# Lecture 28

CSE 331

Nov 7, 2022

# Reflection P2 due TODAY

| | | |
|---|---|---|
| Fri, Nov 4 | Kickass Property Lemma F21 F19 F18 F17 x² | [KT, Sec 5.4] (**Project (Problem 2 `Coding`) in**) |
| Mon, Nov 7 | Weighted Interval Scheduling F21 F19 F17 x² | [KT, Sec 6.1] (**Project (Problem 2 `Reflection`) in**) |
| Tue, Nov 8 | | (**HW 6 out**) |
| Wed, Nov 9 | Recursive algorithm for weighted interval scheduling problem F21 F19 F17 x² | [KT, Sec 6.1] |
| Fri, Nov 11 | Subset sum problem F21 F19 F18 F17 x² | [KT, Sec 6.1, 6.2, 6.4] |
| Mon, Nov 14 | Dynamic program for subset sum F21 F19 F18 F17 x² | [KT, Sec 6.4] |
| Tue, Nov 15 | | (**HW 7 out, HW 6 in**) |
| Wed, Nov 16 | Shortest path problem F21 F19 F18 F17 x² | [KT, Sec 6.8] |
| Fri, Nov 18 | Bellman-Ford algorithm F21 F19 F18 F17 x² | [KT, Sec 6.8] |
| Mon, Nov 21 | The P vs. NP problem F21 F19 | [KT, Sec 8.1] |
| Wed, Nov 23 | **No class** | Fall Recess |
| Fri, Nov 25 | **No class** | Fall Recess |
| Mon, Nov 28 | More on reductions F21 F19 | [KT, Sec 8.1] |
| Tue, Nov 29 | | (**HW 8 out, HW 7 in**) |
| Wed, Nov 30 | The SAT problem F21 F19 | [KT, Sec 8.2] |
| Fri, Dec 2 | NP-Completeness F21 F19 | [KT, Sec. 8.3, 8.4] (**Project (Problem 3 `Coding`) in**) |
| Mon, Dec 5 | *k*-coloring problem F21 F19 | [KT, Sec 8.7] (**Quiz 2**)<br>(**Project (Problem 3 `Reflection`) in**) |

# Group formation instructions

## Autolab group submission for CSE 331 Project

The lowdown on submitting your project (especially the coding and reflection) problems as a group on Autolab.

Follow instructions **EXACTLY** as they are stated

**The instruction below are for Coding Problem 1**

**You will have to repeat the instructions below for EACH coding AND reflection problem on project on Autolab** (with the appropriate changes to the actual problem).

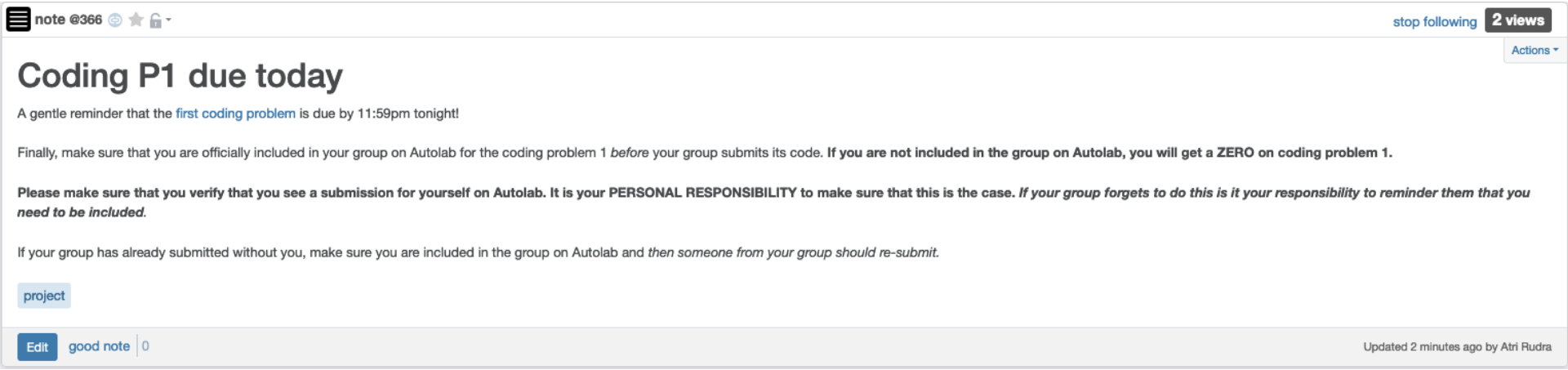
## Form your group on Autolab

**Groups on Autolab will NOT be automatically created**

You will have to form a group on Autolab by yourself (as a group). Read on for instructions on how to go about this.

Click to add notes

# Make sure you are in your group



# Reflection P1 graded

note @401

stop following 24 views

Actions

## Reflection 1 graded

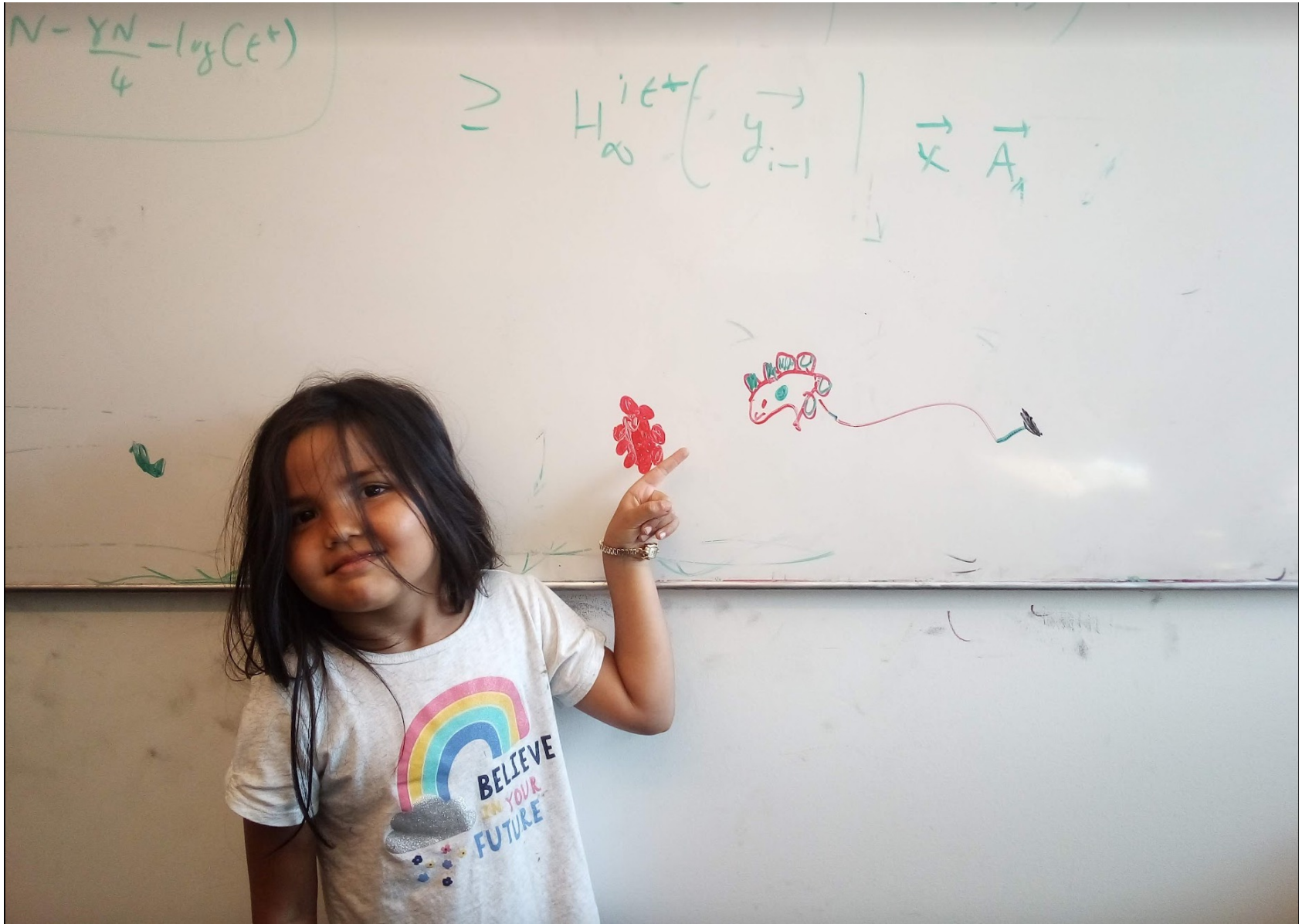
Reflection 1 grades have been released on Autolab. Hope the feedback helps as y'all prepare your reflection 2.

