Visual Comparison of Business Process Flowcharts

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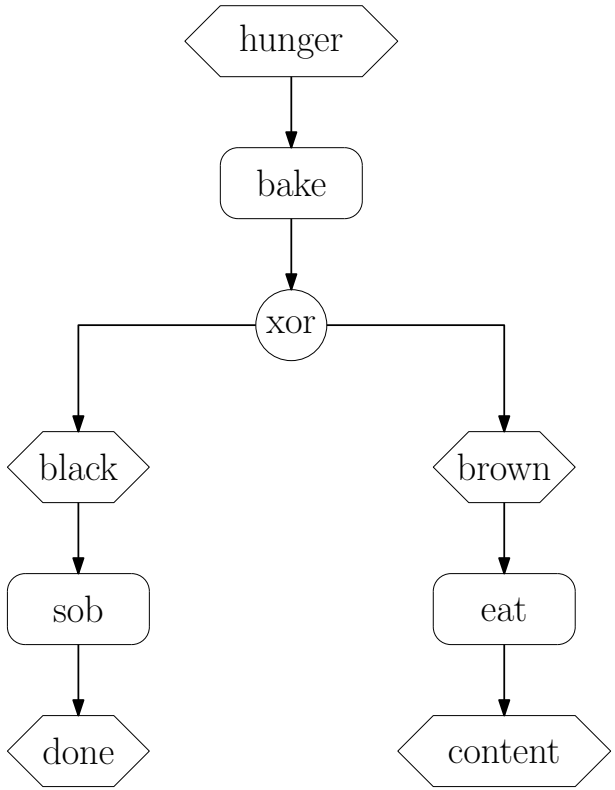
What are Business Process Flowcharts?



Example for an event-driven process chain (EPC) as described by W. M. P. van der Aalst 1999. The process of making and consuming pie.

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- Adaption of commercial off-the-shelf (COTS) software [Komplex-e]
- Workflows are documented, managed and compared as digital business process models. [de Moor and Delugach 2006]
- Merging organizational units

Automatic process model matching

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- A process model matching contest yielded various results [Antunes et al. 2015]
- Results are never completely correct, making human visual comparison necessary

Business process flowcharts are graph drawings

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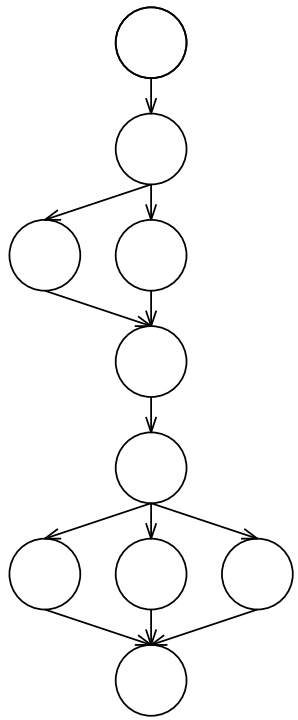
- Business processes are basically graphs
- With nodes and edges
- Use graph drawing for layouting

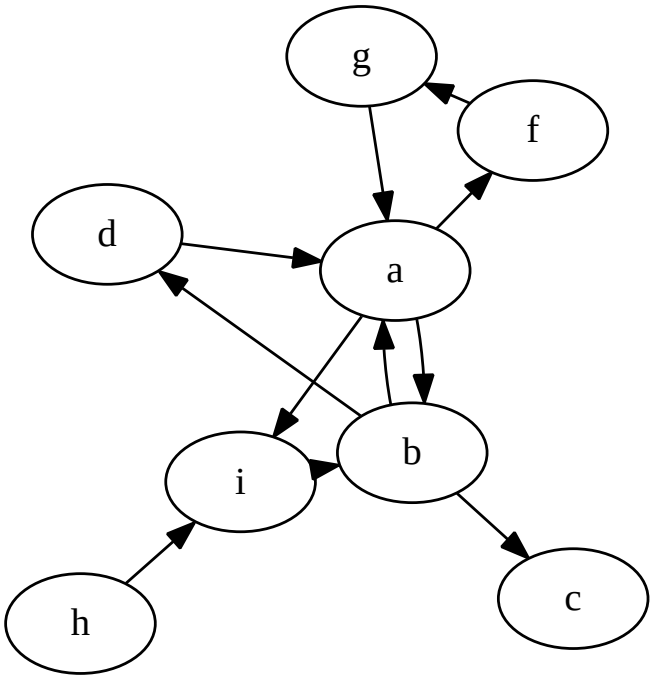
Sugiyama [1981] graph drawing is suitable for business process flowcharts

Five steps of layered graph drawing:

