Exploratory Visualizations of Rules for Validation of Expert Decisions

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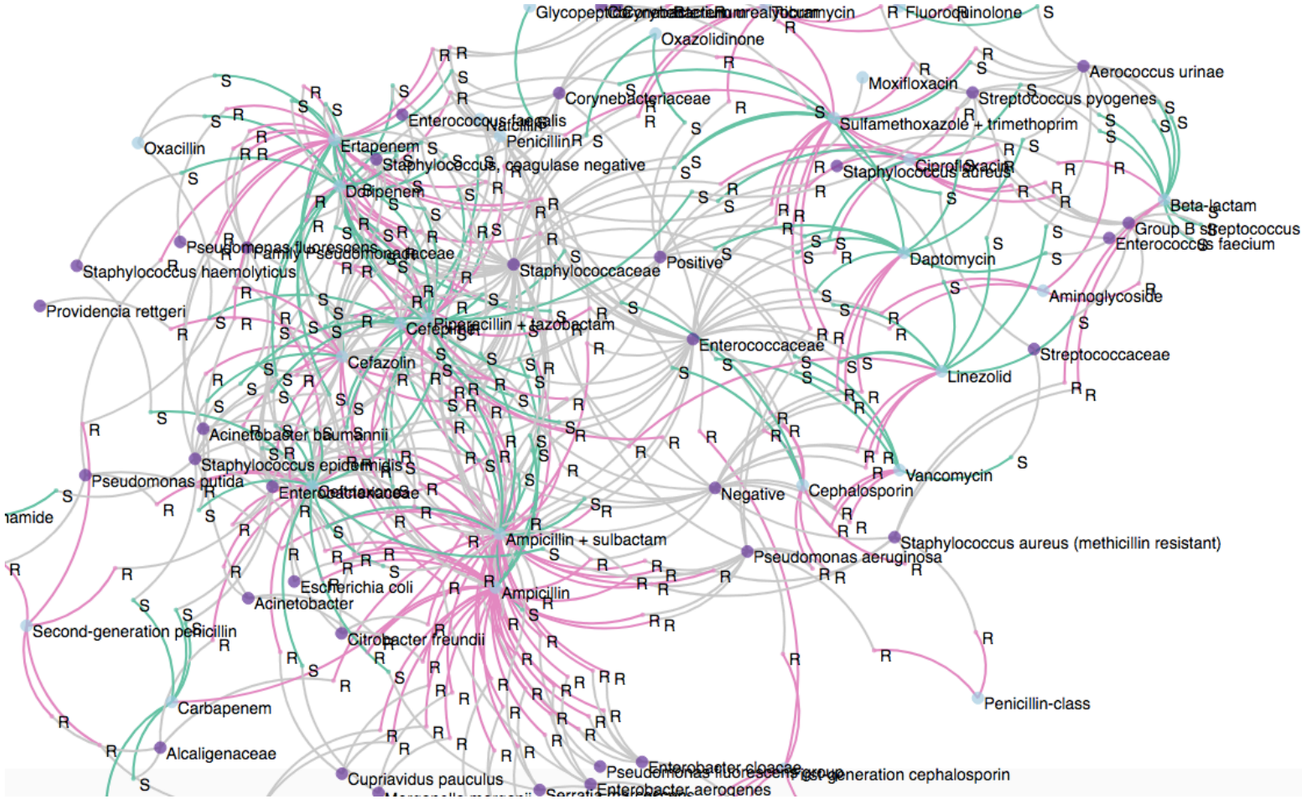
Introduction

- Rule-based systems are common in medical data pipelines
- Visualizing rules is challenging
- Methods to visualize rules
- Interactively edit rule sets