**(Please see the re-grade policy as well as the grading rubric below before contacting us with questions on grading.)**

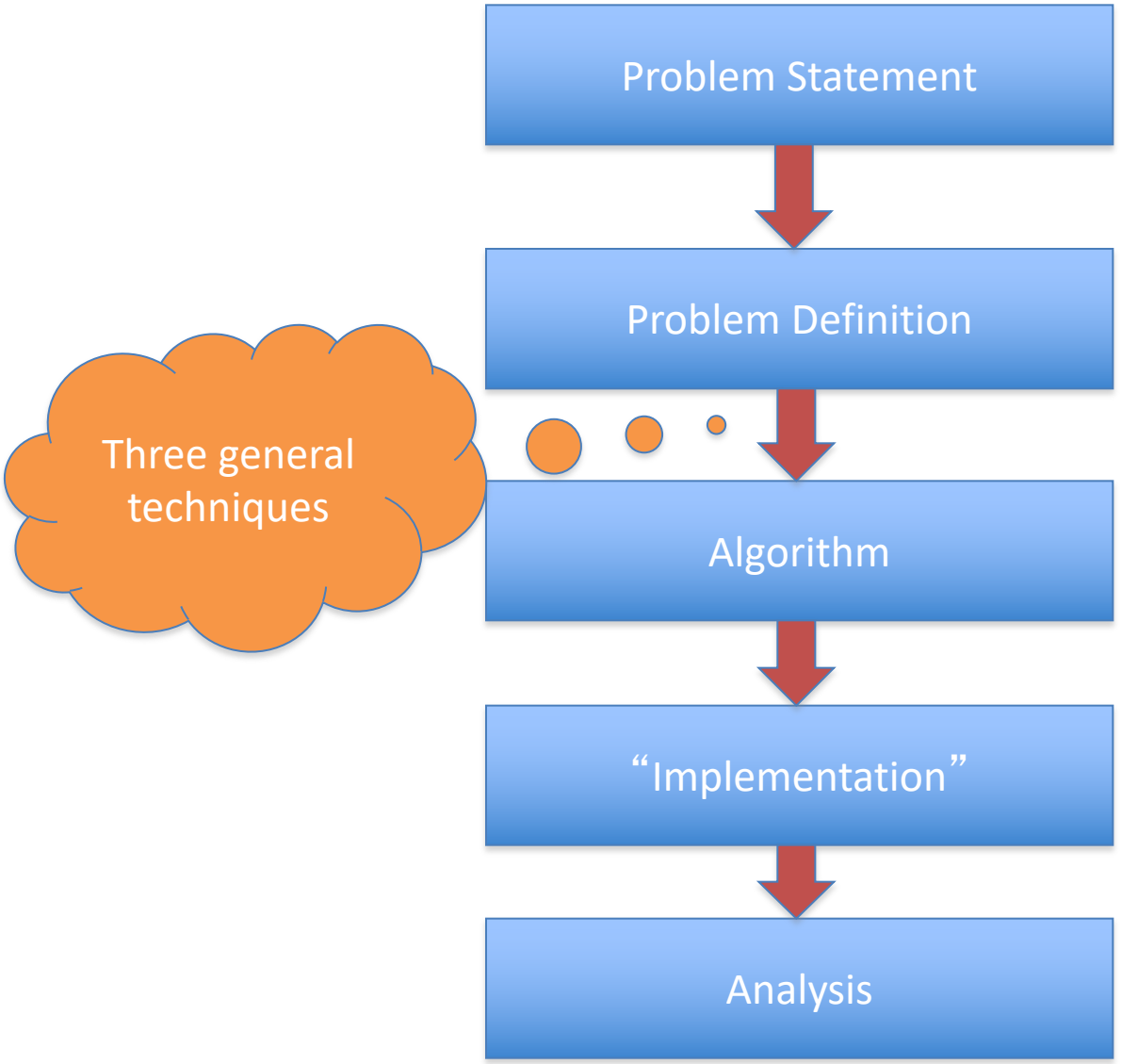
Here are the stats:

| Problem | Mean | Median | StdDev | Max | Min |
|---|---|---|---|---|---|
| Stakeholder 1 | 0.9 | 1.0 | 0.2 | 1.0 | 0.5 |
| Stakeholder 2 | 0.9 | 1.0 | 0.2 | 1.0 | 0.0 |
| Stakeholder 3 | 0.9 | 1.0 | 0.2 | 1.0 | 0.0 |
| Stakeholder 4 | 0.8 | 1.0 | 0.3 | 1.0 | 0.0 |