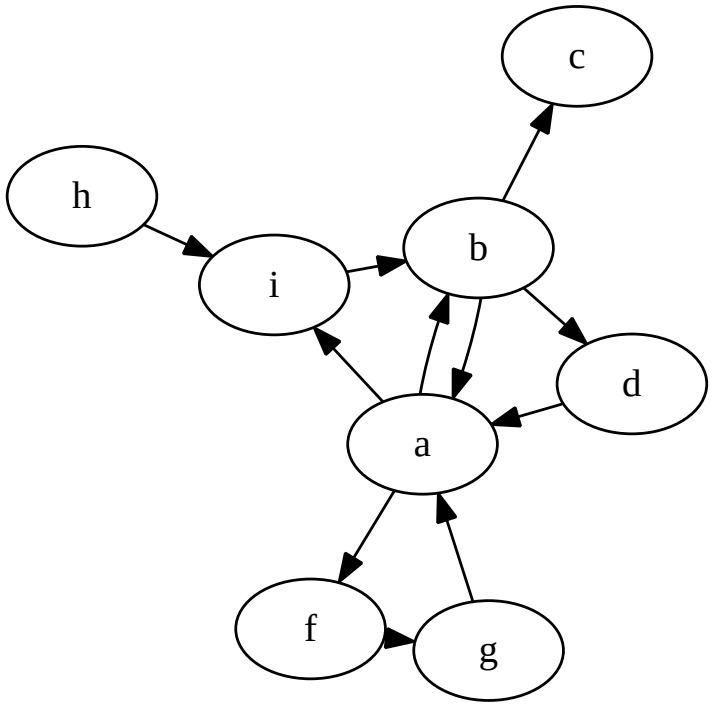
- Cycle breaking
- Layer assignment
- Vertex ordering
- Horizontal positioning
- Edge drawing



Visual graph comparisons are not easy



A graph.



The same graph?

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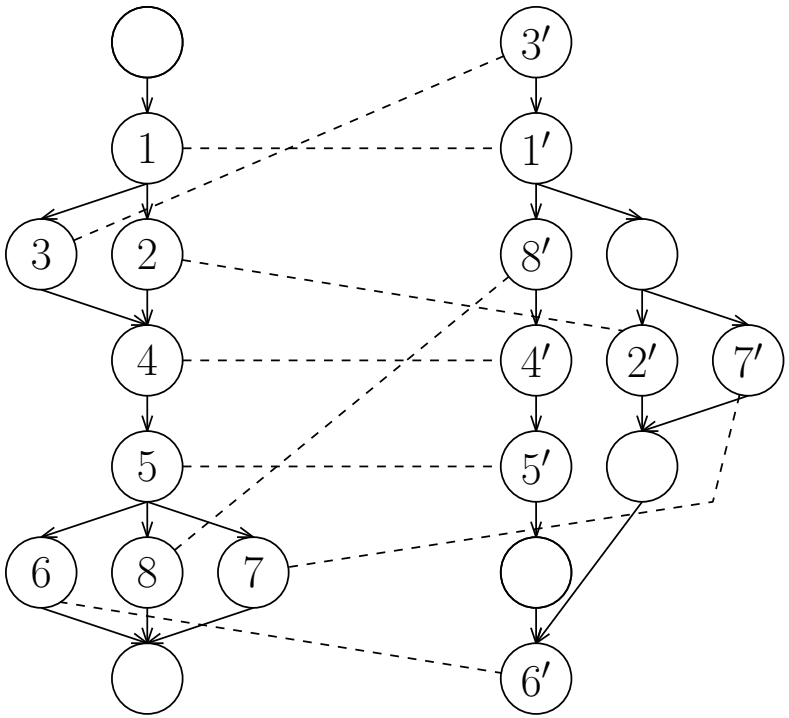
- New idea: Bringing vertices to the same height

Bringing vertices to the same height



A graph with “constraints” between similar nodes

Bringing vertices to the same height

- Inserting space between layers

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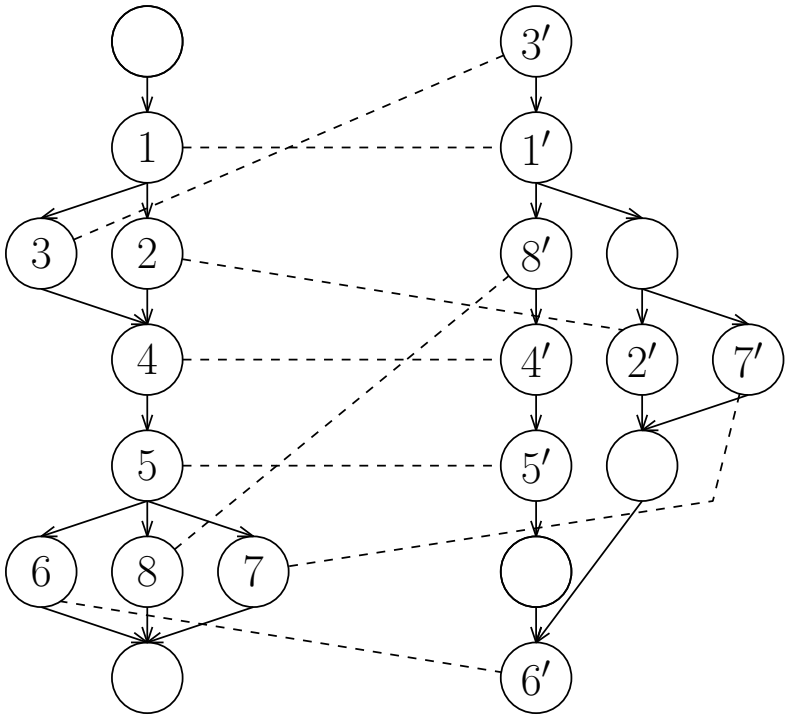
Bringing vertices to the same height

