UNIVERSITY OF LIVERPOOL

Vertex Unique Labelled Subgraph Mining

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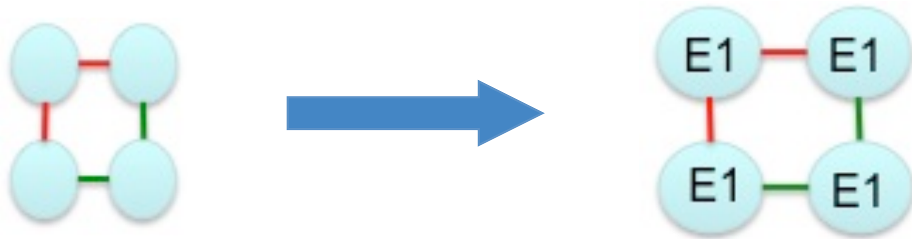
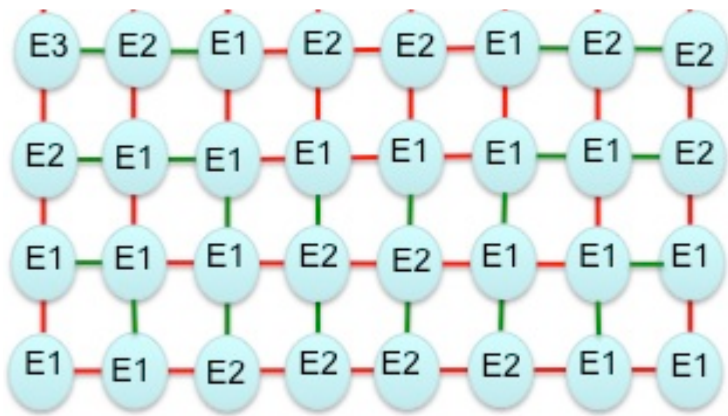
Overview

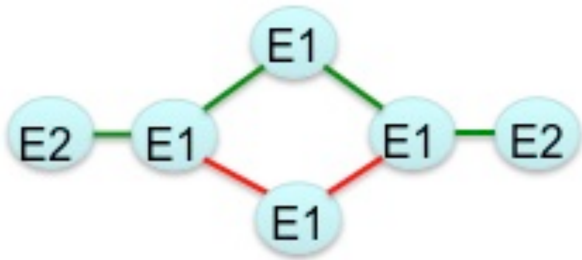
- Vertex Unique Labelled Subgraph (VULS)
- Motivation for mining VULS’s
- Mining Algorithms
- Results of our experiments

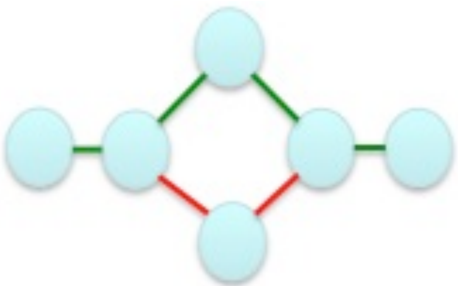
Definition of VULS

- A VULS is a subgraph with a specific edge labelling that has a unique vertex labelling associated with it.









Remarks

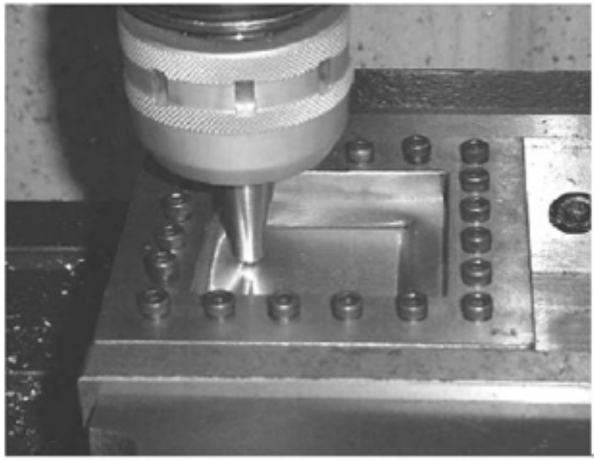
- The number of VULS depends heavily on the number of labels we use:
  - One edge label and many vertex labels => typically NO SMALL VULS
  - One edge label, one vertex label => every graph is a VULS

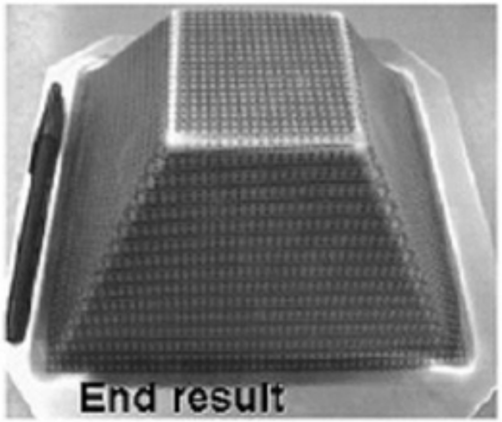
Motivation

Motivation

In Asymmetric Incremental Sheet Forming (AISF) a metal sheet is clamped into a "blank holder" and a desired shape is "pressed out" by the continuous movement of a round-headed forming tool.

Due to the nature of the metal used, and the AISF process itself, springback is introduced; as a result the geometry of the manufactured part is different from the geometry of the desired part.