# Questions/Comments?



# High level view of CSE 331

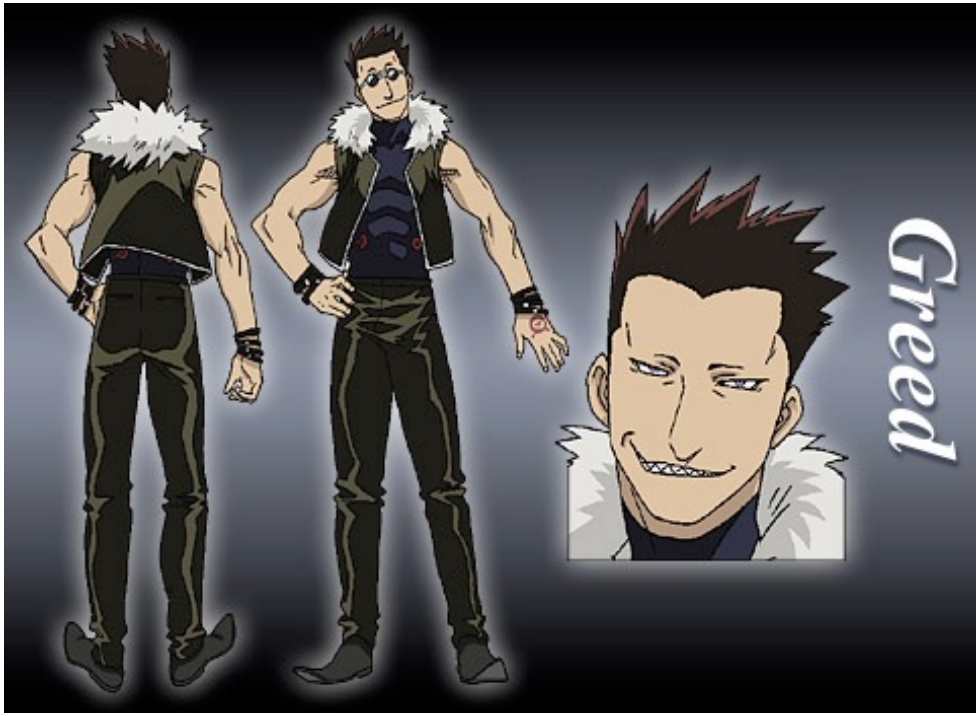


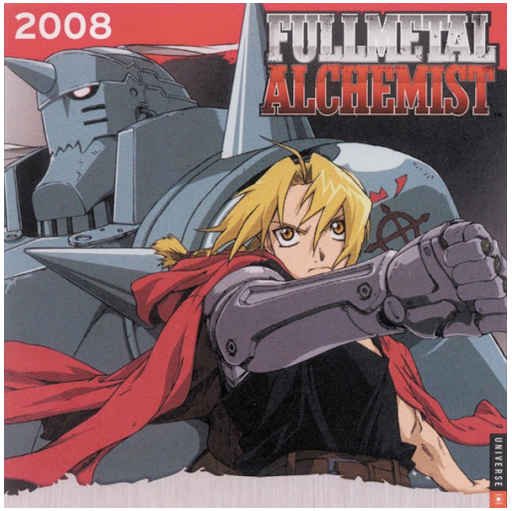

Data Structures

Correctness+Runtime Analysis

# Greedy Algorithms

Natural algorithms




Reduced exponential running time to polynomial

# Divide and Conquer

Recursive algorithmic paradigm


Reduced large polynomial time to smaller polynomial time

# A new algorithmic technique

Dynamic Programming

# Dynamic programming vs. Divide & Conquer

# Same same because

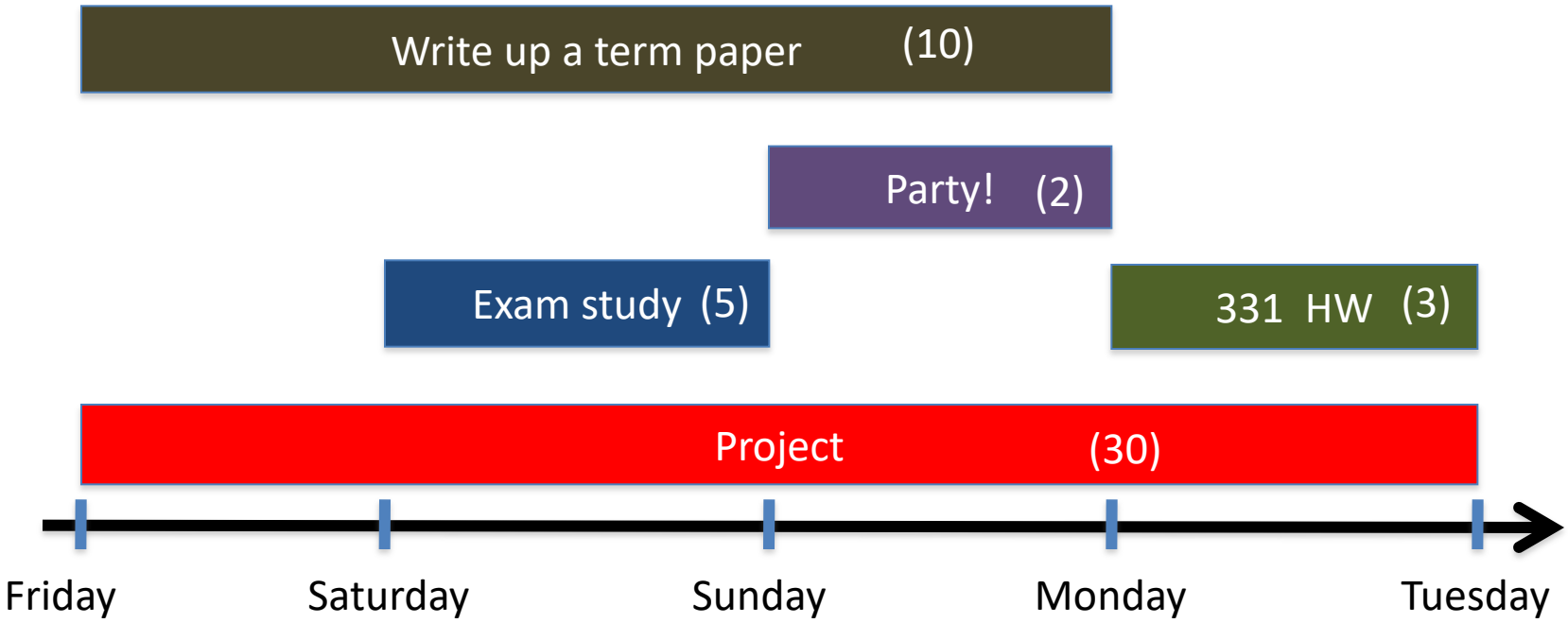
Both design recursive algorithms

# Different because

Dynamic programming is smarter about solving recursive sub-problems

# End of Semester blues

Can only do one thing at any day: what is the optimal schedule to obtain maximum value?



# Previous Greedy algorithm

Order by end time and pick jobs greedily

Greedy value = 5+2+3= 10

Write up a term paper (10)

Party! (2)

Exam study (5)

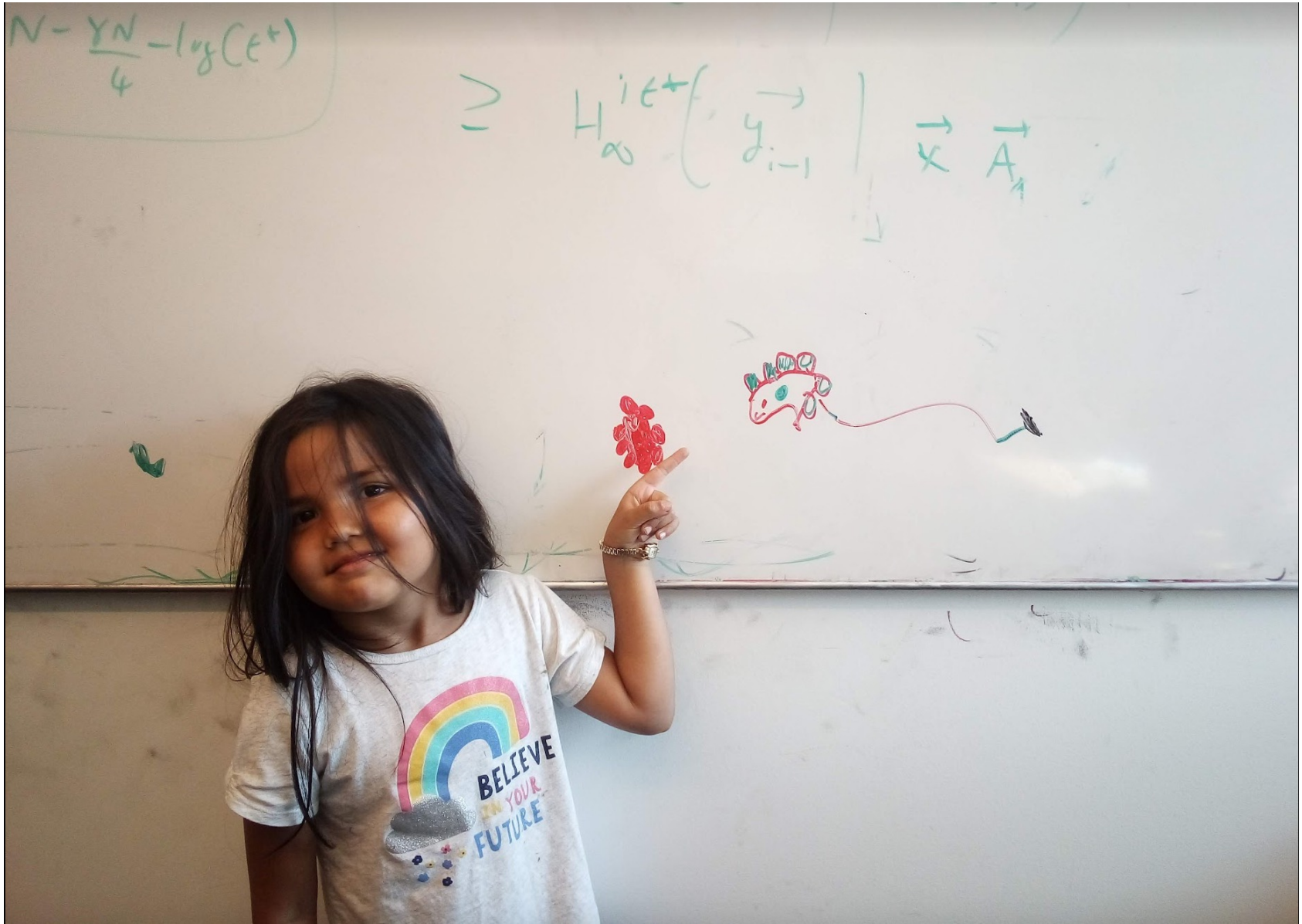
331 HW (3)