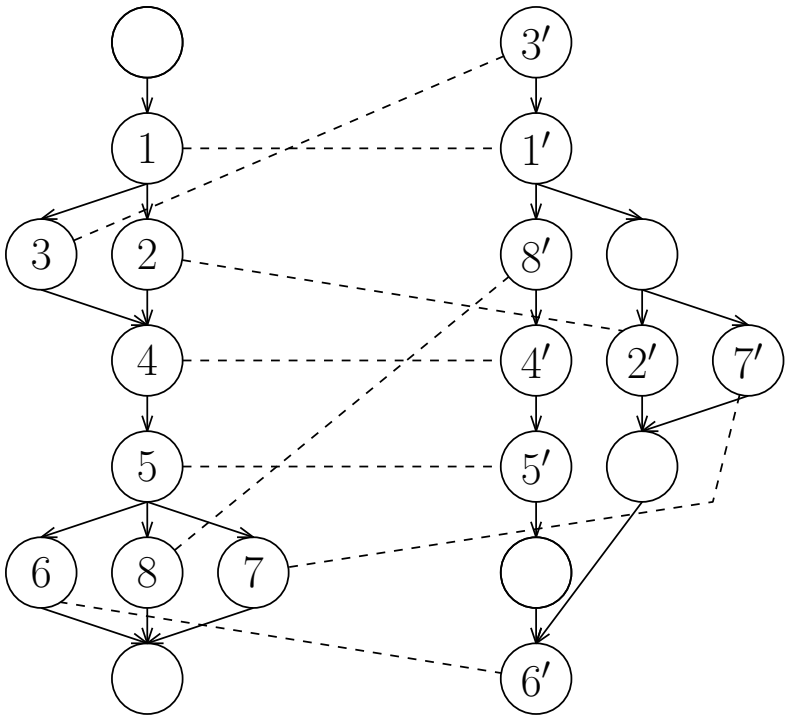
- Inserting space between layers
- Problem: Crossings of constraints
- Solution: select as many non crossing constraints as possible
- But how?

Bringing vertices to the same height



Two graphs with similarities

Bringing vertices to the same height



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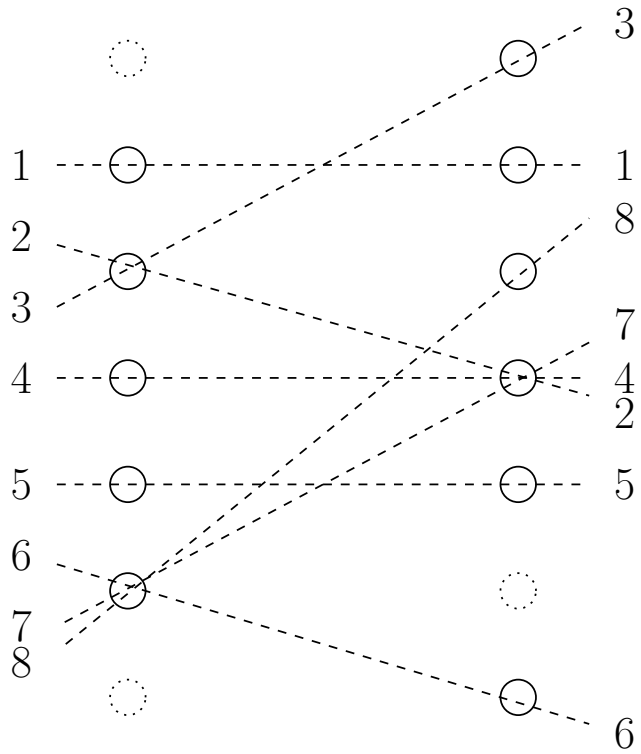

We only need to look at layers

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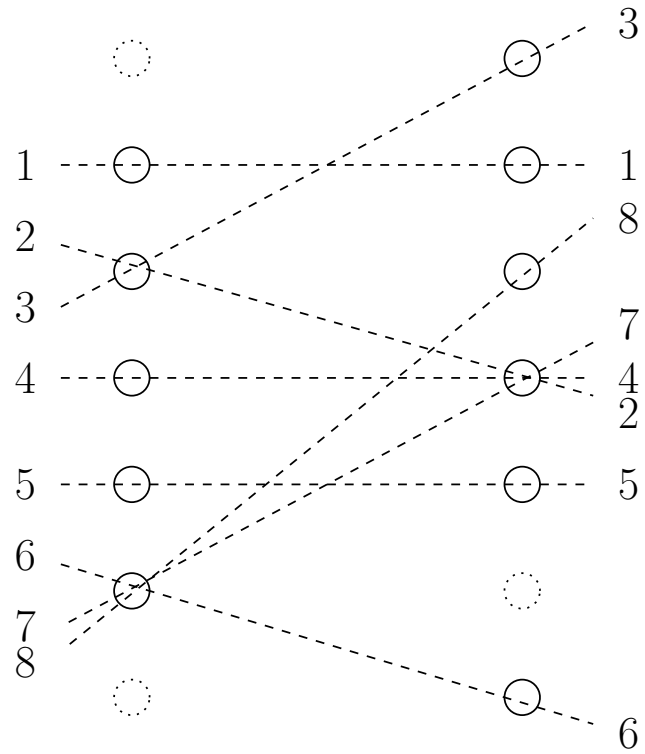