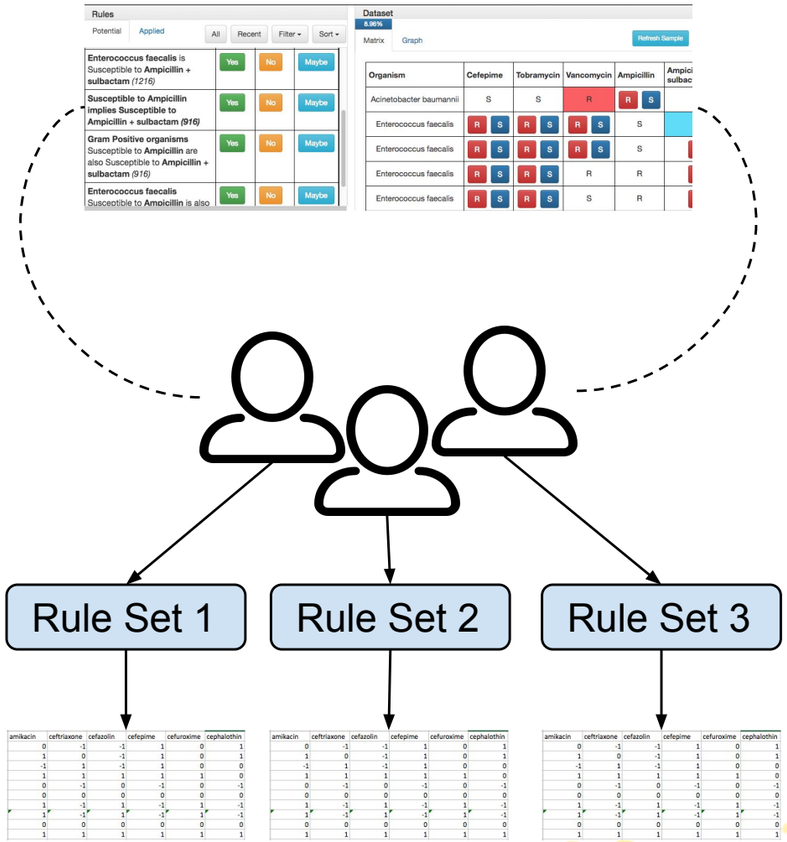
Motivation and Context

- Automated methods fail when filling in missing data (see our VLDB'18 paper, Icarus)
- Microbiology patient lab results
- Each row is a patient record
  - Organism
  - Sensitivities to antibiotics

Organism	Cefepime	Tobramycin	Vancomycin	Ampicillin	Ampicillin + sulbactam
Acinetobacter baumannii	S	S	R	R S	S
Enterococcus faecalis	R S	R S	R S	S	S
Enterococcus faecalis	R S	R S	R S	S	R S
Enterococcus faecalis	R S	R S	R	R	R S
Enterococcus faecalis	R S	R S	S	R	R S
Escherichia coli	R	S	R	R	S
Escherichia coli	S	R	R	R	S
Escherichia coli	S	S	R	S	S
Proteus mirabilis	R	S	R	R	R
Pseudomonas aeruginosa	R	R	R	R S	R S