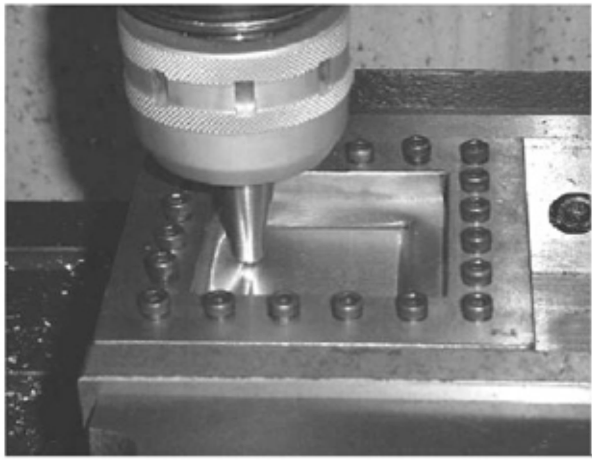
Motivation

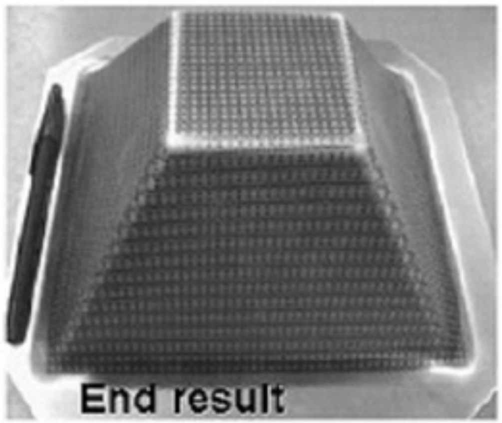
VULS mining can be used to describe the typical AISF errors

Real

Graph

Ideal





Remarks

- For any graph G, G itself is a VULS

Only *small* VULS's (size at most Max) characterize the local error patterns in G

- We want a way to cover all of G through a collection of (small) VULS's

VULS Mining Algorithm

INPUT: A vertex and edge labelled graph G and an integer value Max

PROCESS:

1. Find all connected edge labelled subgraphs of G with at most Max edges. Use canonical labelling to store them. Store their labellings too

2. Of all the subgraphs found in step 1. return those that occur in G with a unique vertex labelling

Experiments

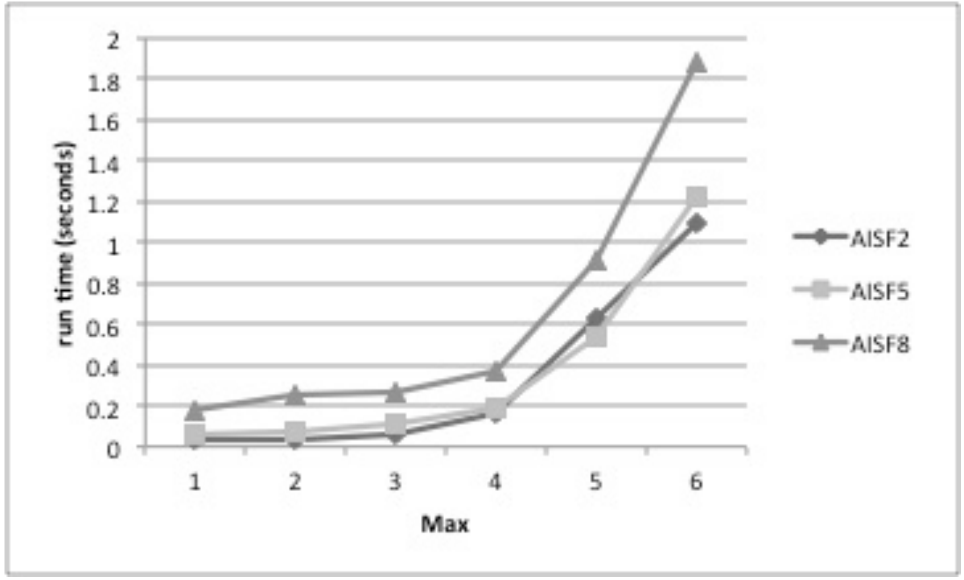
graph set	# vertices	# edge labels	# vertex labels
AISF1	36	3	2
AISF2	36	2	2
AISF3	36	2	3
AISF4	100	3	2
AISF5	100	2	2
AISF6	100	2	3
AISF7	441	3	2
AISF8	441	2	2
AISF9	441	2	3
AISF10	441	4	2

Summary of AISF evaluation graph sets

Measures

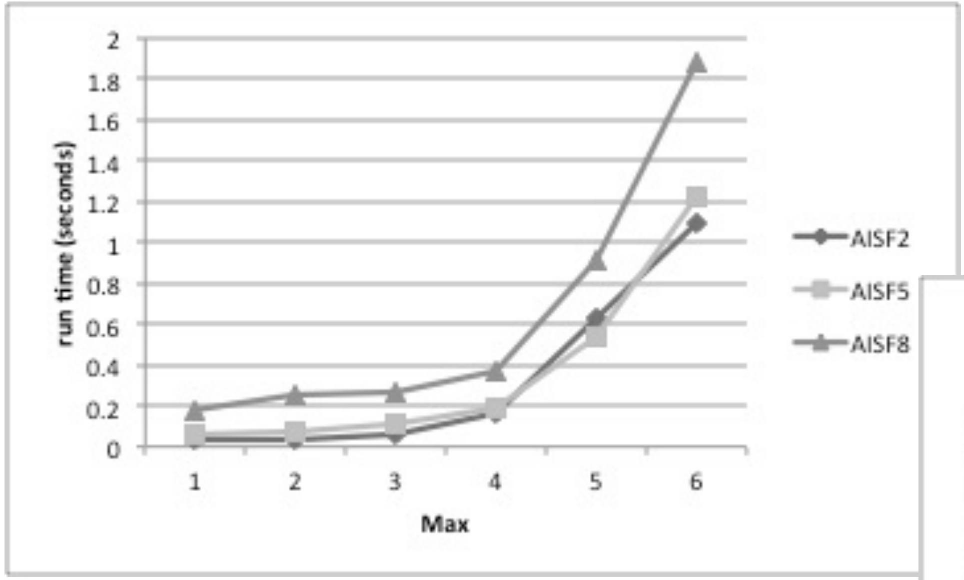
- Run Time
- Number of VULS identified
- Coverage Rate, defined as the proportion of vertices in G that belong to at least one VULS
- Discovery Rate, defined as the proportion of subgraphs of G that are VULS