OPT = 30

Project (30)

Friday Saturday Sunday Monday Tuesday

# Questions/Comments?



# Today's agenda

Formal definition of the problem

Start designing a recursive algorithm for the problem

# Weighted Interval Scheduling

Input: $n$ jobs/intervals. Interval $i$ is triple $(s_i, f_i, v_i)$

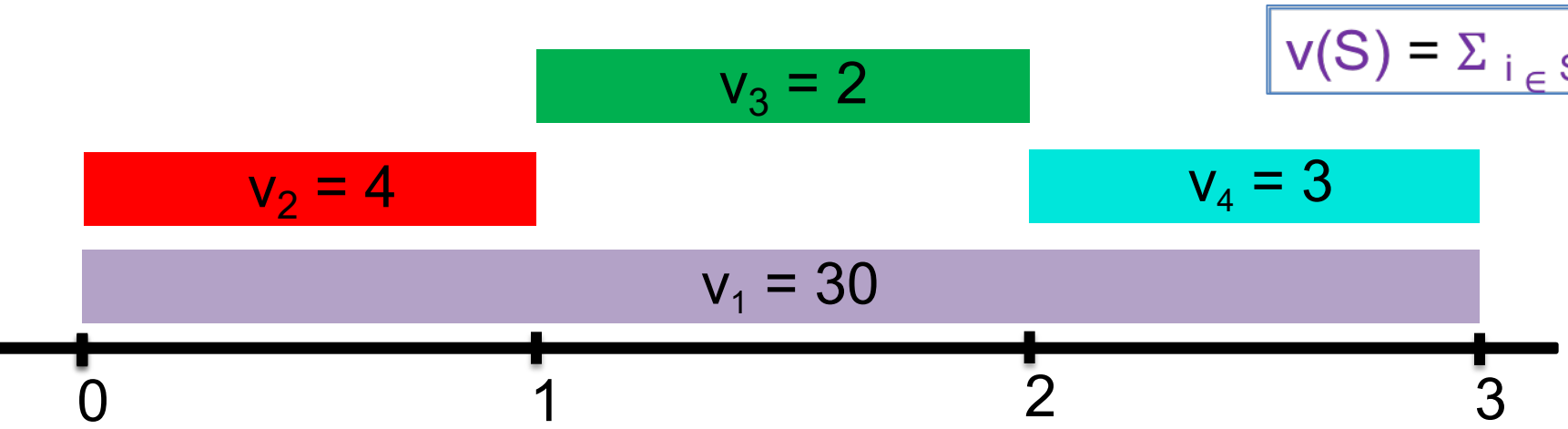
start time

finish time

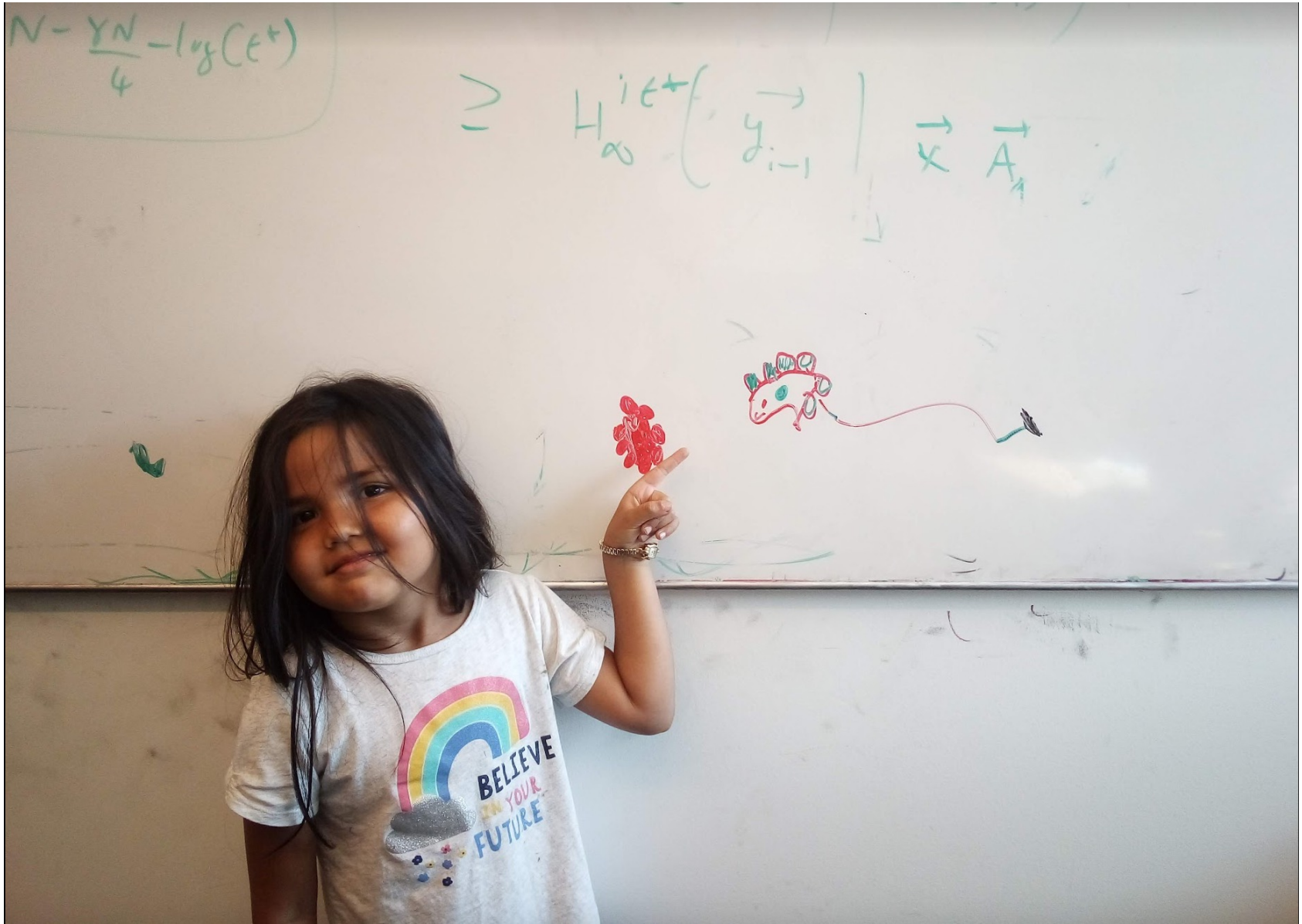
value

Output: A valid schedule $S \subseteq [n]$ that maximizes $v(S)$

$v(S) = \Sigma_{i \in S} v_i$



# Questions/Comments?



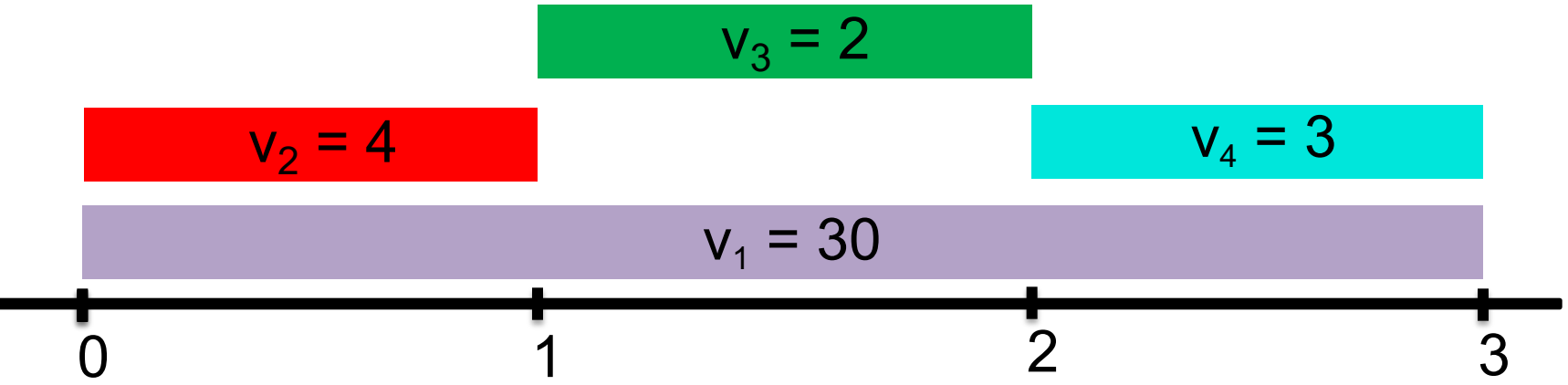
# Previous Greedy Algorithm

R = original set of jobs

S = $\phi$

While R is not empty
    Choose i in R where $f_i$ is the smallest
    Add i to S
    Remove all requests that conflict with i from R

