Planning, Packing and Playing in Liberal Arts Mathematics

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MATH 1503: Contemporary Mathematics

- General Education Mathematics Course
- Equivalent Courses at all Oklahoma Public Universities and Colleges
- Required Topics: Logic & Descriptive Statistics
- Other Topics: Optional; must include at least one unit of some “Mathematics of Decision-Making” and one unit of some “Mathematics of Patterns”

MACHINE-SCHEDULING: Set-Up

Identical Processors

- Processor works on a task without interruption until the task is complete.
- Available processor will work on an available task.

Set List of Tasks

- Tasks are shown in Order-Requirement Digraphs (directed graph) – realistic constraints.
- Priority Lists independent of the digraphs can also arrange tasks.

MACHINE-SCHEDULING: GOAL

Schedule the tasks according to the constraints and priorities so that the time to complete all the tasks is minimized.

Secondary Goal: Minimize the time that the processors are idle.

BIN-PACKING: Set-Up

BINS

- All bins have the same capacity.
- An individual weight cannot be split among multiple bins.
- Bins cannot be packed beyond capacity.

WEIGHTS

- All weights are known at the beginning of the problem.
- Each is less than the total capacity of one bin.
- Priority lists or special criteria may be used.

BIN-PACKING: GOAL

Find the minimum number of bins into which the weights can be packed.

NOTICE: This is a scheduling problem with the amount of time a processor can work being fixed (capacity) and the goal being to minimize the number of processors needed.

MACHINE-SCHEDULING: Algorithms

- List-Processing: Digraph and Priority List
- Critical-Path Scheduling: Use longest remaining paths in the digraph to determine priorities
- Independent Tasks
  - Priority Lists
  - Decreasing-Time-Lists
- NO ALGORITHM IS GUARANTEED TO BE OPTIMAL IN ALL SITUATIONS!

BIN-PACKING: Algorithms

- NEXT FIT (NF): Use one bin until full or until next weight does not fit.
- FIRST FIT (FF): Put weight into first bin already opened that has room. If no such bin exists, open a new one.
- WORST FIT (WF): Put weight into bin that has the most room available and has room for that weight. If no such bin exists, open a new one.
- Apply all three algorithms after first sorting the weights into decreasing order (NFD, FFD, WFD).

MORE COMPLEXITY: Realistic Modeling

- Not all processors or bins are identical.
- Processors require “down-time”.
- Priority lists include “idle” tasks.
- Bin-Packing has time constraints.
  - Re-prioritizing the weights into decreasing order is a task that eats time.
  - Going back to already used bins is inefficient.
- Not all weights or tasks are known.