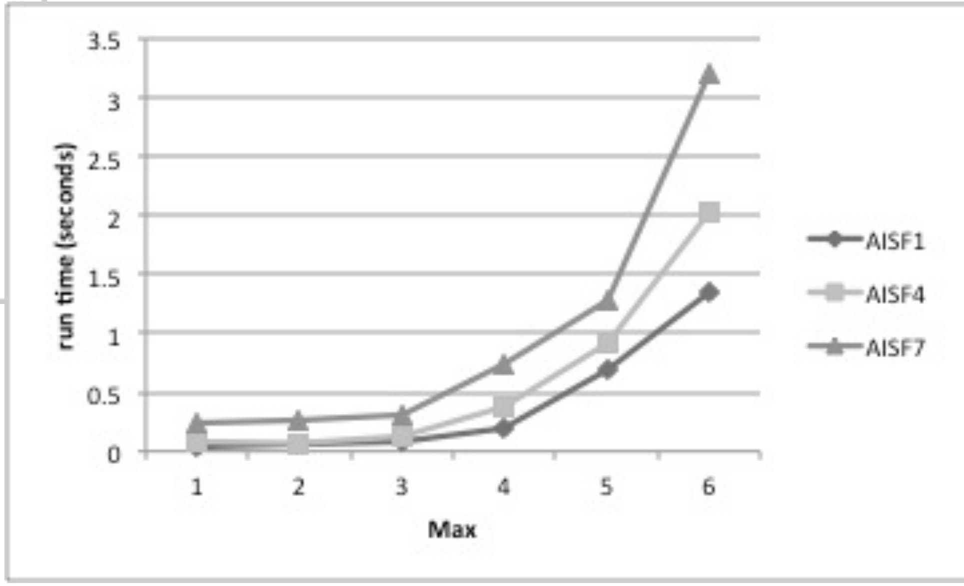
Run Time



2 edge labels,
2 vertex labels

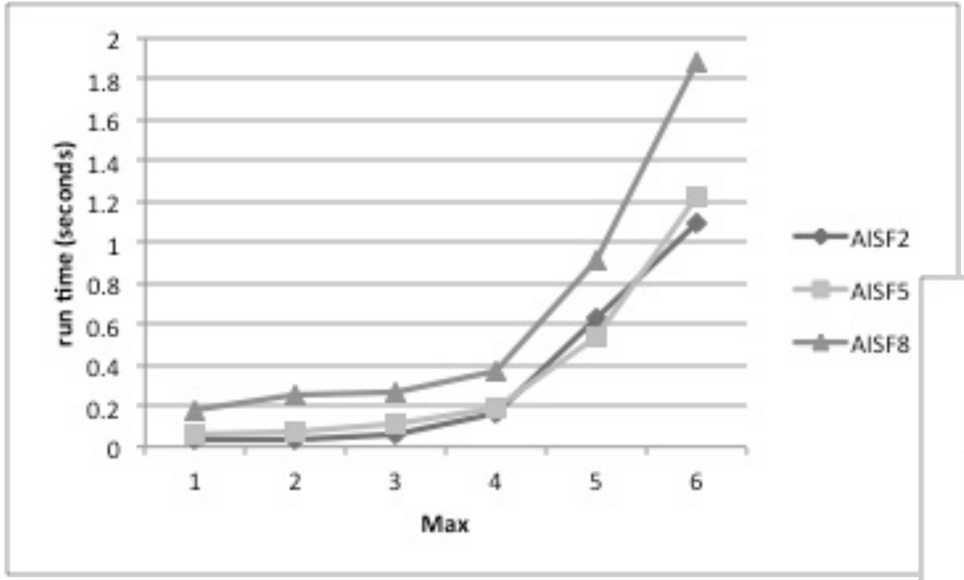
Run Time

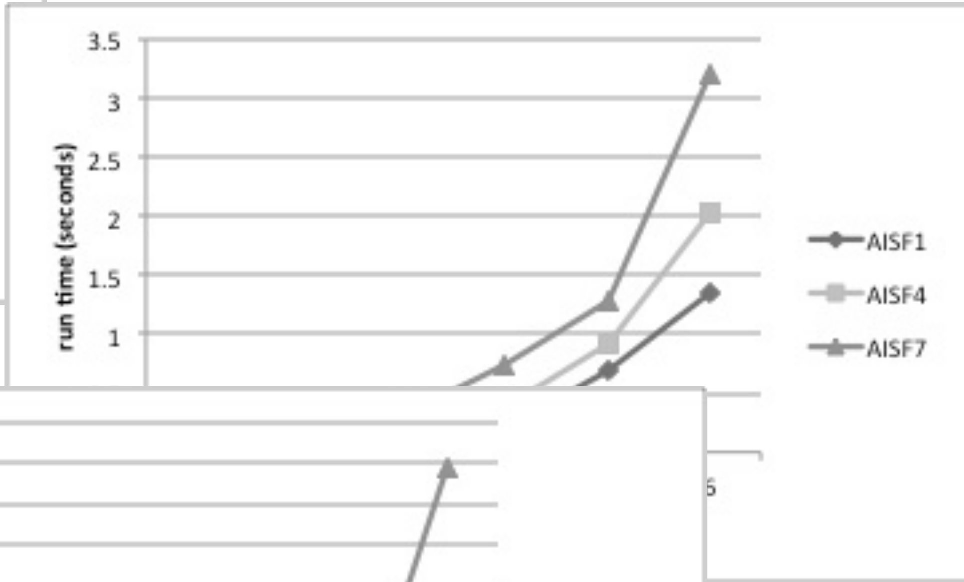


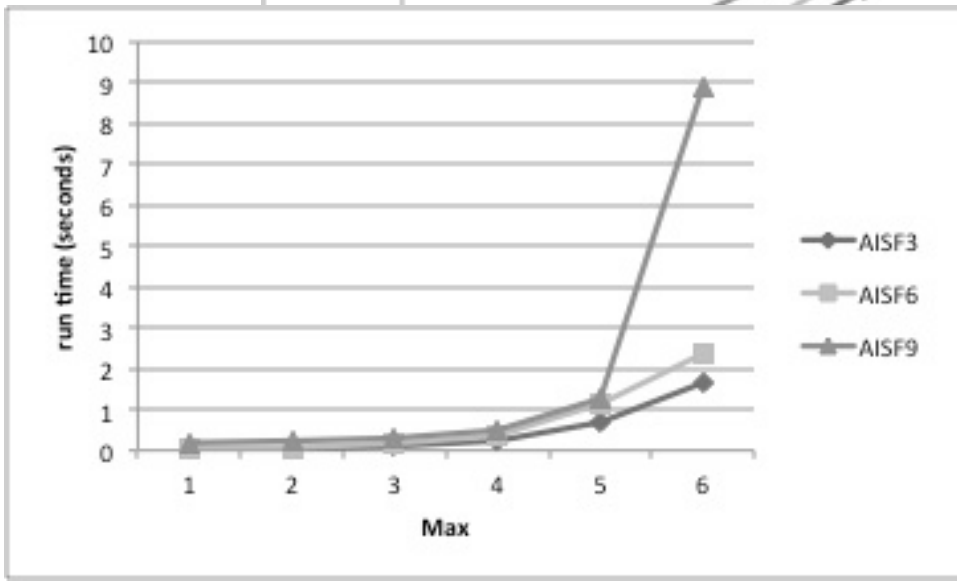