Return S* = S



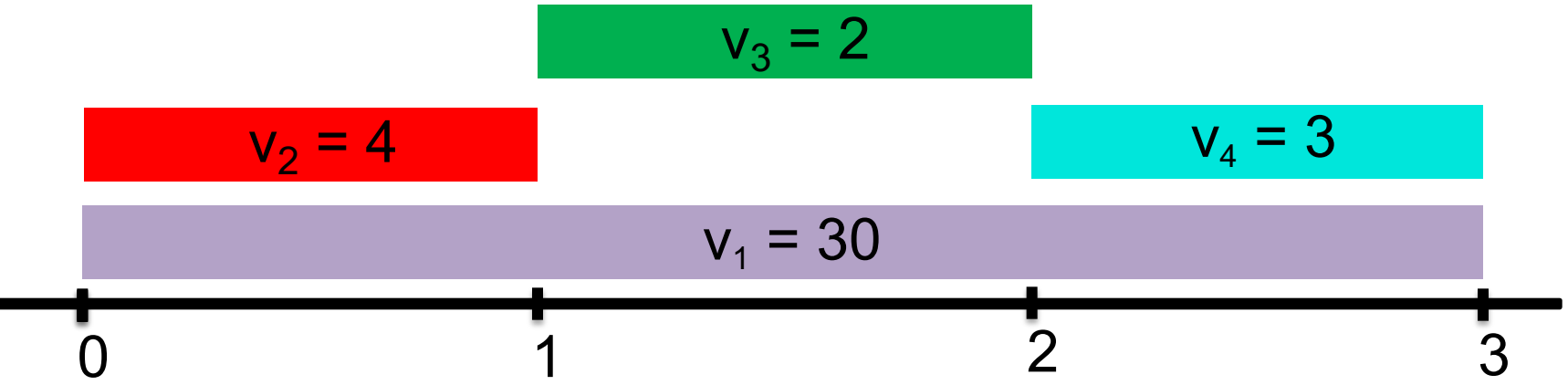
# Perhaps be greedy differently?

R = original set of jobs

S = $\phi$

While R is not empty
  Choose i in R where $v_i/(f_i - s_i)$ is the largest
  Add i to S
  Remove all requests that conflict with i from R

Return S* = S



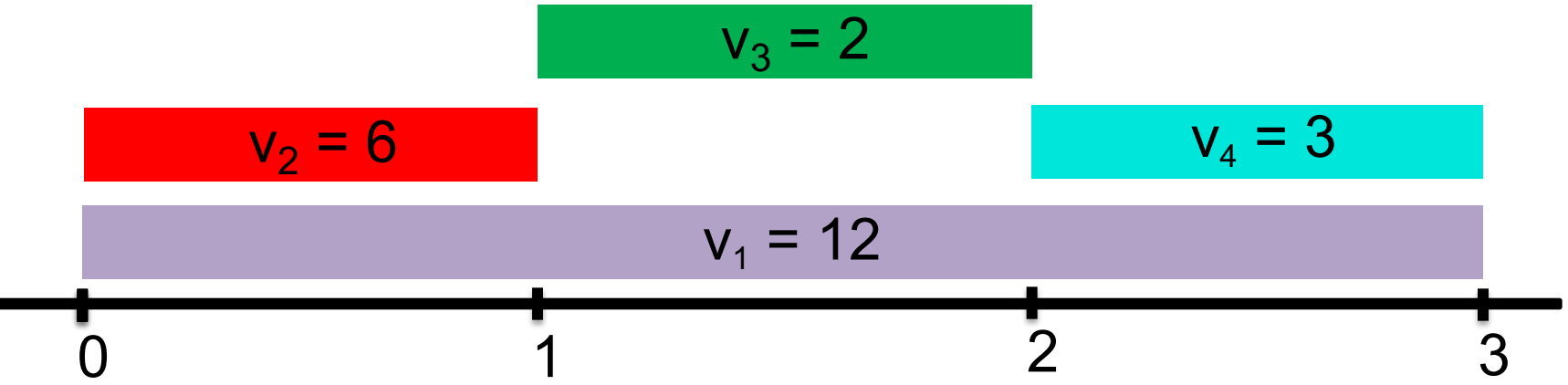
# Can this work?

R = original set of jobs

S = $\phi$

While R is not empty
  Choose i in R where $v_i/(f_i - s_i)$ is the largest
  Add i to S
  Remove all requests that conflict with i from R

