ENTIRE EDIH Training Course AI Based Scheduling

Helmut Simonis

School of Computer Science and Information Technology

University College Cork

Cork, Ireland

email:helmut.simonis@insight-centre.org

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Abstract

This document describes the detailed structure of a training course on AI based scheduling for the ENTIRE EDIH project. The training course provides an overview of current Constraint-based techniques to model and scheduling problems arising in project scheduling and manufacturing industries. It provides some hands-on experience with available open-source tools, and also describes key features of commercial solutions.

1 Introduction

2 Intended Audience

The course is intended for decision makers and persons facing scheduling problems in their professional work. IT personnel or consultants charged with choice of tools, development of models, or integration into the existing infrastructure will also be interested.

3 Learning Outcomes

After attending the course, the students should be able to

- Understand the need and potential for automated scheduling

- Understand the basic ideas behind Constraint-Based Scheduling

    - Declarative modeling
    - Abstraction of complex solving methods
    - Explainable reasoning

- Identify and apply the basic constraint types occurring in scheduling

- Understand the strength and weaknesses of available tools

- Be aware of basic visualization methods for scheduling

4 Timetable

Table 1 shows the format of the course delivered in a two-day event. The course consists of seven modules, which will be described in more detail in Section 5.

Table 1: Proposed Two Day Course Structure

Time	Day 1	Day 2
09:00-10:30	Introduction & Motivation	Costs & Objective Functions
10:30-11:00	Coffee	Coffee
11:00-12:30	Scheduling Concepts	Advanced Concepts
12:30-14:00	Lunch	Lunch
14:00-15:30	Machine Constraints	Case Studies
15:30-16:00	Coffee	Coffee & Close
16:00-17:00	Experiments	-

5 Modules

This section gives a brief bullet-point list of the key elements of each of the modules of the course. The course will be delivered as a mix of overview slides, some example problems and solutions using different solvers, and a hands-on session to explore programs and demonstrators.

5.1 Introduction & Motivation

- What is scheduling?
- What is constraint-based Scheduling?
- Solution approaches
- Some industrial examples
- Benefits of automated scheduling
- Why not just use a package?
- A short history of Constraint-Based Scheduling

5.2 Scheduling Concepts

- Core Concepts: Products, orders, jobs, tasks
- Temporal relations
- Release date and due date
- Processes, bill of material (BoM)
- Problem classification

- RCPSP
- Job-Shop, Flow-shop, Open-shop
- α, β, γ Notation

- Visualization methods

  - Gantt chart (Job/Machine view)
  - Precedence graphs
  - Resource profiles

5.3 Machine Constraints

- Disjunctive resources
- Cumulative Resources
- Machine Choice
- Work in progress
- Calendars

  - Factory-wide calendar
  - Machine specific calendars
  - Changing work pattern

5.4 Experiments

- Hands-on experience with some open-source tools
- Based on provided examples
- Impact of different solvers
- Visualization of results

5.5 Costs and Objective Functions

- Different types of objectives
- Cost vs. profit based objectives
- Makespan
- Lateness
- Just-in-time
- Interactive Scheduling

5.6 Advanced Concepts

- Sequence dependent setup
- Human resource constraints
    - Cumulative limits
    - Assigned operators
    - Skill levels
    - Operator speed
- Preemption
- Producer/Consumer constraints
- Alternative process paths
- Outsourcing decisions

5.7 Case Studies

- Present some industrial success stories
- Show how they fit into the framework provided
- Blades and Vanes Production for Gas Turbines (Siemens Energy)
- Oven Scheduling: Short-term and Long-term Objectives (Atlas-Copco)
- Factory Design Analysis (Johnson & Johnson)
- A guide to the literature
- Teaser: Try before you buy Scheduling

6 Conclusion