3 edge labels,
2 vertex labels

Run Time

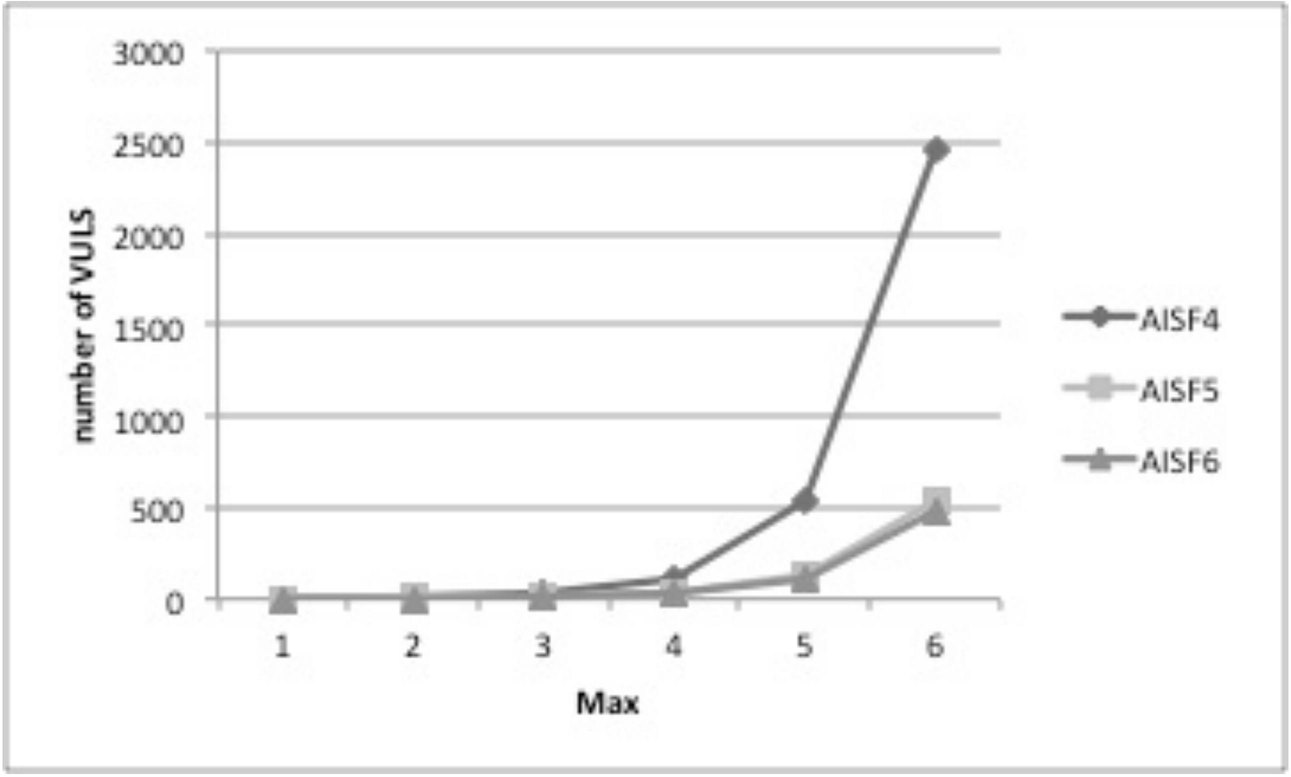






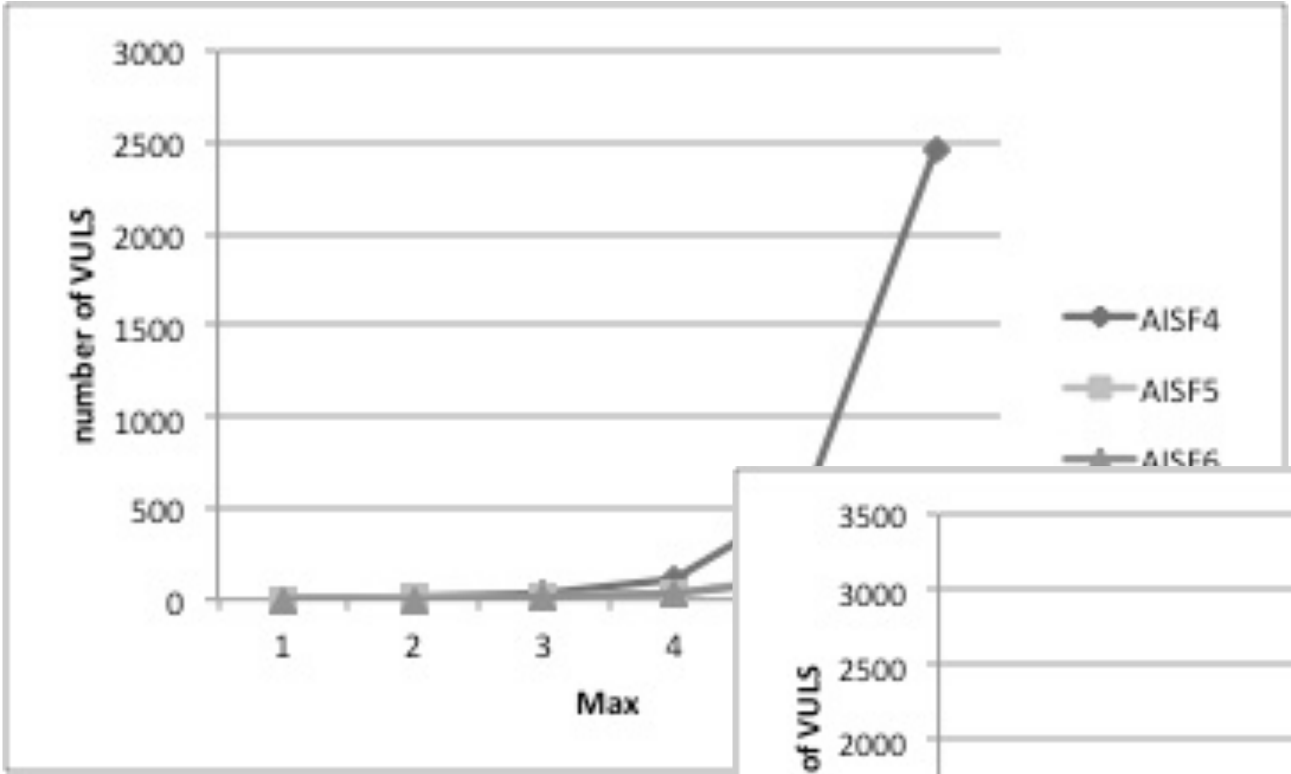
2 edge labels,
3 vertex labels

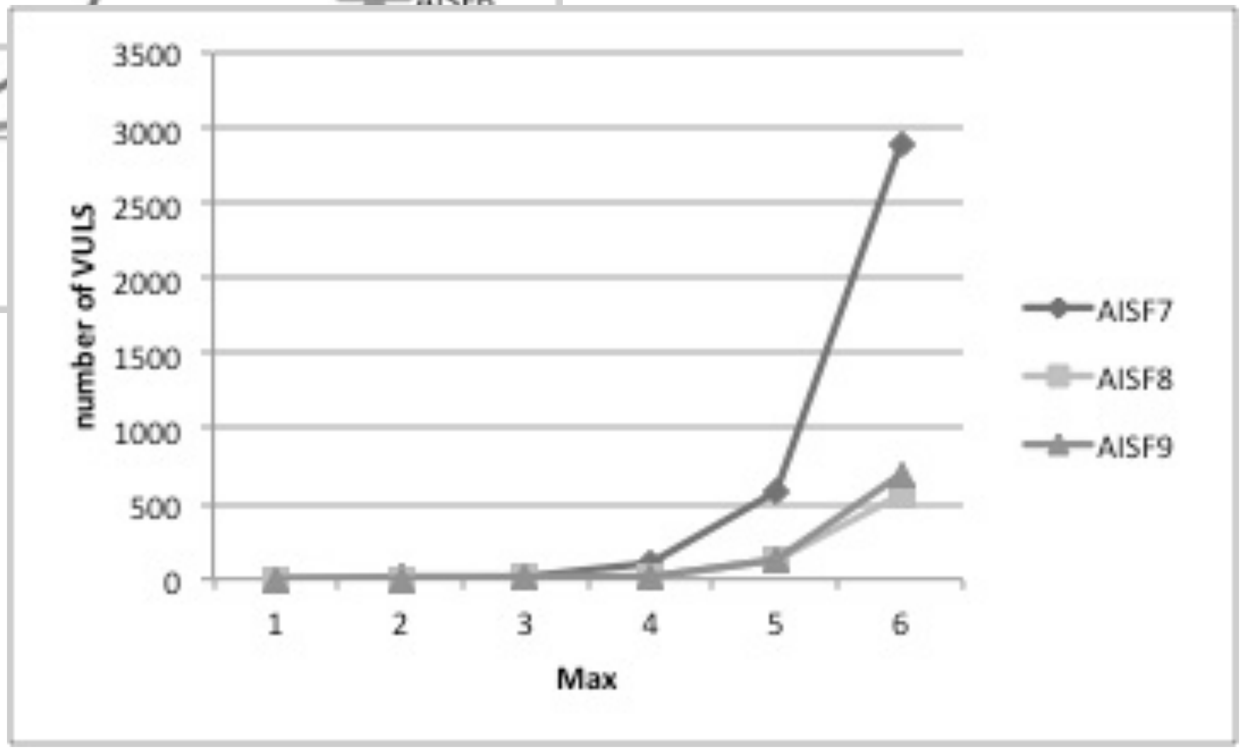