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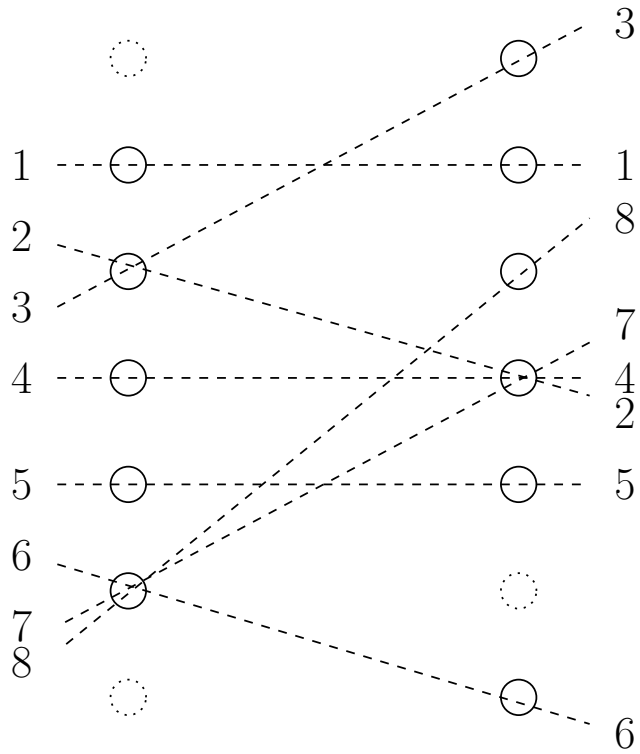

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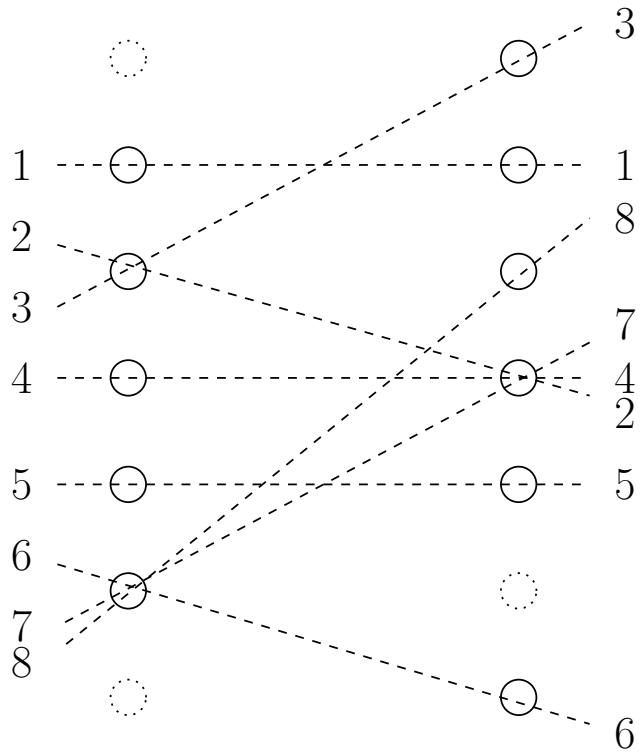
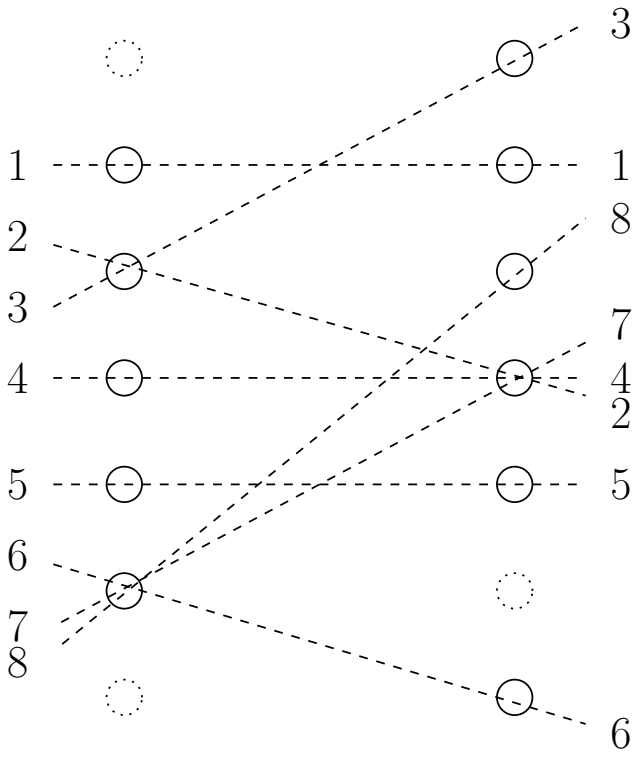


We only need to look at layers

- We can only bring one of two crossing lines to the same level
- Line crossings form a conflict graph
- Just need to find a maximum independent set
- NP complete?

