The problem defines the study hours are continued and days are also continued, so this problem can be solved with a 1D array.

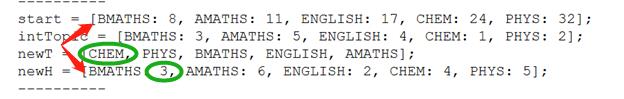
The basic idea is, set an array “start” with the value 0..D\*H-1 to record the start point of each TOPIC, due to the study hours being continued, so we only need to record length(TOPIC) number of start points.

However, we can’t directly use the TOPIC as the order of start because the order of start should be a new order of TOPIC after applying before/after constraint (item in start should start from small to big).

The continuing of start is based by

start(topic) + hours(topic) <= start (next topic)

even start follows the index order of old TOPIC, as we replace the hours with new hours: newH, it also follows the index order of old TOPIC, but the value belongs to new TOPIC: newT



**Extra parameters:**

int: h2; 🡪 The hour of half day.

int: totalTime; 🡪 The sum of hours of total study day.

TOPIC: last; 🡪 The last item of TOPIC

**Valuables:**

array [TOPIC] of var 0...totalTime: start;

🡪an array to record start time point of each TOPIC.

array [TOPIC] of var 1...length (TOPIC): intTopic;

🡪an array to find new TOPIC order after applying before/after constraint.

array [1...length (TOPIC)] of var TOPIC: newT;

🡪an array to store the order of topic after applying before/after constraint.

array [TOPIC] of var int: newH;

🡪 an array to store the continue hours of each topic at newT.

**Constraints:**

The main purpose of constraints at line (67-82) above is finding a new order of TOPIC: newT and continue hours newH bind to newT applying before/after constraint

The constraints at line (85-95) make sure each item In start is continued and no item cross each other.

The constraint at line (98-104) makes sure that for the days have sport session, there are no topics hold In the session.

The constraint at line (107-109): for each topic In start, the start point mod H should always be the numbers between 0 to H. Then we can know the time of hour that this topic start, we need to make sure the start time is on morning (< h2). And there should be no other topics ahead it (< min(hours)). To make sure the morning topics start at first hour of the day, we need object function to limit it.

**Extension Constraints:**

constraint forall (i in TOPIC) (

start[newT[i]] mod H < (start[newT[i]] + newH[newT[i]] - 1) mod H

);

We already know that the start point mod H will get a number between 0 to H, it is same as end point. Due to there are no topic’s hour greater than H, and start is continued. If the end point mod H is smaller than start point mod H, it means this topic is cross night and end point is ahead of start point, for example (start at day1,7: 7mod8 = 7 and end at day2,2: 10mod8=2. 2<7). So, just make sure start point mod H is always smaller than end point mod H, then the topic will always remain In same day.

**Object function:**

solve maximize min(start) - sum(i in morning)(start[TOPIC[intTopic[i]]] mod H);

To start as late as possible, the first start point should be maximized. To let the morning topic start as early as possible, the distance between morning topics starts points to the first hour of the day should be minimum.

**Output:**

Solve e0 without extension

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Hour0 | Hour1 | Hour2 | Hour3 | Hour4 | Hour5 | Hour6 | Hour7 |
| Day1 |  |  |  |  |  |  |  |  |
| Day2 | CHEM | | | PHYS | | | | |
| Day3 | PHYS | BMATHS | |  |  |  |  |  |
| Day4 | ENGLISH | | | |  |  |  |  |
| Day5 | ATMATH | | | | |  |  |  |

with solver Gecode 6.3.0 Finished in 479msec.

Solve e0 with extension

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Hour0 | Hour1 | Hour2 | Hour3 | Hour4 | Hour5 | Hour6 | Hour7 |
| Day1 |  |  |  |  |  |  | BMATHS | |
| Day2 | ATMATH | | | | | |  |  |
| Day3 | ENGLISH | | | |  |  |  |  |
| Day4 | CHEM | | |  |  |  |  |  |
| Day5 | PHYS | | | | | |  |  |

with solver Gecode 6.3.0 Finished in 513 msec.

Solve e1 without extension

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Hour0 | Hour1 | Hour2 | Hour3 | Hour4 | Hour5 | Hour6 | Hour7 |
| Day1 |  |  |  |  |  |  |  |  |
| Day2 |  |  |  |  |  |  |  |  |
| Day3 |  |  |  |  |  |  |  |  |
| Day4 |  |  |  |  |  |  |  |  |
| Day5 | CHEM | | | PHYS | | | | |
| Day6 | PHYS | PROG | | | | GRAPH | | |
| Day7 | GRAPH | | BMATHS | |  |  |  |  |
| Day8 | OR | | | | STATS | | | |
| Day9 | DIGITAL | | | |  |  |  |  |
| Day10 | AMATHS | | | | | DISCRETE | | |

with solver Gecode 6.3.0 Finished in 682msec.

Solve e1 with extension

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Hour0 | Hour1 | Hour2 | Hour3 | Hour4 | Hour5 | Hour6 | Hour7 |
| Day1 |  |  |  |  |  |  |  |  |
| Day2 |  |  |  |  |  |  |  |  |
| Day3 |  |  |  |  |  |  |  |  |
| Day4 |  |  |  |  |  |  |  |  |
| Day5 | CHEM | | | GRAPH | | | | |
| Day6 | BMATHS | | PHYS | | | | | |
| Day7 | STATS | | | |  |  |  |  |
| Day8 | OR | | | | PROG | | | |
| Day9 | DIGITAL | | | |  |  |  |  |
| Day10 | AMATHS | | | | | DISCRETE | | |

with solver Gecode 6.3.0 Finished in 462msec.