Number of VULS



100 vertices

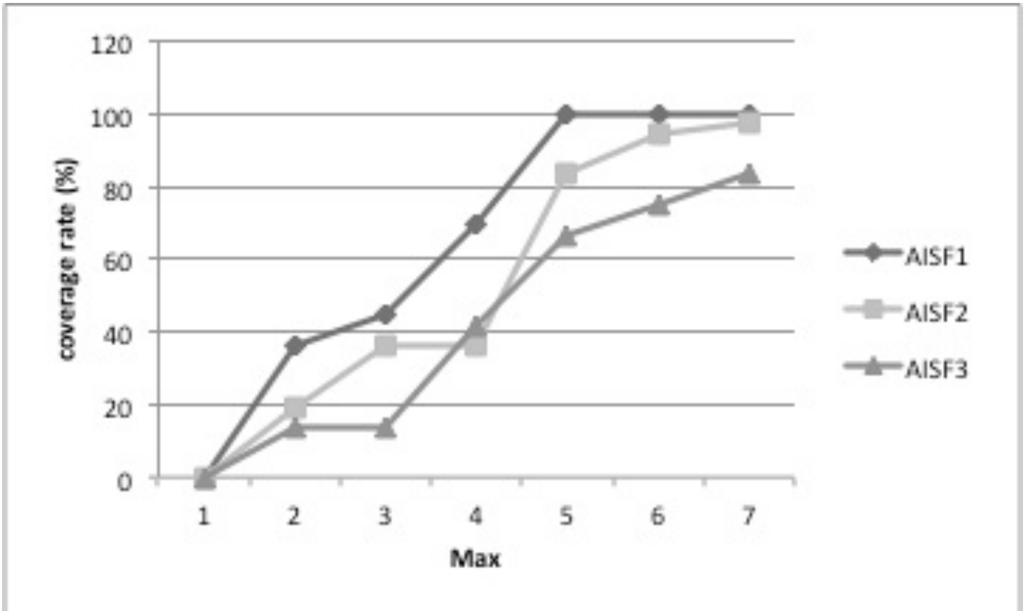
Number of VULS





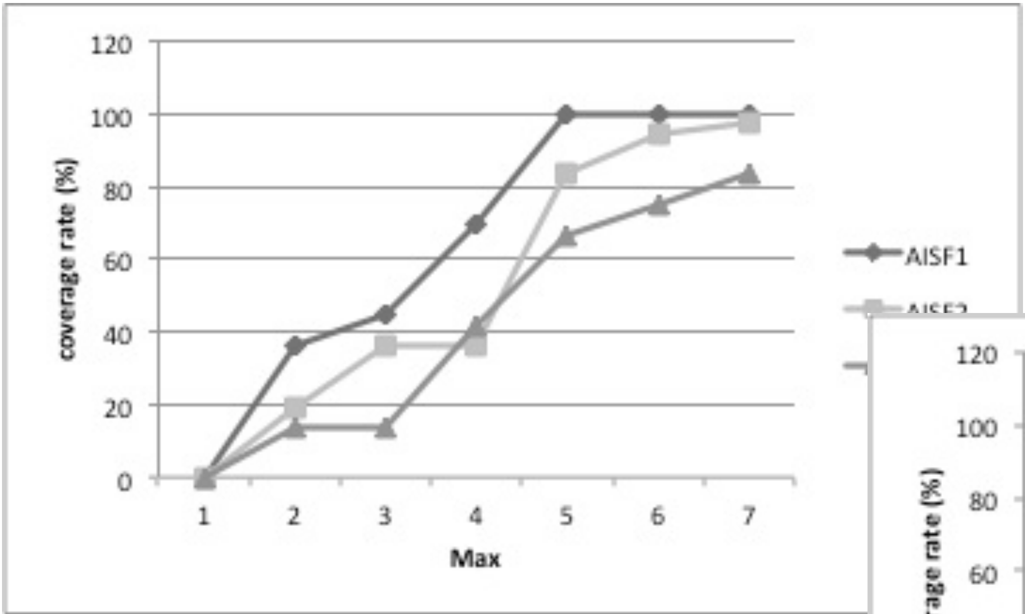
441vertices

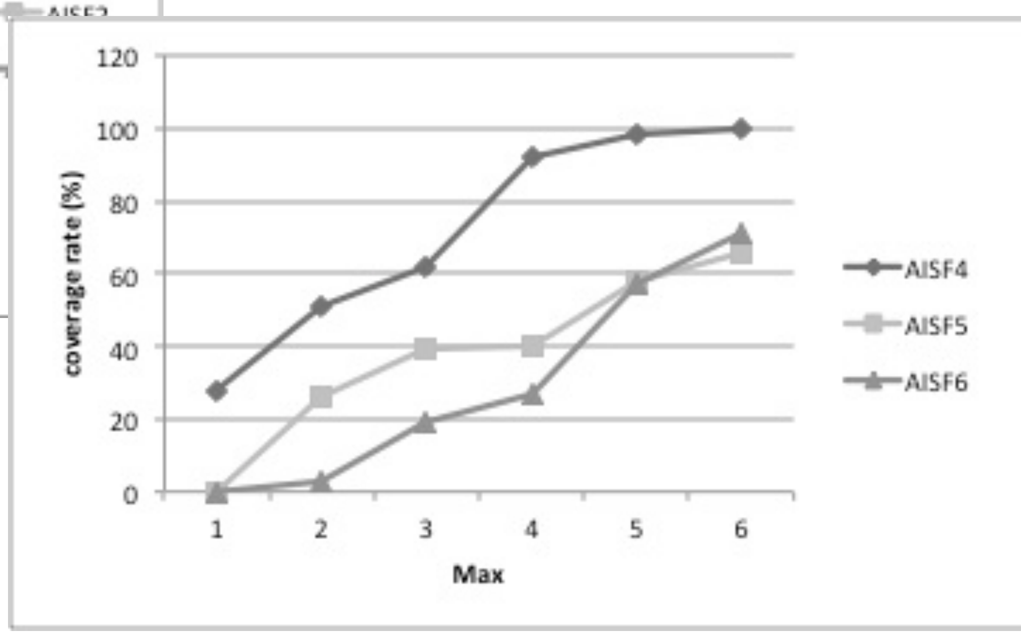
