Dynamic Scheduling With Real-time Requirements

Kajeepan Umaibalan

Motivation

Dynamic scheduling

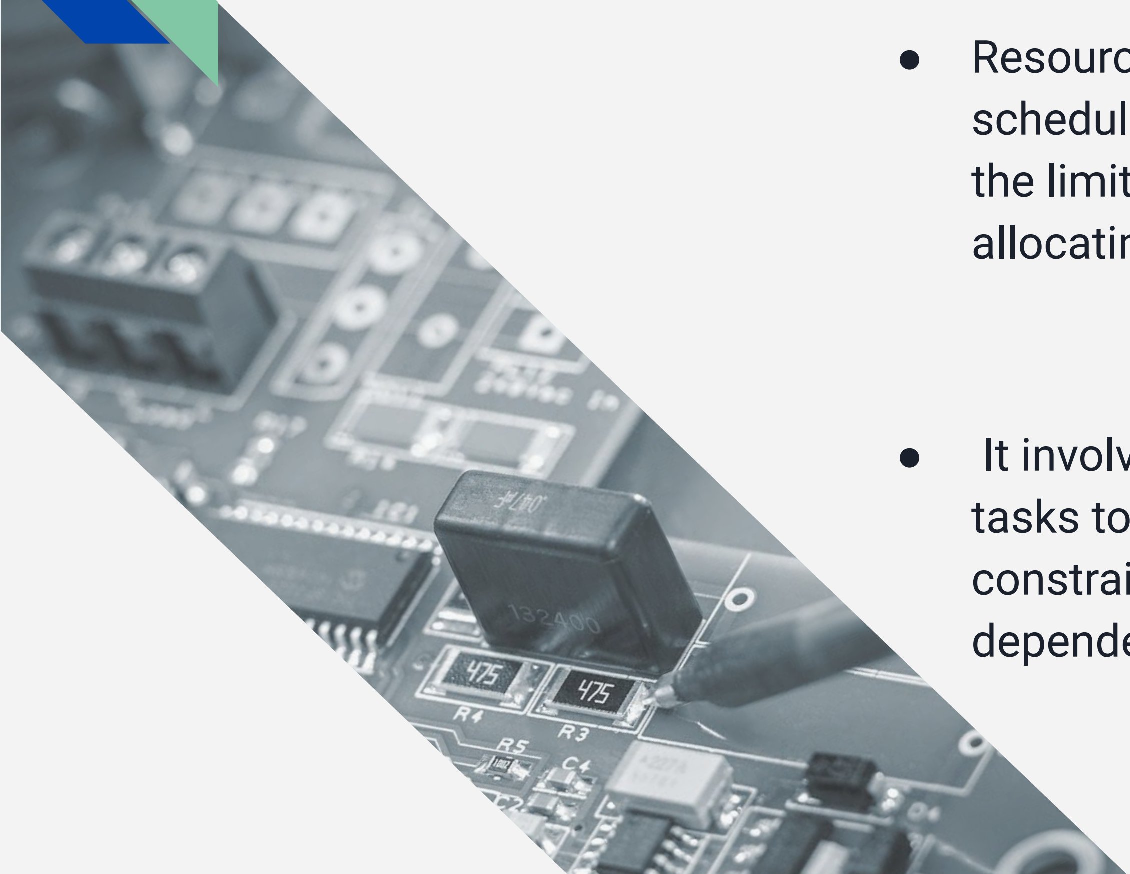
- **Dynamic scheduling for real-time systems refers to the process of adapting and adjusting task schedules in real-time to meet strict timing constraints and deadlines.**

- **Makes runtime decisions about task priorities, task assignment to resources, and task execution while optimizing system performance.**

Different types of dynamic scheduling

- Uniprocessor Scheduling
- Multicore Scheduling
- Resource-Constrained scheduling

Resource-Constrained Scheduling



- Resource-constrained scheduling is a scheduling technique that takes into account the limited availability of resources when allocating tasks or activities.

- It involves optimizing the assignment of tasks to resources while considering constraints like resource capacity, task dependencies, and timing requirements.