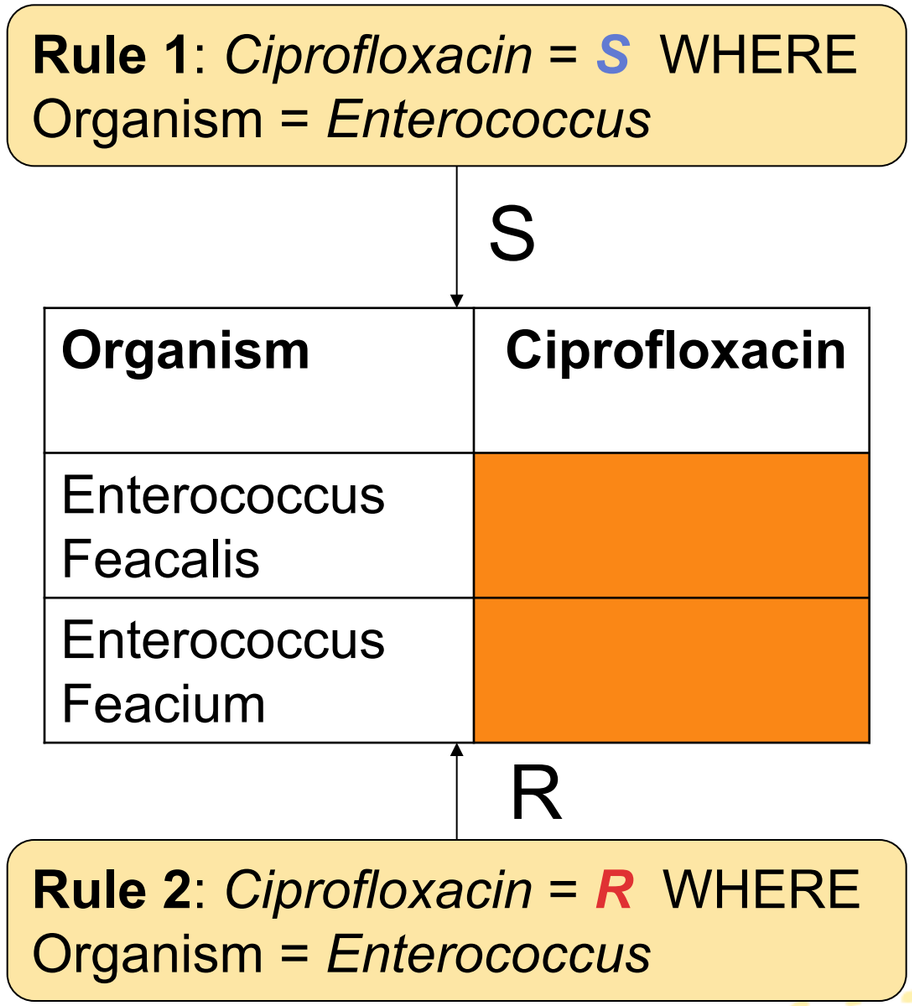
Motivation and Context (contd.)

- Domain expert input required via rules
- Subjectivity in rules
- Multiple experts must come to consensus