Coverage



36 vertices

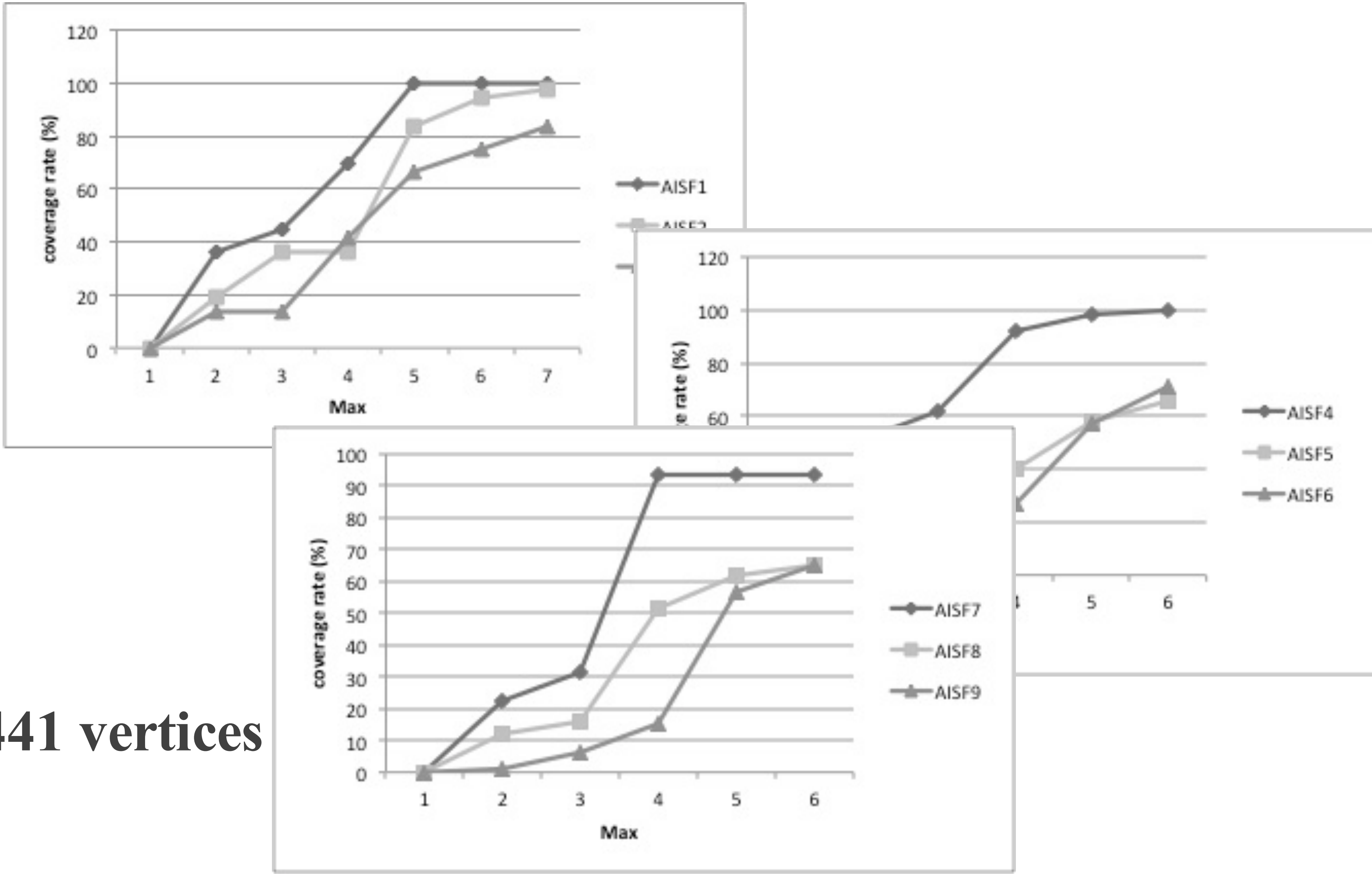
Coverage





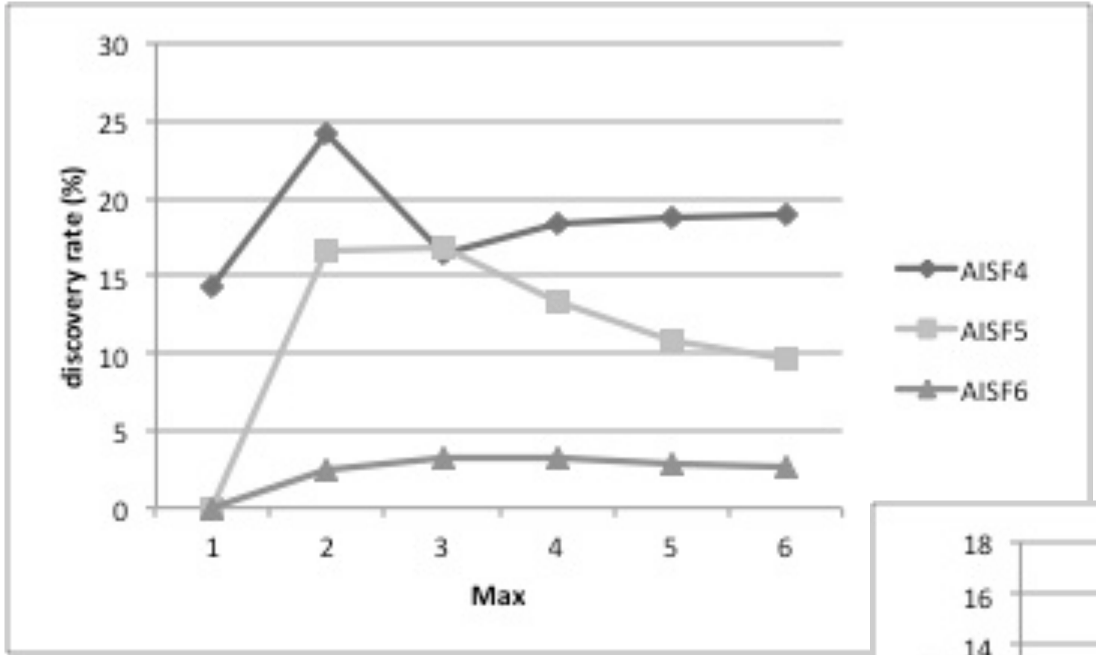
100 vertices

Coverage

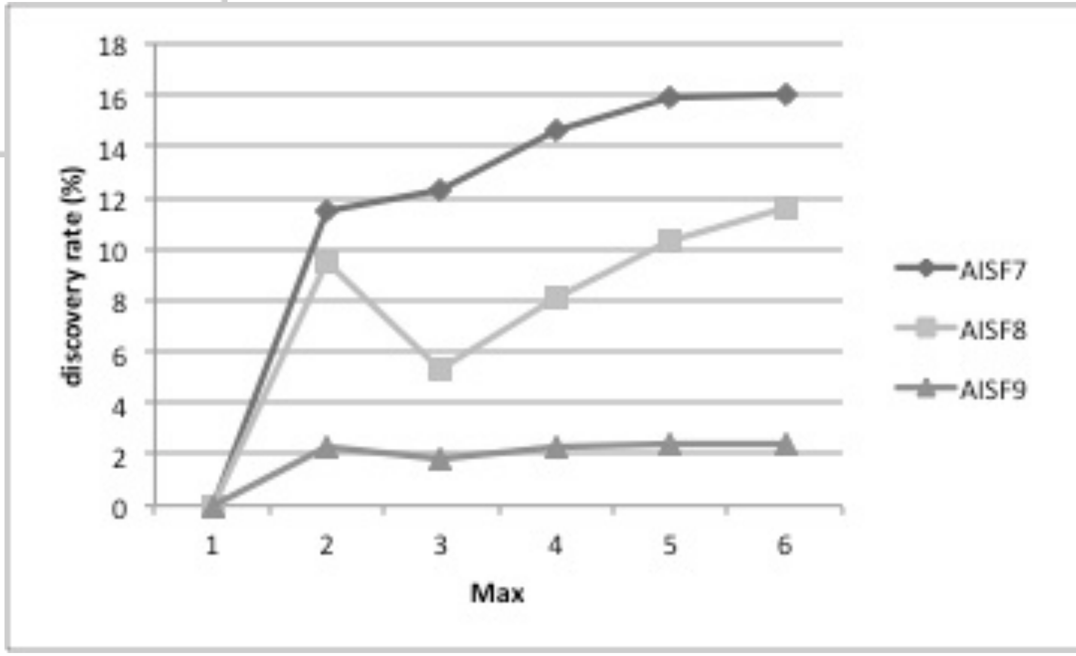


441 vertices

Discovery Rate



100 vertices



441 vertices

Conclusions and further study

- The concept of VULS was introduced together with a way to mine such graphs.
- Envisaged application area: VULS can be used to improve error prediction in sheet metal forming.
- Empirical evidence of soundness.
- Further work on refined related notions and classification is very much in progress.

End

Thank you for your attention!