Bringing vertices to the same height



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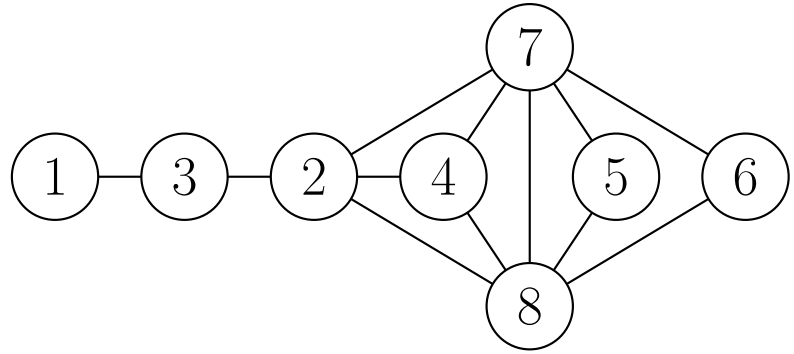
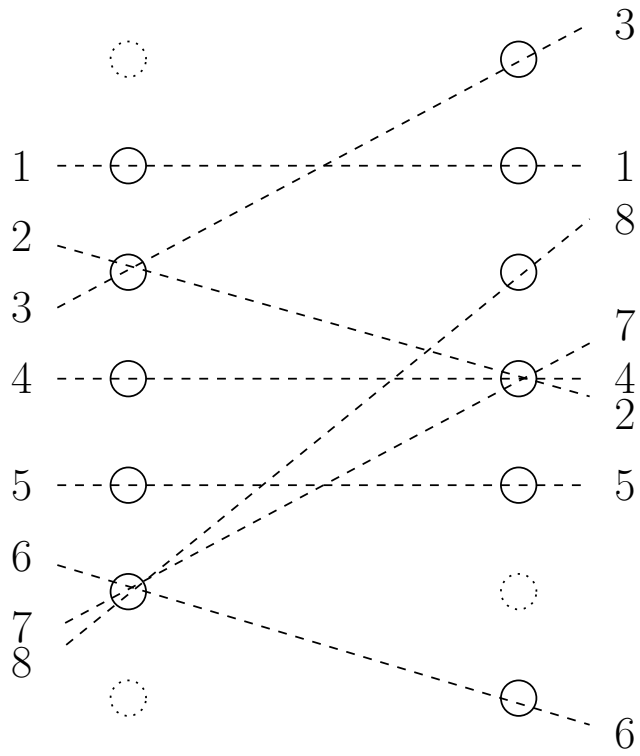


Conflict graph

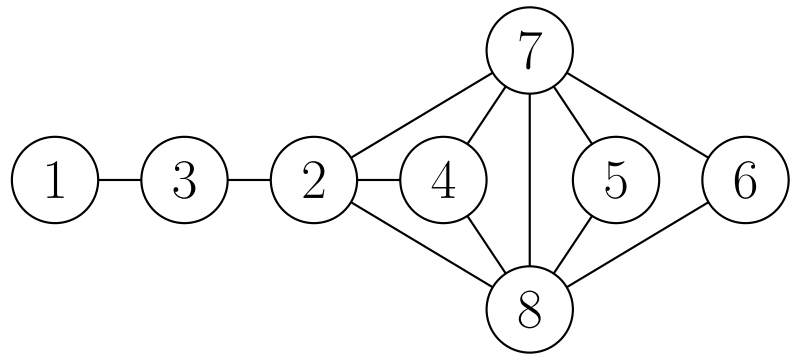
Permutation graphs

- Permutation graphs [Even et al. 1972]
- Vertices: elements of a permutation
- Edges: pairs of elements that are reversed by the permutation
- The conflict graphs are permutation graphs