Common Approaches of Resource-Constrained Scheduling

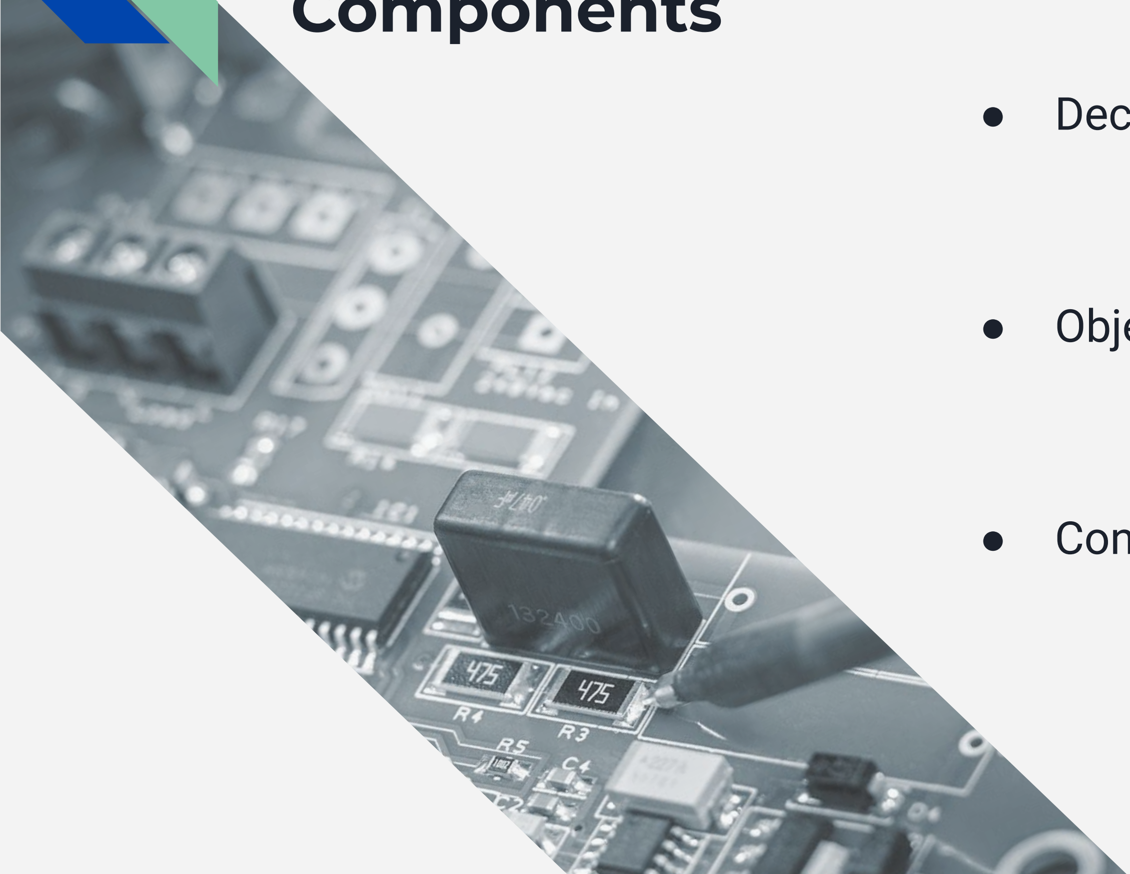
- Heuristics Algorithms
- Genetic Algorithms
- Metaheuristics Algorithms
- Integer Linear Programming Model

Integer Linear Programming Model (ILP)

- A formal model of the scheduling problem under resource constraints can be achieved by using binary decision variables with two indices

- ILP model in scheduling resource constraints provides a systematic and mathematical approach to optimize resource allocation and scheduling decisions