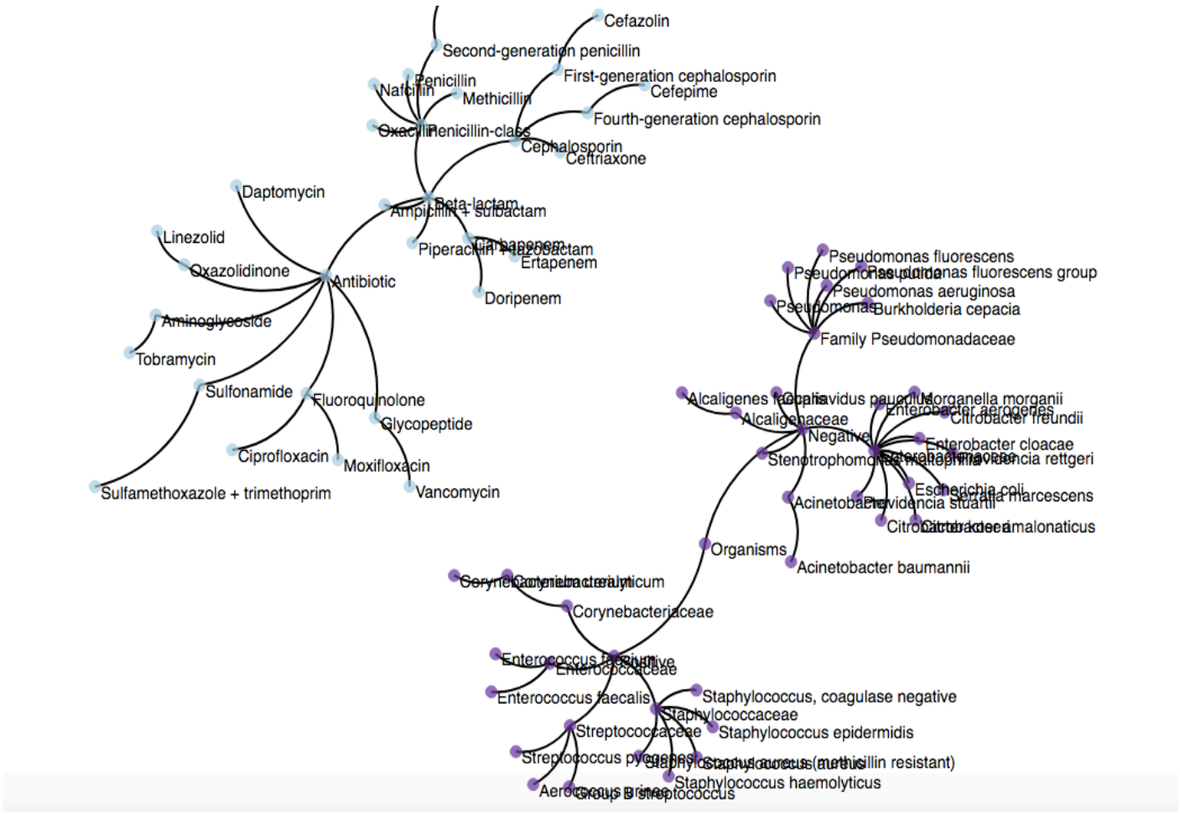
Goal

- Visualize rules to identify
  - Conflicts
  - Redundancies
- Interactive editing of rule-set to arrive at a consensus rule-set