Bringing vertices to the same height



The permutation reads as 3, 1, 8, 7, 4, 2, 5, 6

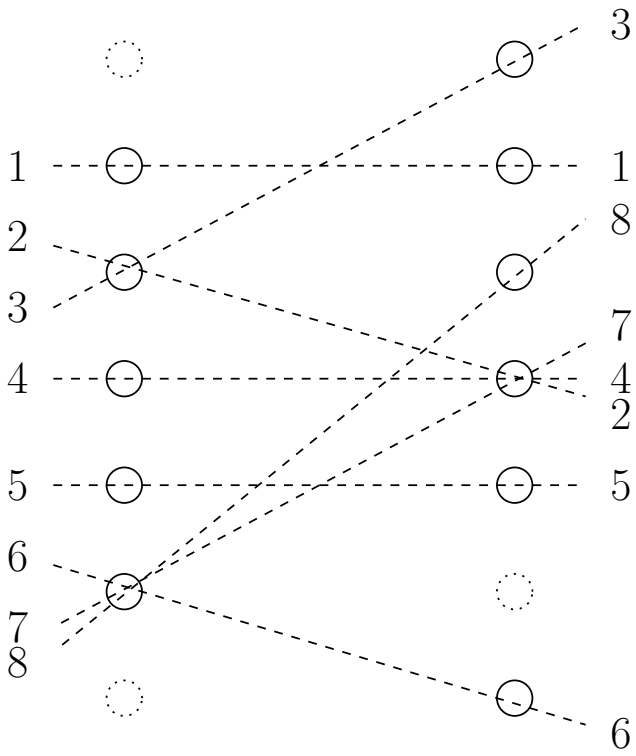


Permutation graph

Finding an independent set

- (Maximum) independent sets are (longest) increasing subsequences
- Can be found in $O(n \log n)$ time
- Algorithm uses ideas from Aldous and Diaconis 1999 and Kim 1990

Example



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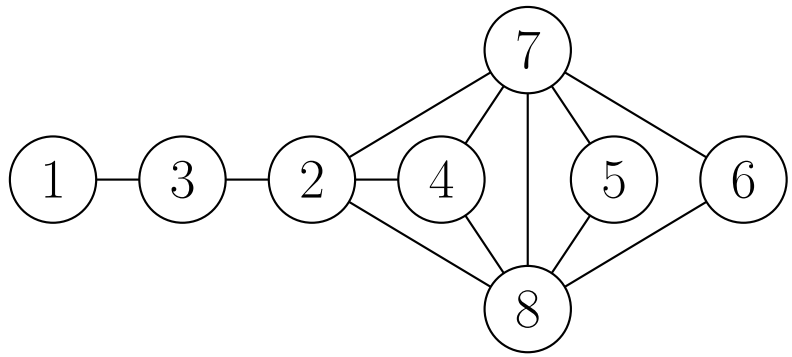
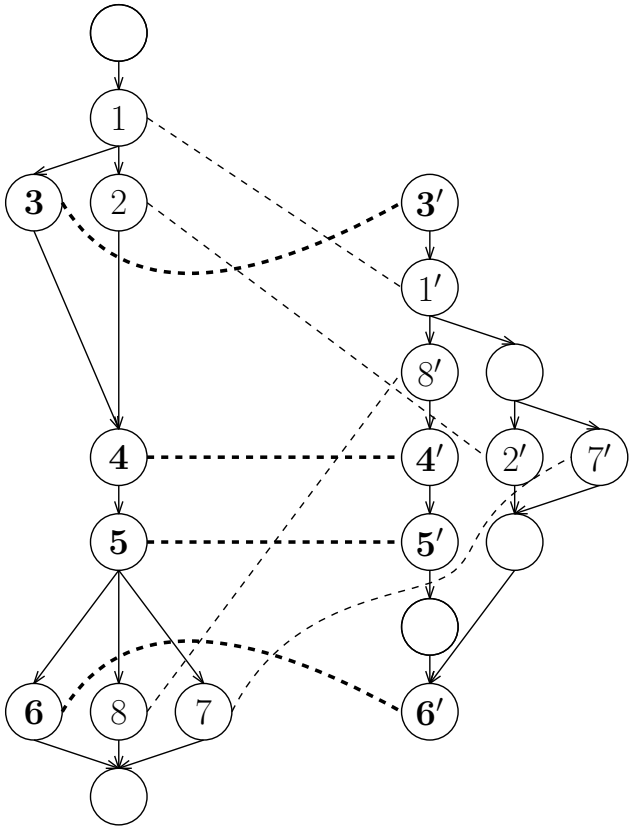