Integer Linear Programming Model Components

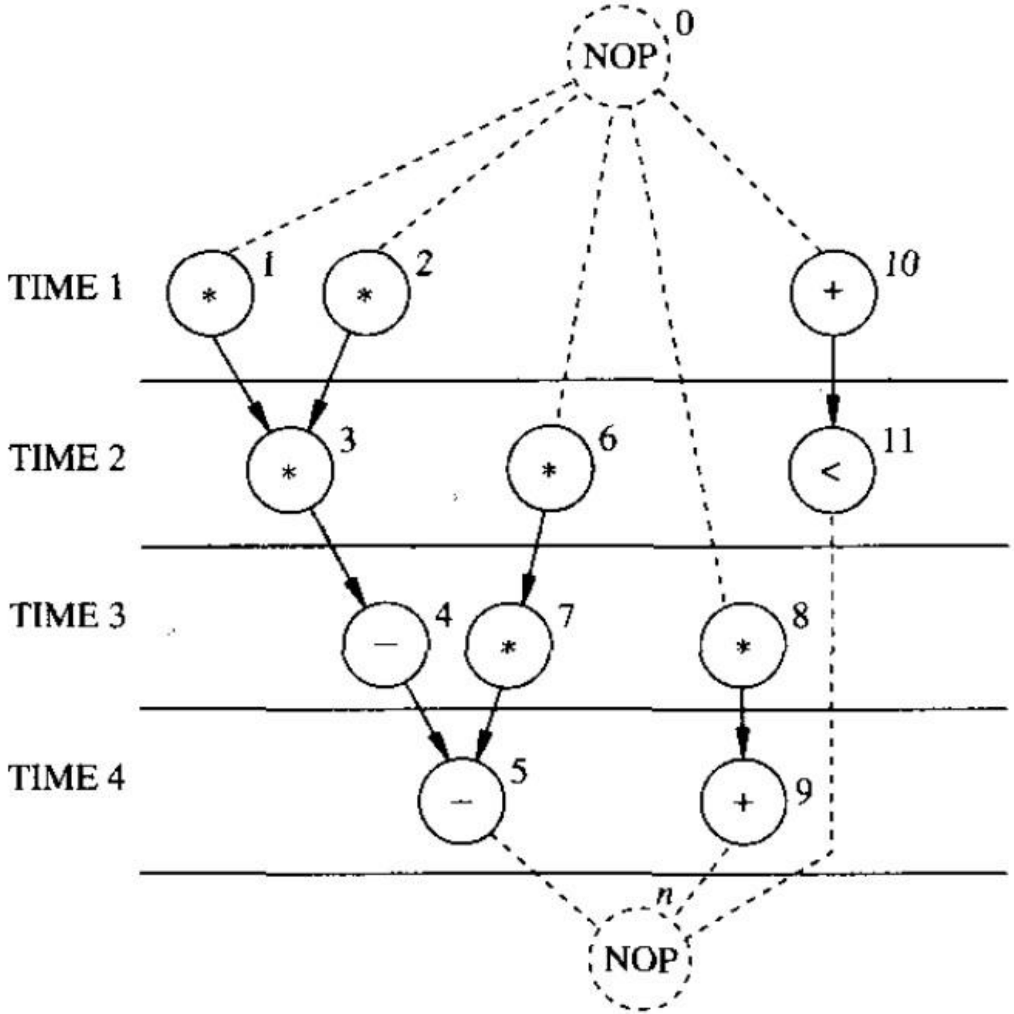


- Decision Variables
- Objective Function
- Constraints

Optimum Schedule Under Resource Constraints

- We assume that there are two types of resources: a multiplier and an ALU that performs addition/subtraction and comparison.

- the upper bounds on the number of both resources is 2



constraint sets one at a time. First, all operations must start
only once

$$
\begin{aligned}
x_{0,1} &= 1 \\
x_{1,1} &= 1 \\
x_{2,1} &= 1 \\
x_{3,2} &= 1 \\
x_{4,3} &= 1 \\
x_{5,4} &= 1 \\
x_{6,1} + x_{6,2} &= 1 \\
x_{7,2} + x_{7,3} &= 1 \\
x_{8,1} + x_{8,2} + x_{8,3} &= 1 \\
x_{9,2} + x_{9,3} + x_{9,4} &= 1 \\
x_{10,1} + x_{10,2} + x_{10,3} &= 1 \\
x_{11,2} + x_{11,3} + x_{11,4} &= 1 \\
x_{n,5} &= 1
\end{aligned}
$$

Constraints involving more than one possible start time for at least one operation

$$2x_{7,2} + 3x_{7,3} - x_{6,1} - 2x_{6,2} - 1 \geq 0$$

$$2x_{9,2} + 3x_{9,3} + 4x_{9,4} - x_{8,1} - 2x_{8,2} - 3x_{8,3} - 1 \geq 0$$

$$2x_{11,2} + 3x_{11,3} + 4x_{11,4} - x_{10,1} - 2x_{10,2} - 3x_{10,3} - 1 \geq 0$$

