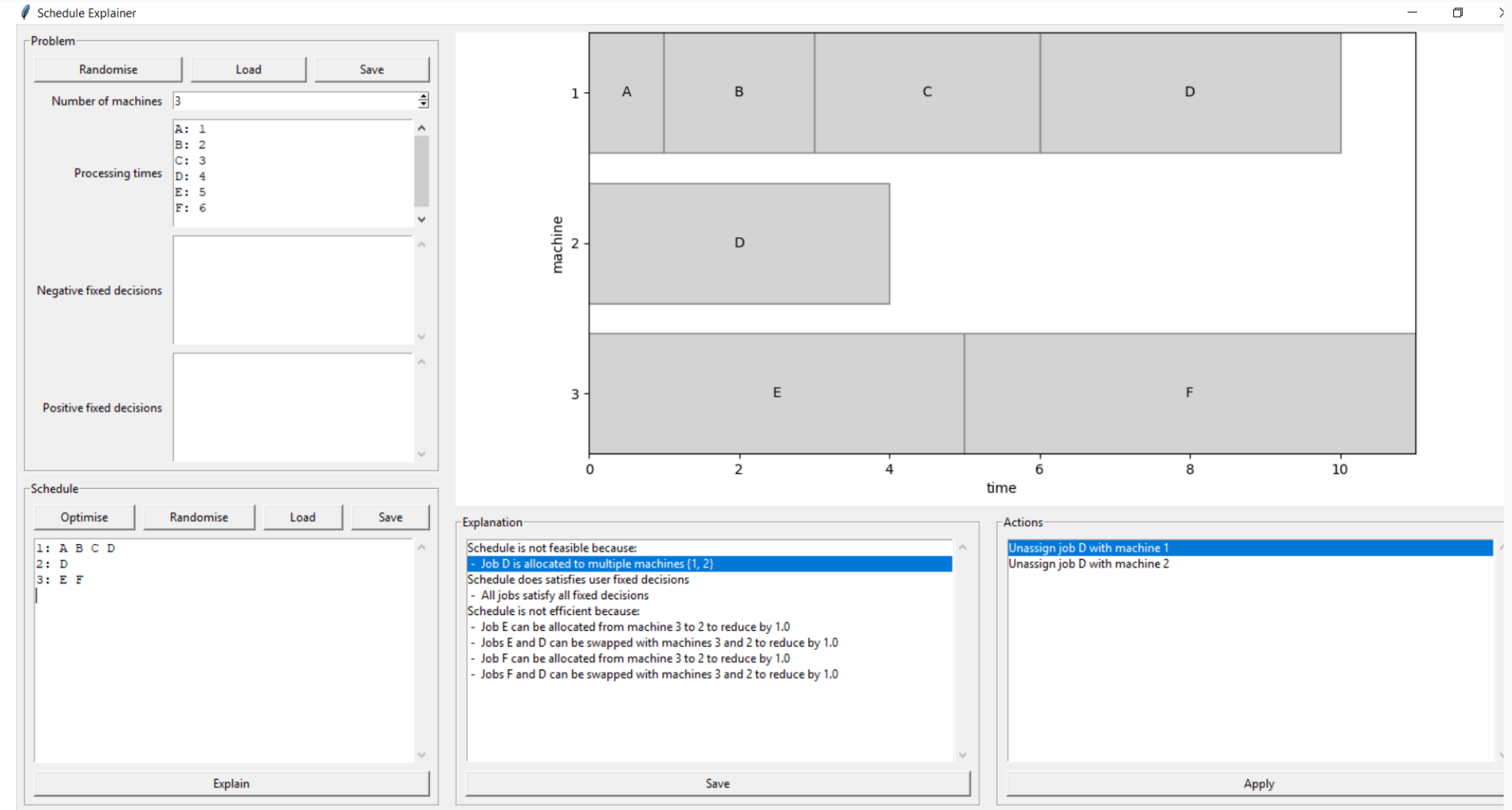




The attack from $a_{2,3}$ to $a_{1,2}$ explains why $\{a_{1,1}, a_{1,2}, a_{2,3}\} \approx S$ is not stable and thus $S$ is not efficient:

> *Because $S$ can be improved by swapping jobs 3 and 2 between nurses 2 and 1.*



# Stand-alone ArgOpt Tool



# AI-assisted Schedule Explainer for Nurse Rostering

# References

Čyras, K., Letsios, D., Misener, R., and Toni, F. (2019).
**Argumentation for Explainable Scheduling.**
In *33rd AAAI Conference on Artificial Intelligence*, pages 2752–2759, Honolulu, Hawaii. AAAI Press.