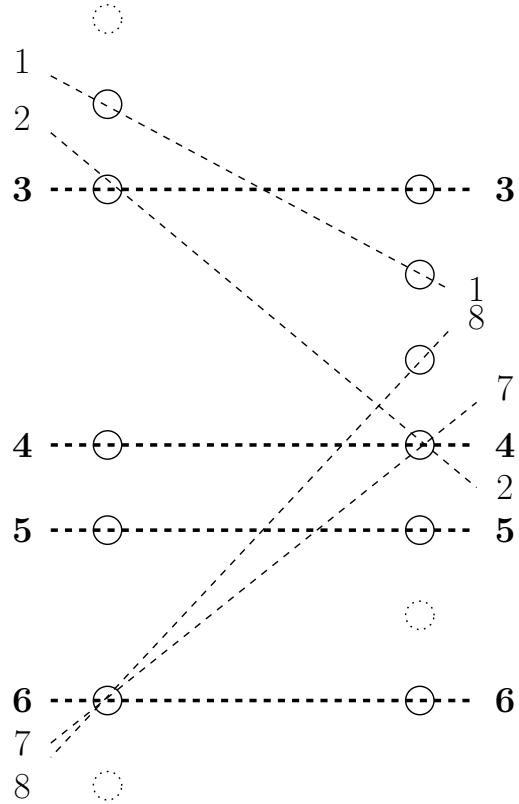
Permutation graph

Other examples:
3, 8, 7, 4, 5, 6, 1, 2
4, 2, 3, 1

Result

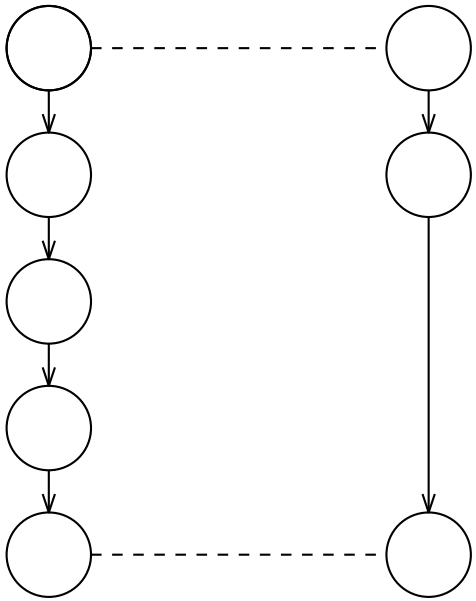


The graphs adjusted according to the longest increasing subsequence

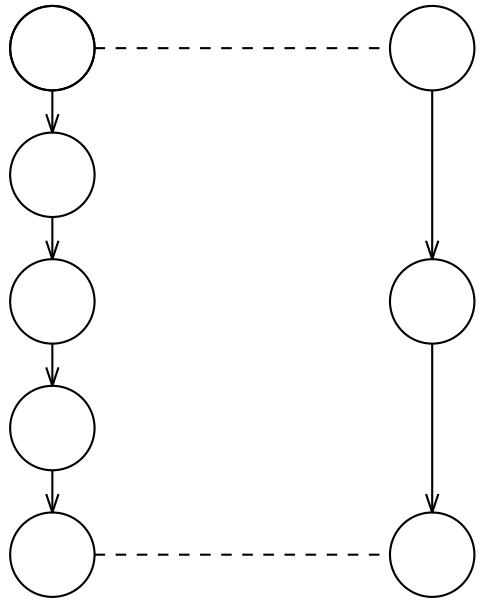


The adjusted layers

Possible improvement: interpolation

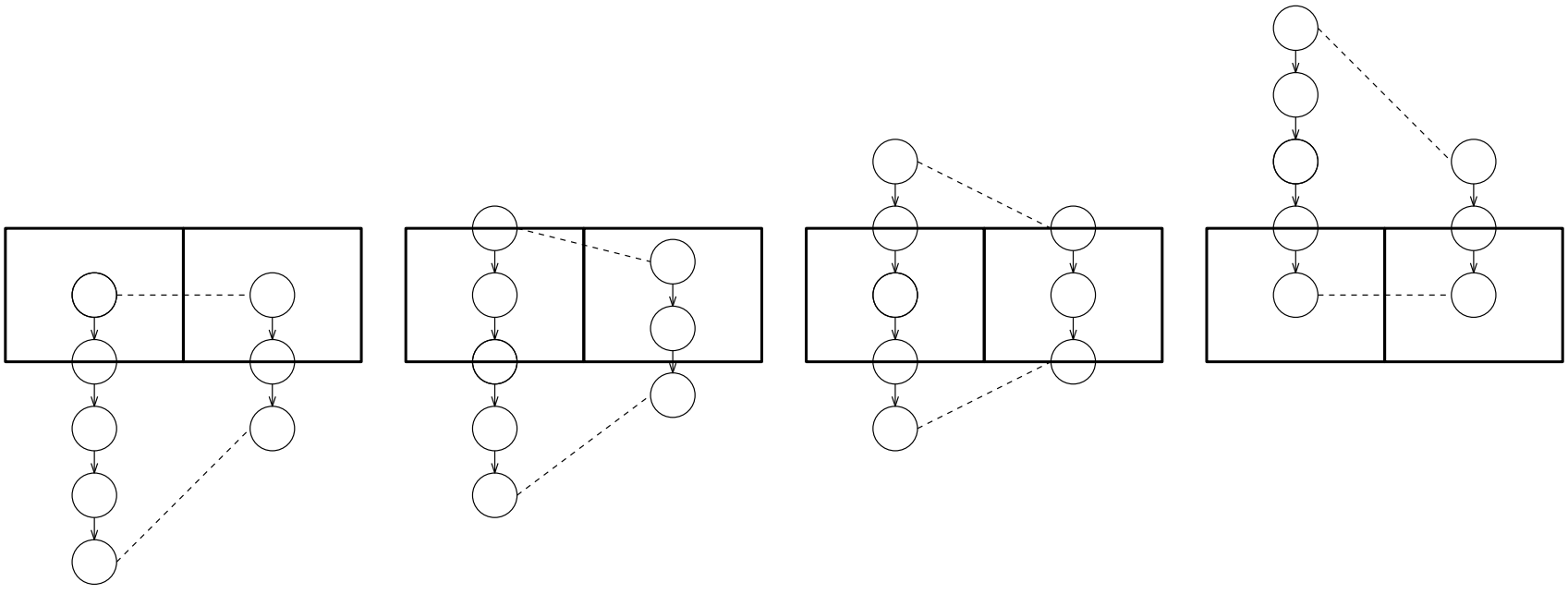


Adjusted by adding space

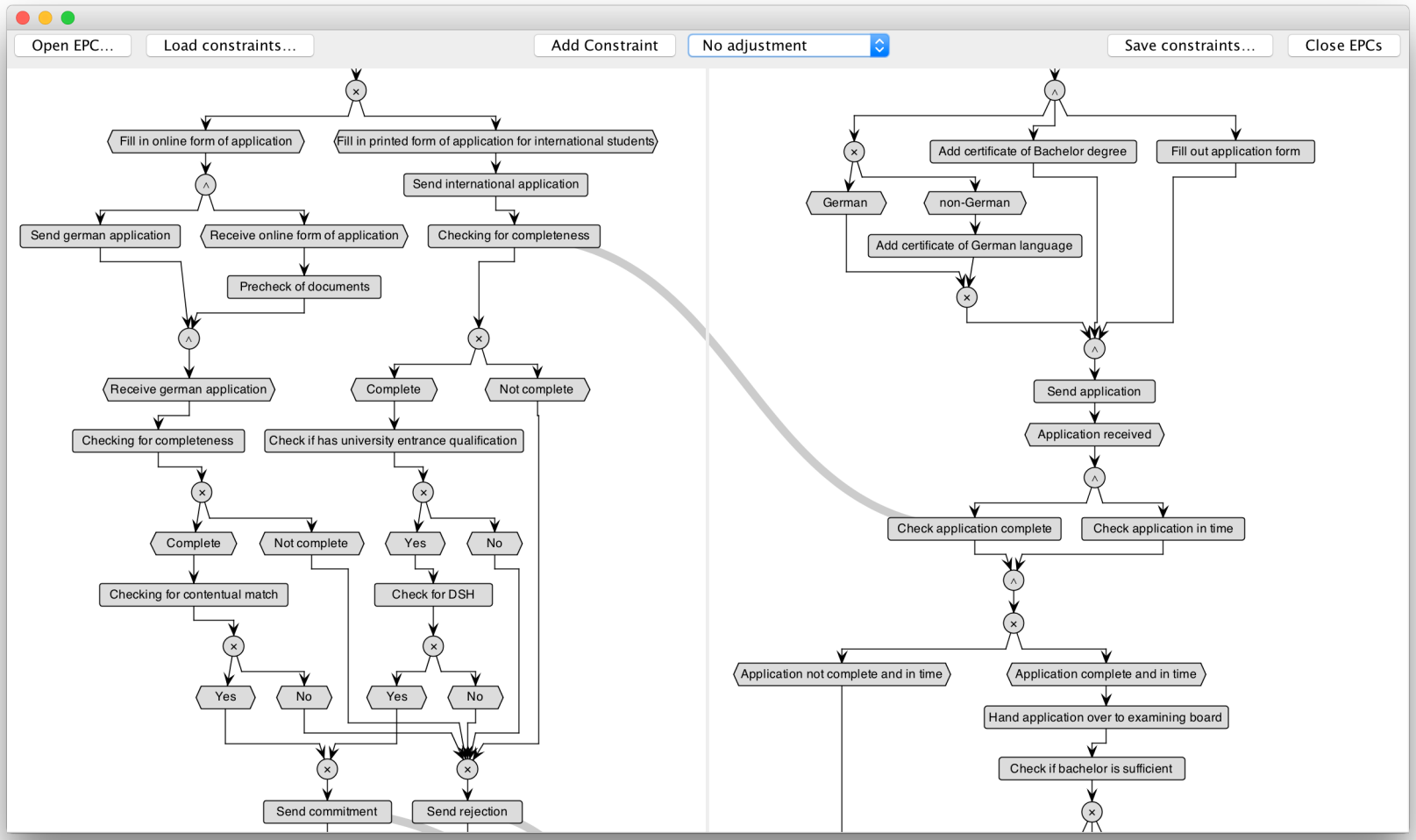


Adjusted by spreading to fill the space

Another variant: adjusted scrolling



Demo


Open EPC...
Load constraints...
Add Constraint
No adjustment
Save constraints...
Close EPCs
Fill in online form of application
Fill in printed form of application for international students
Send international application
Send german application
Receive online form of application
Checking for completeness
Precheck of documents
Receive german application
Complete
Not complete
Checking for completeness
Check if has university entrance qualification
Complete
Not complete
Yes
No
Checking for contentual match
Check for DSH
Yes
No
Yes
No
Send commitment
Send rejection
Add certificate of Bachelor degree
Fill out application form
German
non-German
Add certificate of German language
Send application
Application received
Check application complete
Check application in time
Application not complete and in time
Application complete and in time
Hand application over to examining board
Check if bachelor is sufficient

Evaluation

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- Works on EPCs, including those from Komplex-e and the 2015 process model matching contest

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- Height adjustment: height: +3 % to 46 %, on average +22 %
- Height adjustment: width: no change

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- Learnings were incorporated into a final questionnaire of 42 questions
- Three different example processes were picked
- 13 participants (8 CS, 3 Econ., 2 others)
  Result: slightly more generous answers for height adjustment and adjusted scrolling vs. merged layout, but only small sample size.

Future Work

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