$$4x_{5,4} - 2x_{7,2} - 3x_{7,3} - 1 \geq 0$$

$$5x_{n,5} - 2x_{9,2} - 3x_{9,3} - 4x_{9,4} - 1 \geq 0$$

$$5x_{n,5} - 2x_{11,2} - 3x_{11,3} - 4x_{11,4} - 1 \geq 0$$

Considering Resource Constraints

$$x_{1,1} + x_{2,1} + x_{6,1} + x_{8,1} \leq 2$$

$$x_{3,2} + x_{6,2} + x_{7,2} + x_{8,2} \leq 2$$

$$x_{7,3} + x_{8,3} \leq 2$$

$$x_{10,1} \leq 2$$

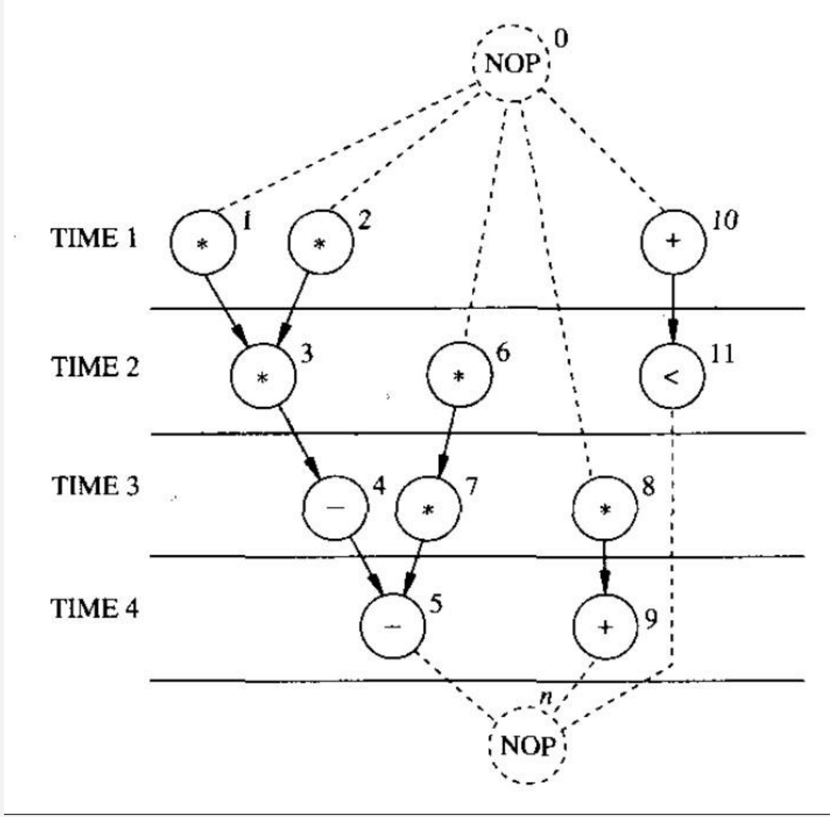
$$x_{9,2} + x_{10,2} + x_{11,2} \leq 2$$

$$x_{4,3} + x_{9,3} + x_{10,3} + x_{11,3} \leq 2$$

$$x_{5,4} + x_{9,4} + x_{11,4} \leq 2$$

By minimizing the expression above we can achieve an optimum solution that meets the real-time requirements

$$X_{6.1}+2X_{6.2}+2X_{7.2}+3X_{7.3}+X_{8.1}+2X_{8.2}+3X_{8.3}+2X_{9.2}$$
$$+3X_{9.3}+4X_{9.4}+x_{10.1}+2X_{10.2}+3X_{10.3}+2X_{10.2}$$
$$+3X_{11.3}+4X_{11.4}$$



Summary

the presentation focused on resource-constrained scheduling, its key components, and its applications in industries such as manufacturing, project management, and logistics. Resource-constrained scheduling involves optimizing the allocation of tasks to limited resources while considering constraints such as resource capacity, task dependencies, and timing requirements.

Reference

[1]Synthesis and optimisation of digital circuits By Giovanni De Micheli

ISBN:978-0-07-016333-1 Published:01 January 1994

[2] Hard Real-Time Computing Systems Predictable Scheduling Algorithms

and Applications By Giorgio C Buttazzo 2013.

[3] Baruch, Zoltan. “Scheduling Algorithms for High-Level Synthesis.”

(2003).

[4] Implementation Of aScheduling and Allocation Algorithm for Hardware

Evaluation Kangmin Chen LiTH-ISY-EX–05/3754–SE Link ̈oping 2005