Splitting the Zones of Feasibility for a Given Schedule

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Introduction

- Given is a set of jobs, a set of constraints and a schedule [1].
- The schedule might be (close to) optimal, but is it robust?
- Main question: Can we split the zones of constraint values for which the schedule becomes feasible or infeasible?

Method

- Sample random points around base constraint value
- For each point, calculate feasibility using Bellman Ford [2,3]
- Plot results

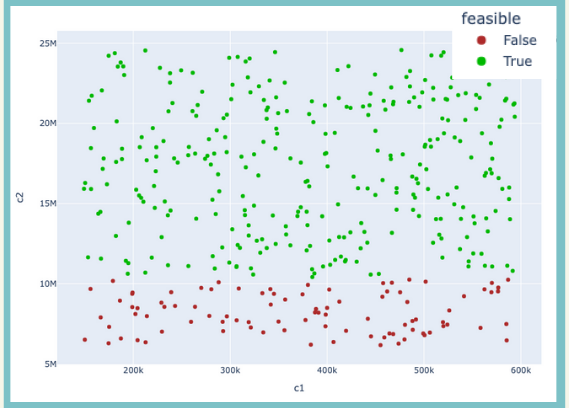

Fig 1: random sampling

Disadvantages: Expensive, No clear border

Can we do better?

Step 1: construct grid graph where nodes represent vectors of constraint values.

Step 2: Run the S^2 Algorithm [4] on this graph, We primarily run Bellman Ford on the edges that are close to the border, saving computation time.

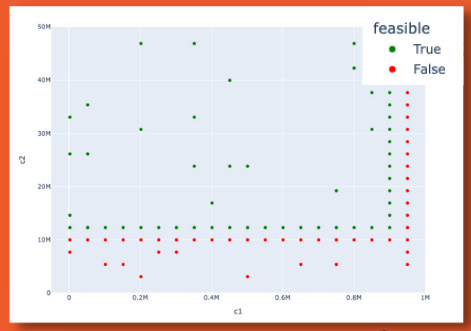

Fig 2: the resulting cut-edges produced by the S^2 algorithm

Step 3: Determine border accurately on a select few edges through binary search [fig 3].

Step 4: Linear interpolate calculated border points, resulting in a feasibility boundary within some margin of error.

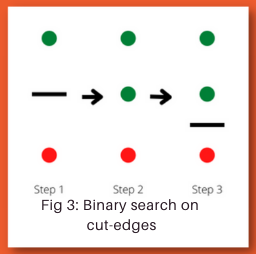

Fig 3: Binary search on cut-edges

Results and future work

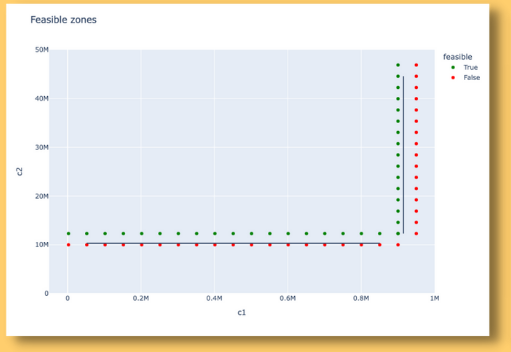

Fig 4: Resulting border, amount of queried points is relatively small

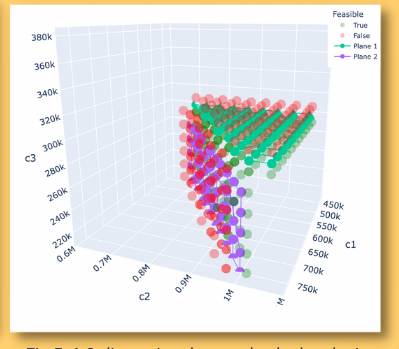

Fig 5: A 3-dimensional example, the border is displayed by the purple and cyan points

Advantages: Less points to query, Clear border

Limitations: Results are purely experimental. 3D border estimation is unreliable

- Under the right settings, the calculated feasibility boundary can classify new samples with 99.9% accuracy over a given domain.
- 2D performs consistent, 3D less so
- Parameters can be tuned to trade off accuracy for a better run-time.

Conclusion

S^2 can be used in combination with interpolation to accurately estimate the feasibility boundary in relatively few queries. All research questions are (partly) answered.

Refrences

[1] Joost Van Pinxten et al. "Online scheduling of 2-re-entrant flexible manufacturing systems". In: ACM Transactions on Embedded Computing Systems (TECS) 16.5s (2017), pp. 1–20

[2] Richard Bellman. "On a routing problem". In: Quarterly of applied mathematics 16.1 (1958), pp. 87–90.

[3] Lester R Ford Jr. Network flow theory. Tech. rep. Rand Corp Santa Monica Ca, (1956)

[4] Gautam Dasarathy, Robert Nowak, and Xiaojin Zhu. "S2: An efficient graph based active learning algorithm with application to nonparametric classification". In: Conference on Learning Theory. PMLR. (2015), pp. 503–522

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