Return S* = S



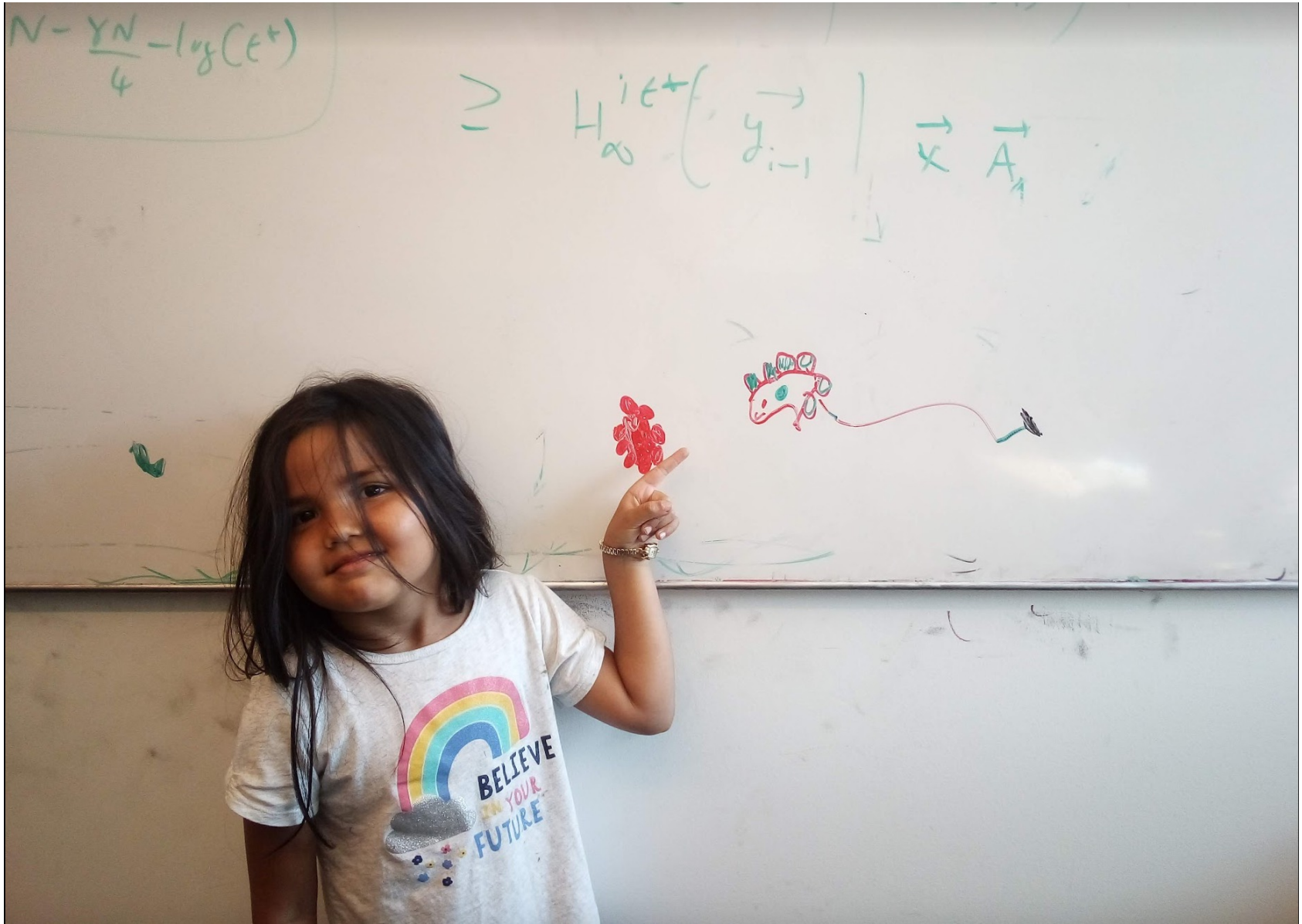
# Avoiding the greedy rabbit hole

https://www.writerightwords.com/down-the-rabbit-hole/

Provably IMPOSSIBLE for a large class of greedy algos

There are no known greedy algorithm to solve this problem

# Questions/Comments?



# Perhaps a divide & conquer algo?

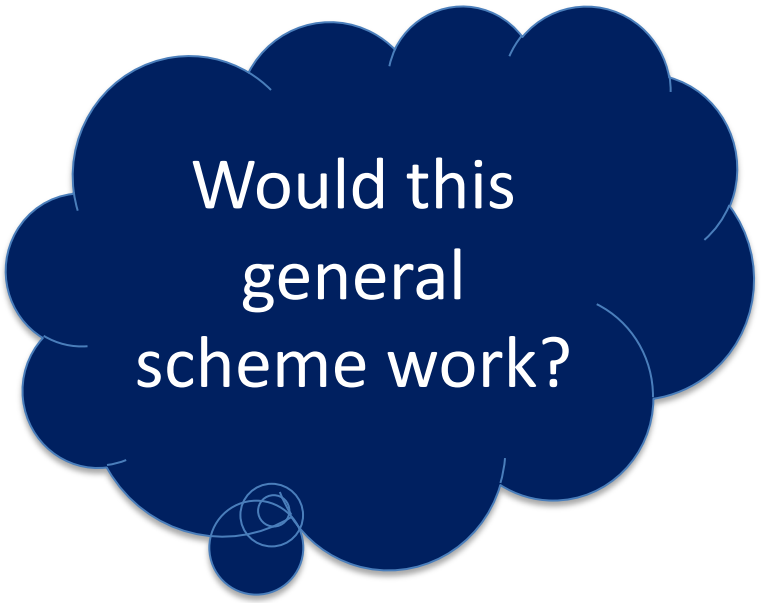
Divide the problem in 2 or more many EQUAL SIZED INDEPENDENT problems

Recursively solve the sub-problems

Patchup the SOLUTIONS to the sub-problems

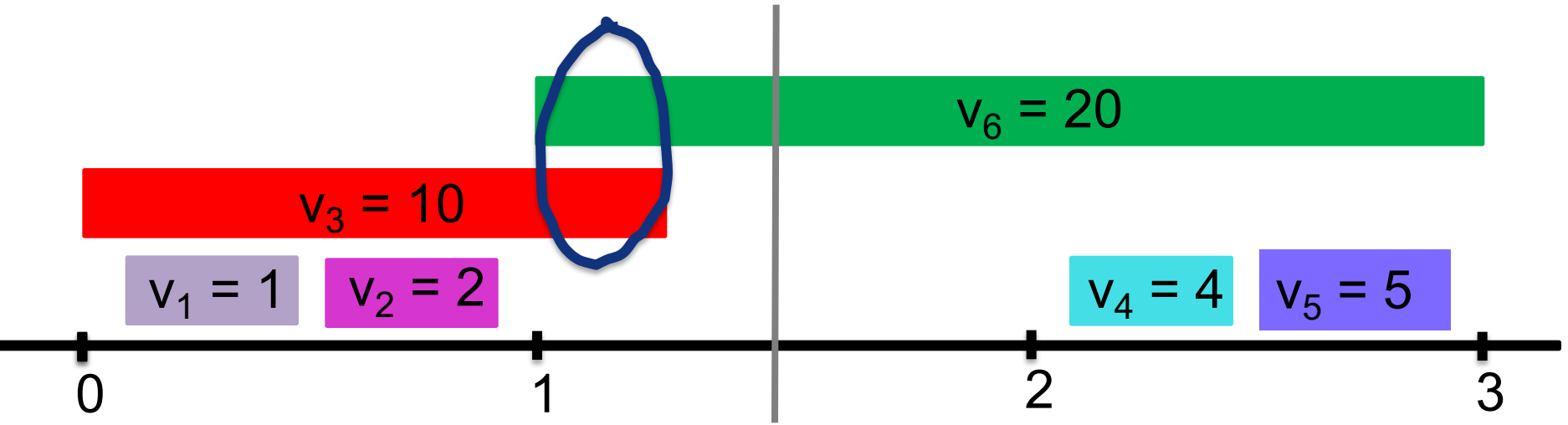
# Perhaps a divide & conquer algo?

```
RecurWeightedInt([n])

    if n = 1 return the only interval

    L = first n/2 intervals
    R = last n/2 intervals

    S_L = RecurWeightedInt(L)

    S_R = RecurWeightedInt(R)

    PatchUp(S_L, S_R)
```