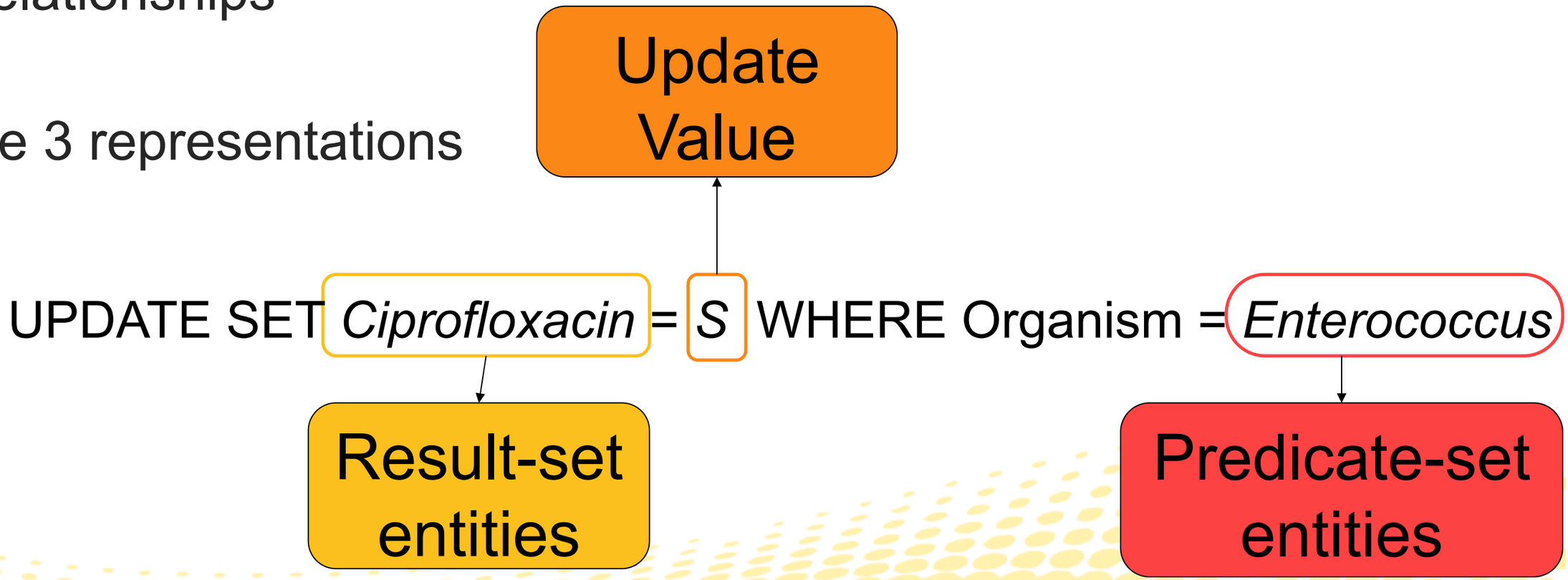
Visualization

- Antibiotics and Organisms have inherent hierarchy
- Node-link diagram
- Match experts mental model of the data