Solve e2 without extension

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Hour0 | Hour1 | Hour2 | Hour3 | Hour4 | Hour5 | Hour6 | Hour7 |
| Day1 |  |  |  |  |  |  |  |  |
| Day2 |  |  | T1 | | T4 | | | T7 |
| Day3 | T7 | | | |  |  |  |  |
| Day4 | T10 | | | |  |  |  |  |
| Day5 | T16 | | | | | | T12 | |
| Day6 | T12 | | | | | T3 | | |
| Day7 | T3 | T9 | | |  |  |  |  |
| Day8 | T15 | | T14 | | | | | T2 |
| Day9 | T2 | | | |  |  |  |  |
| Day10 | T5 | | | | | | T13 | |
| Day11 | T13 | | | |  |  |  |  |
| Day12 | T11 | | | | | | | |
| Day13 | T6 | | | | T8 | | | |

with solver Chuffed 0.10.4 Finished in 2s 886msec.

Gecode 6.3.0 take longer than hour

Solve e2 with extension

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Hour0 | Hour1 | Hour2 | Hour3 | Hour4 | Hour5 | Hour6 | Hour7 |
| Day1 |  |  |  | T14 | | | | |
| Day2 | T5 | | | | | | T1 | |
| Day3 |  | T4 | | |  |  |  |  |
| Day4 | T8 | | | |  |  |  |  |
| Day5 | T7 | | | | | T9 | | |
| Day6 | T16 | | | | | |  |  |
| Day7 | T10 | | | |  |  |  |  |
| Day8 | T15 | | T13 | | | | | |
| Day9 | T6 | | | |  |  |  |  |
| Day10 |  | T12 | | | | | | |
| Day11 | T3 | | | |  |  |  |  |
| Day12 | T11 | | | | | | | |
| Day13 |  |  |  | T2 | | | | |

with solver Chuffed 0.10.4 Finished in 38s 332msec.

Gecode 6.3.0 take longer than hour

Solve e3 without extension

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Hour0 | Hour1 | Hour2 | Hour3 | Hour4 | Hour5 | Hour6 | Hour7 |
| Day1 |  |  |  |  |  |  |  |  |
| Day2 |  |  |  |  |  |  |  |  |
| Day3 |  |  |  |  |  |  |  |  |
| Day4 |  |  |  |  |  |  |  |  |
| Day5 |  |  |  |  |  |  |  |  |
| Day6 |  |  |  |  |  |  |  |  |
| Day7 |  |  |  |  |  |  |  |  |
| Day8 |  |  |  |  |  |  |  |  |
| Day9 |  |  |  |  |  |  |  |  |
| Day10 |  |  |  |  |  |  |  |  |
| Day11 |  |  |  |  |  |  |  |  |
| Day12 |  |  |  |  |  |  |  |  |
| Day13 |  |  |  |  |  |  |  |  |
| Day14 |  |  |  |  |  |  |  |  |
| Day15 |  |  | T1 | | | | | T4 |
| Day16 | T4 | | | |  |  |  |  |
| Day17 |  |  |  |  |  |  |  |  |
| Day18 | T11 | | | | | | | |
| Day19 | T5 | | | | | | T13 | |
| Day20 | T13 | | | |  |  |  |  |
| Day21 | T8 | | | | | T12 | | |
| Day22 | T12 | | | |  |  |  |  |
| Day23 | T15 | | | | |  | T7 | |
| Day24 | T7 | | | T10 | | | | |
| Day25 | T6 | | | | |  | T9 | |
| Day26 | T9 | | | T2 | | | | |
| Day27 | T16 | | | | | | T3 | |
| Day28 | T3 | | | T14 | | | | |

with solver Chuffed 0.10.4 Finished in 529msec.

Gecode 6.3.0 take longer than hour

Solve e3 with extension

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Hour0 | Hour1 | Hour2 | Hour3 | Hour4 | Hour5 | Hour6 | Hour7 |
| Day1 |  |  |  |  |  |  |  |  |
| Day2 |  |  |  | T1 | | | | |
| Day3 |  |  |  |  |  |  |  |  |
| Day4 |  |  |  |  |  |  |  |  |
| Day5 | T11 | | | | | | | |
| Day6 |  |  |  | T4 | | | | |
| Day7 |  |  |  |  |  |  |  |  |
| Day8 |  |  |  | T7 | | | | |
| Day9 |  |  |  |  |  |  |  |  |
| Day10 |  |  |  | T14 | | | | |
| Day11 |  |  |  |  |  |  |  |  |
| Day12 |  |  |  | T10 | | | | |
| Day13 |  |  |  |  |  |  |  |  |
| Day14 |  |  |  |  |  |  |  |  |
| Day15 |  |  | T13 | | | | | |
| Day16 |  |  |  |  |  |  |  |  |
| Day17 |  |  |  |  |  |  |  |  |
| Day18 |  |  |  | T2 | | | | |
| Day19 | T16 | | | | | |  |  |
| Day20 |  |  |  |  |  |  |  |  |
| Day21 |  |  |  | T9 | | | | |
| Day22 |  |  |  |  |  |  |  |  |
| Day23 | T6 | | | | |  |  |  |
| Day24 | T15 | | | | |  |  |  |
| Day25 | T5 | | | | | |  |  |
| Day26 |  | T12 | | | | | | |
| Day27 |  |  |  | T3 | | | | |
| Day28 |  |  |  | T8 | | | | |

with solver Chuffed 0.10.4 Finished in 958msec.

Gecode 6.3.0 take longer than hour