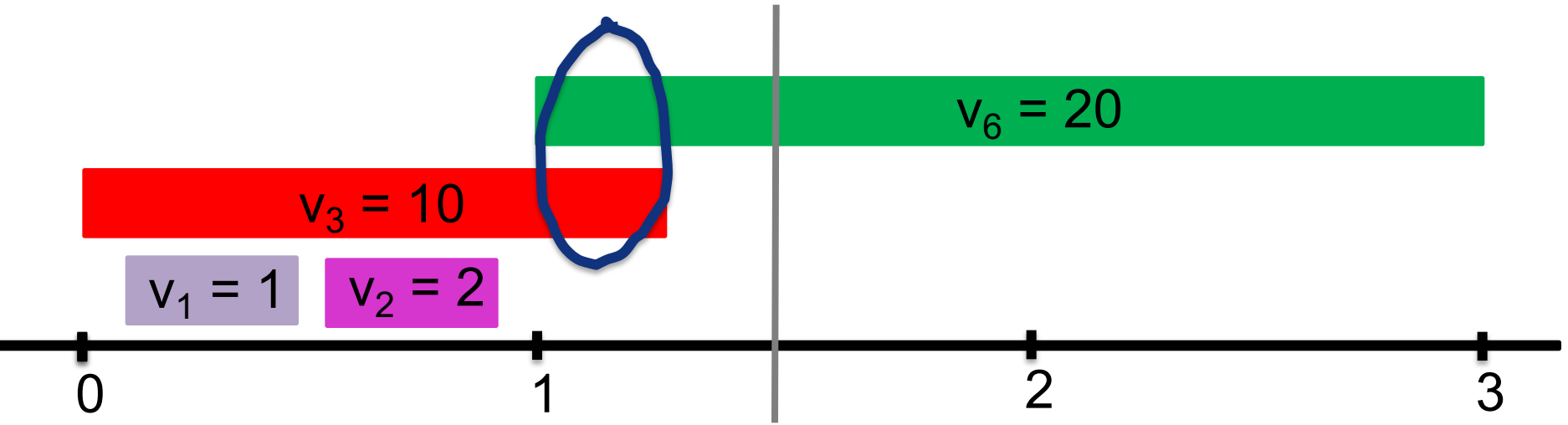

Divide the problem in 2 or more many EQUAL SIZED INDEPENDENT problems

# Sub-problems NOT independent!

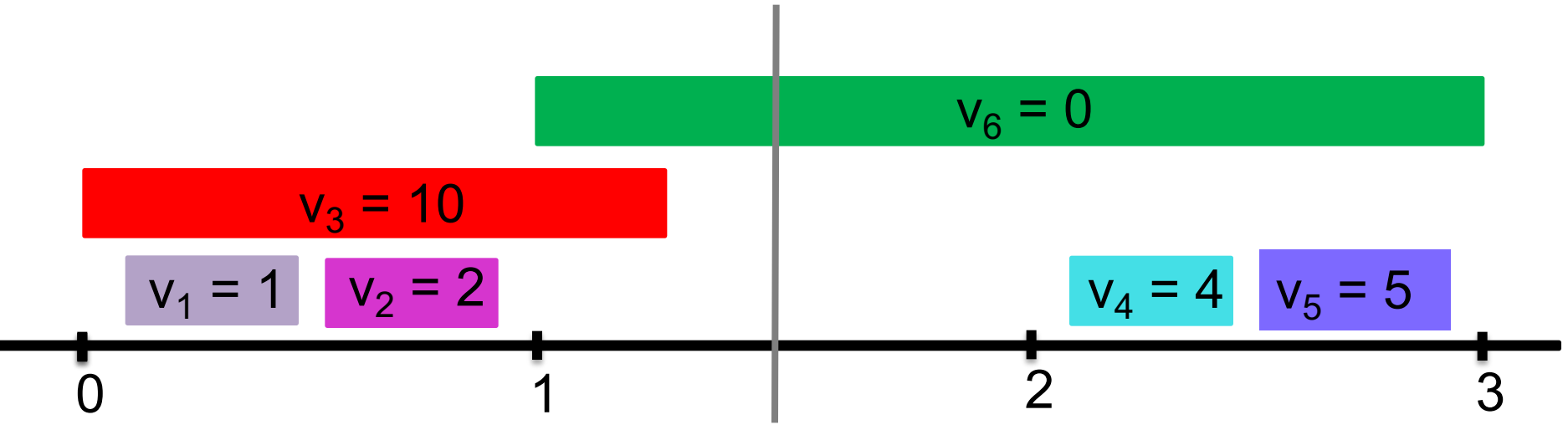


# Perhaps patchup can help?

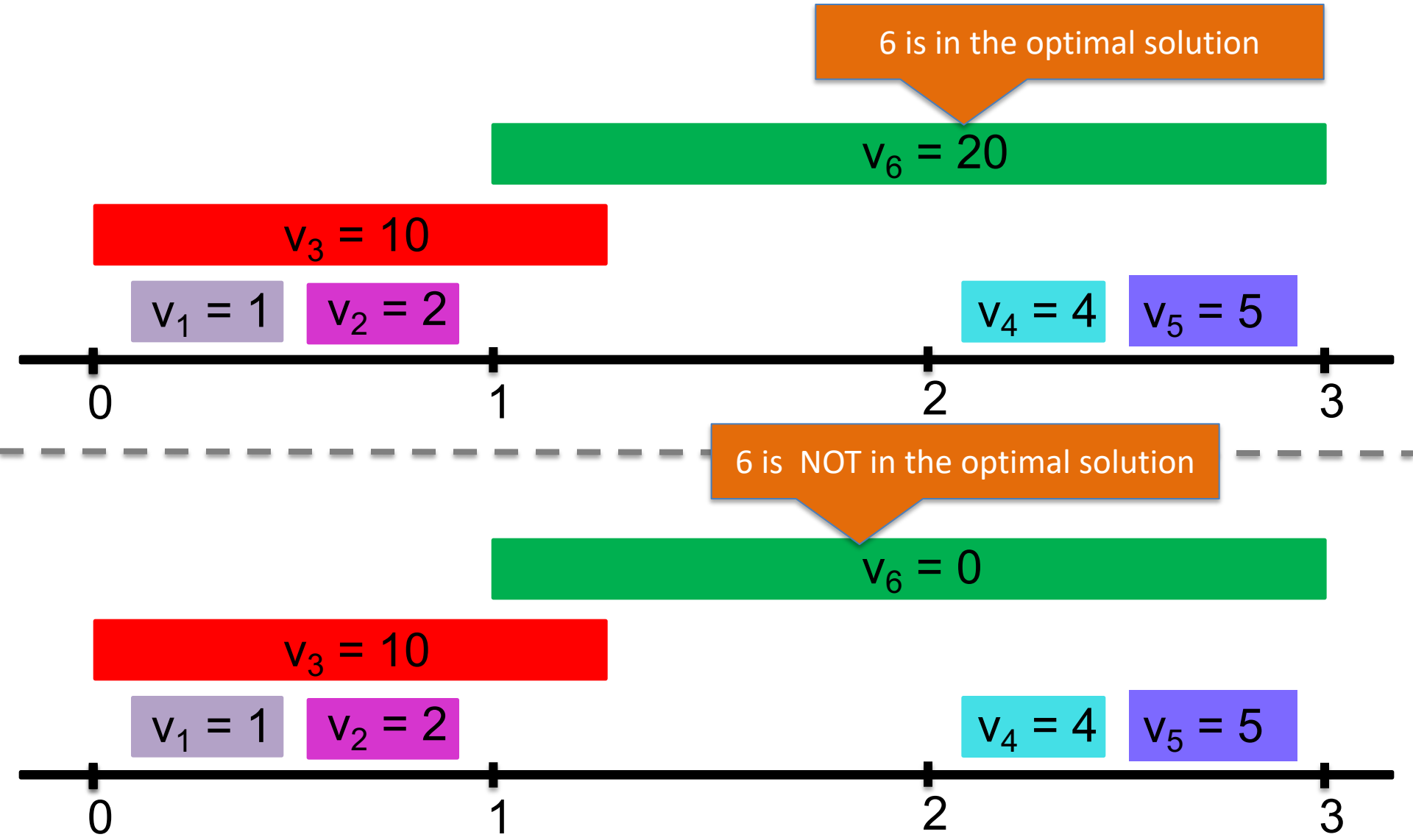
Patchup the SOLUTIONS to the sub-problems



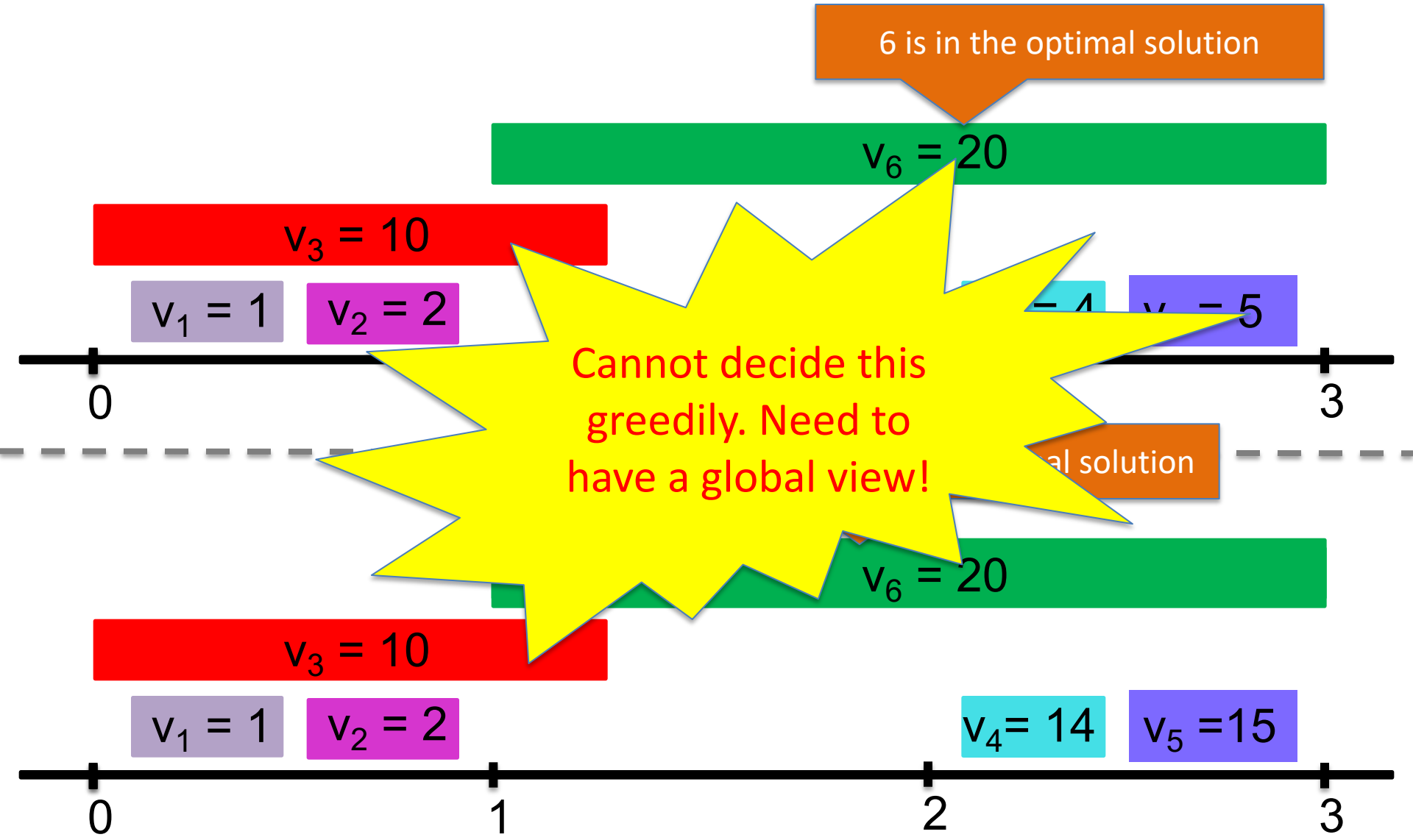
# Sometimes patchup NOT needed!