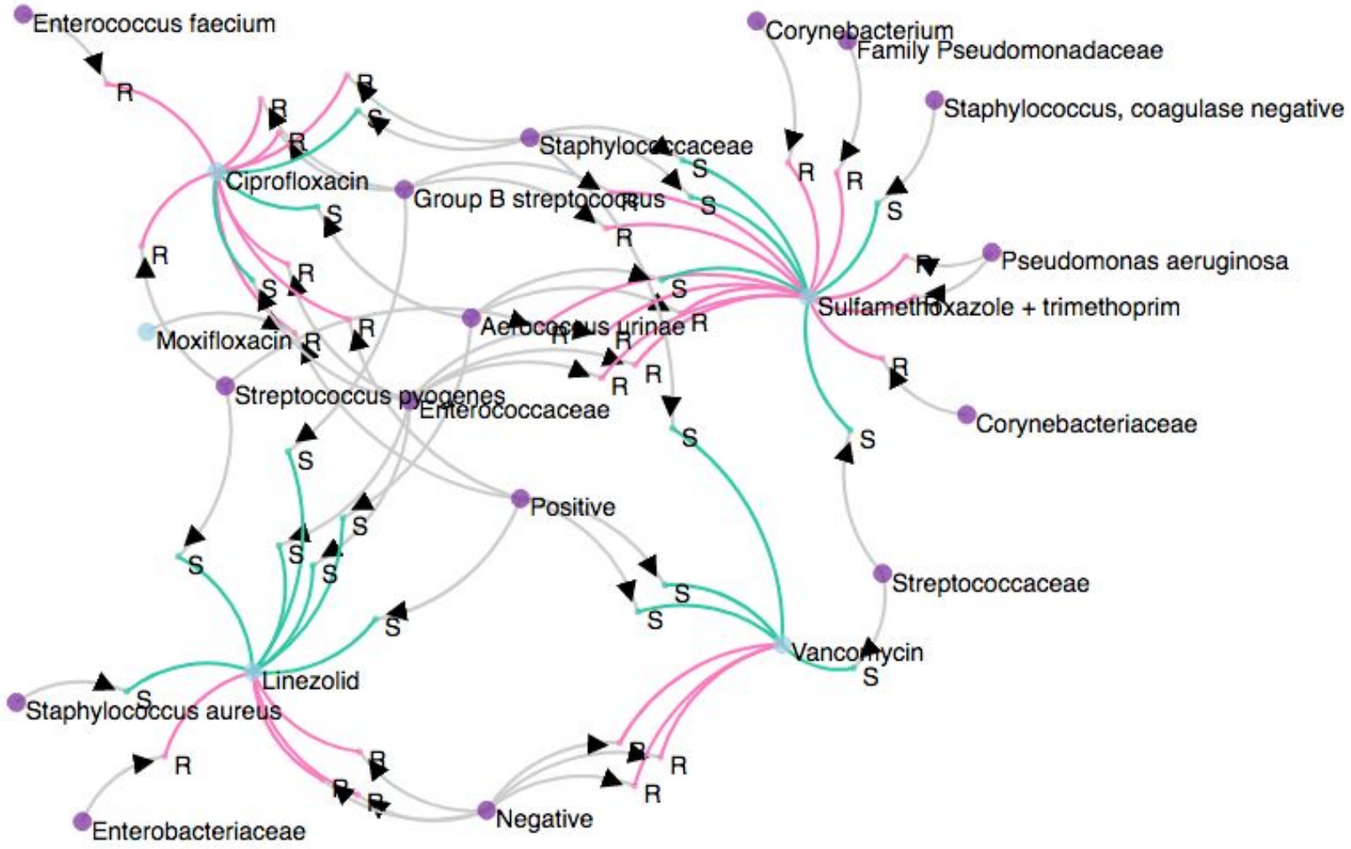
Rule Representation

- Rule - Update query
- Rule relationships
- Explore 3 representations



Rule Representation A

- Rule nodes with edges
  - to result nodes
  - from predicate nodes
- High node degree
  - 6 edges per entity node
- Multiple edge crossings



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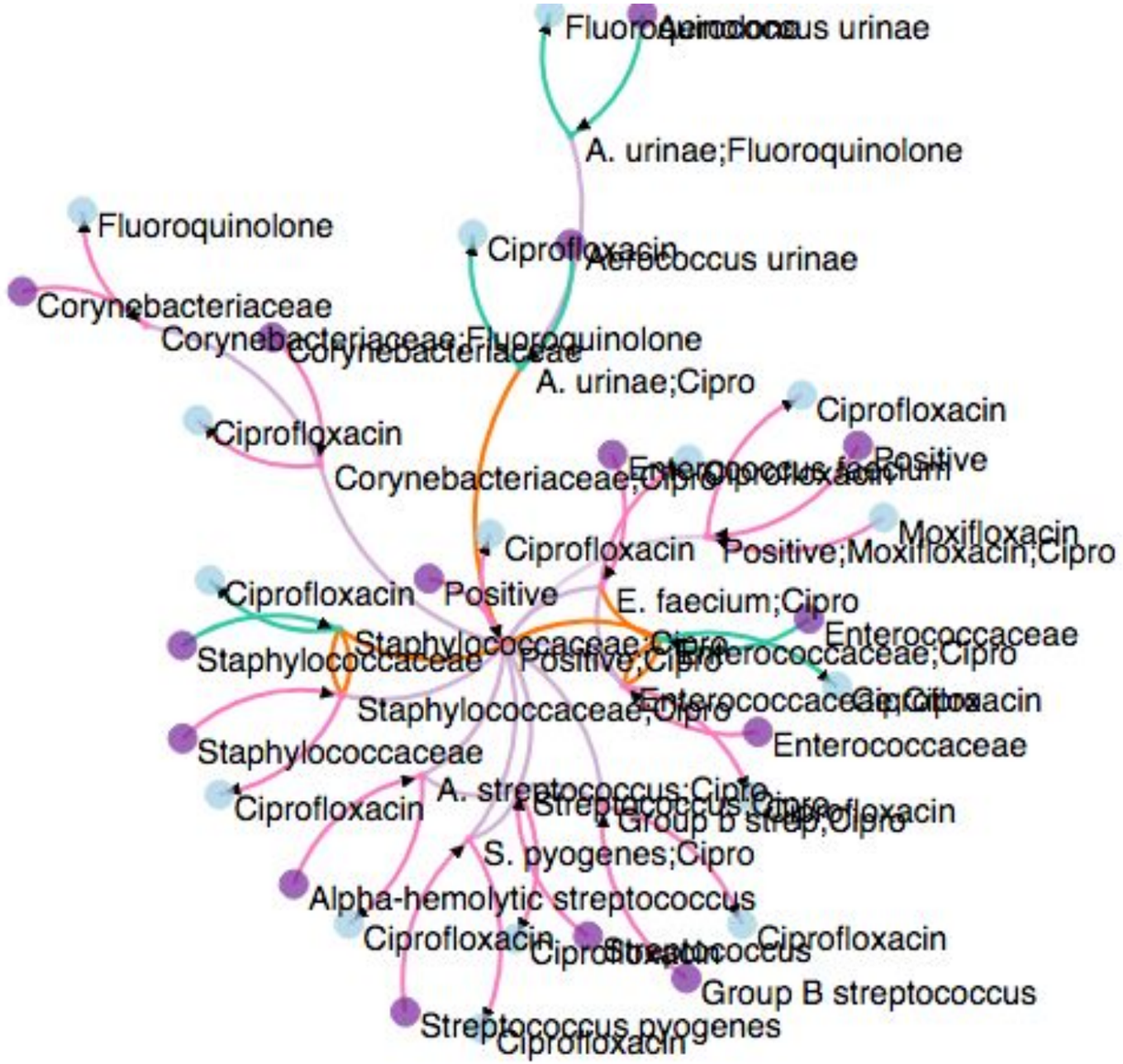
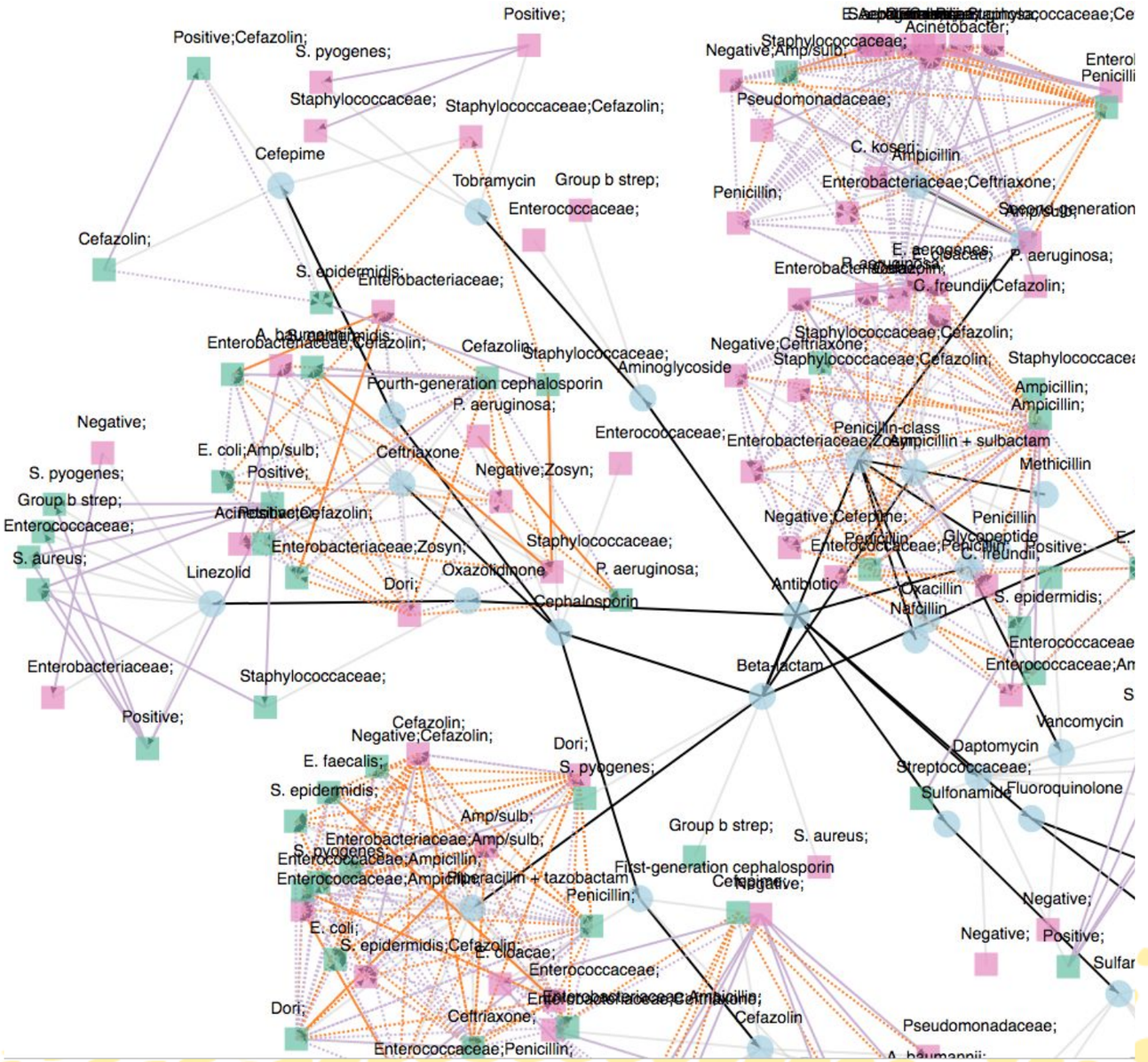
Rule Representation B