# Check for two cases?



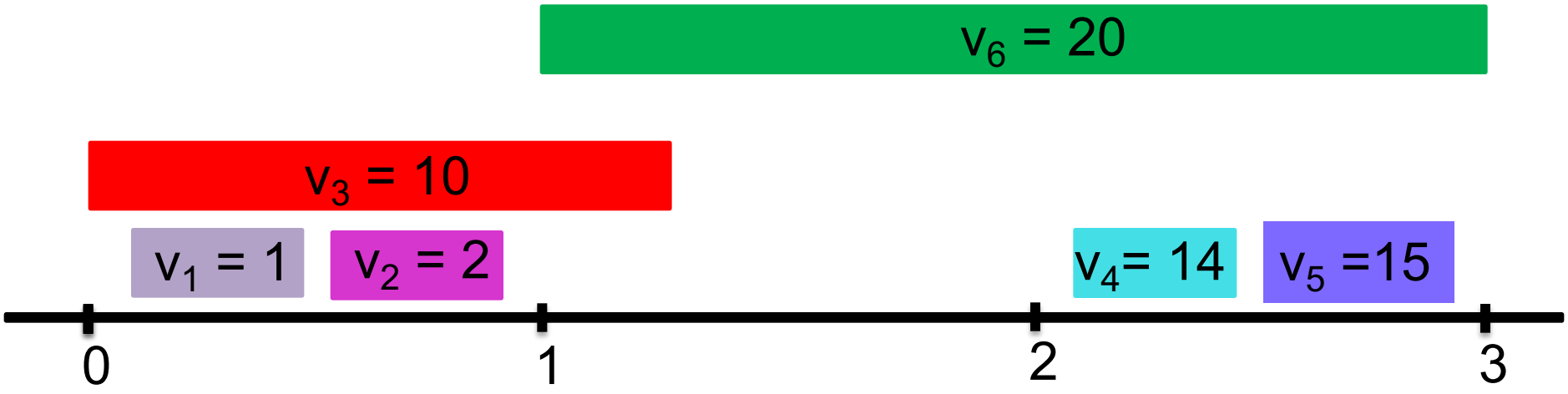
# Check if $v_6$ is the largest value?



# Check out both options!


Case 1: 6 is in the optimal solution

# 6 is not in optimal solution

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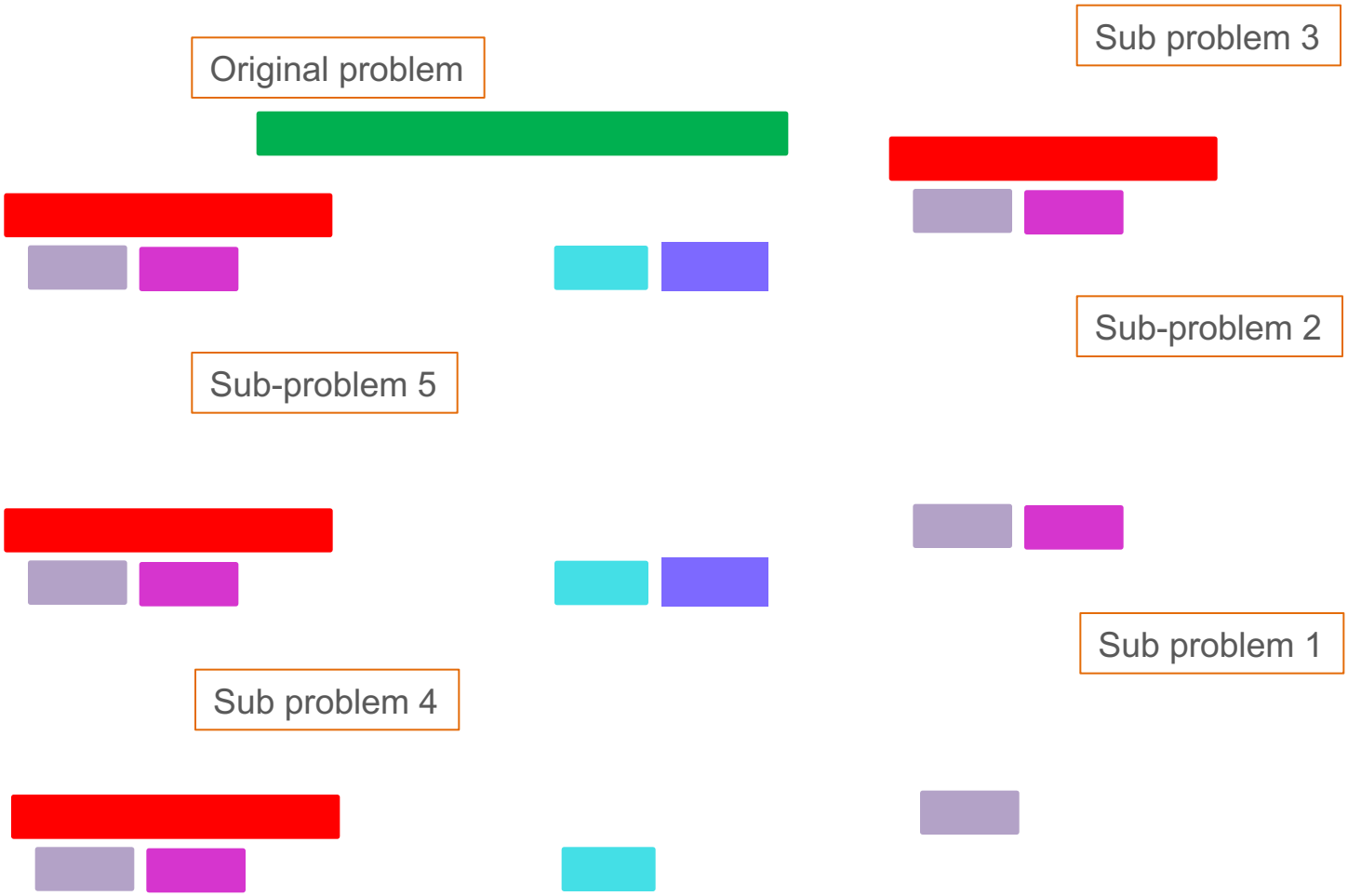
# So what sub-problems?

Divide the problem in 2 or more many ~~EQUAL SIZED INDEPENDENT~~ problems

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