- Separate entity nodes per rule
- Explicit edges for related rules
- 3 nodes to interpret rules
  - High cognitive load

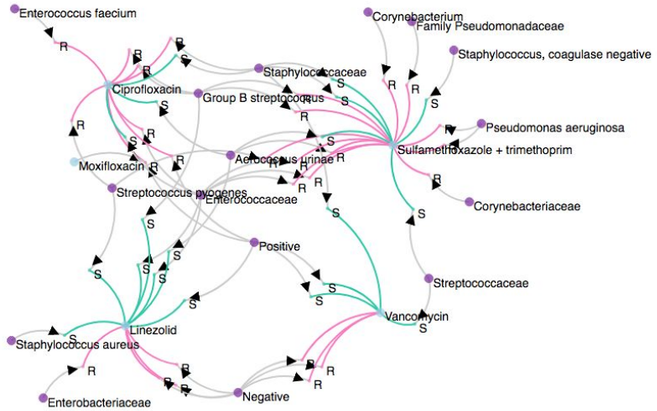


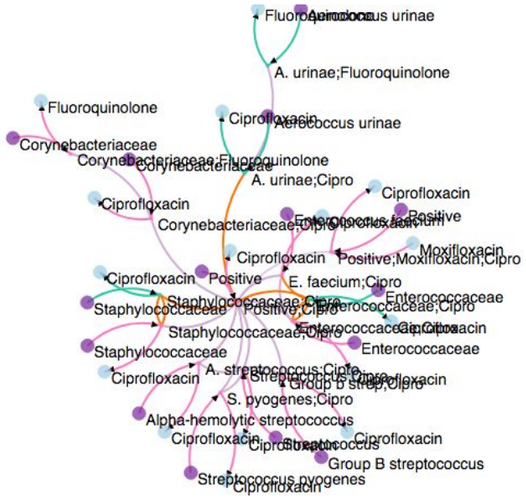
Rule Representation C

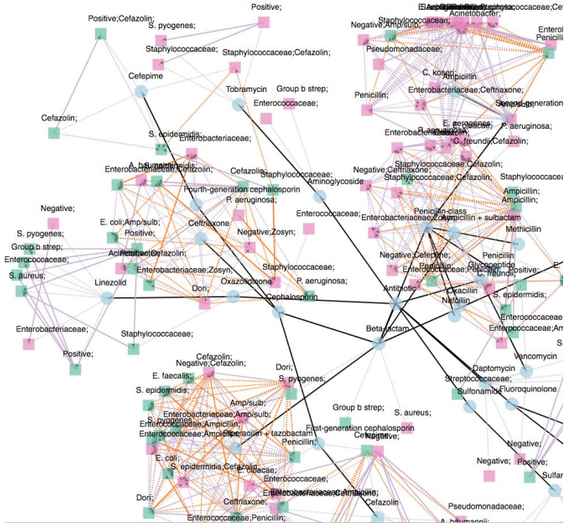
- Nodes for result-set entities
- Predicate entities on label
- Explicit edges for related rules
- Clusters of rules visible



Rule Representation – C







	Representation A	Representation B	Representation C
Low Node Degree	✗	✓	✓
Low Edge Crossings	✗	✗	✓
No. of nodes to interpret rule	3	3	2

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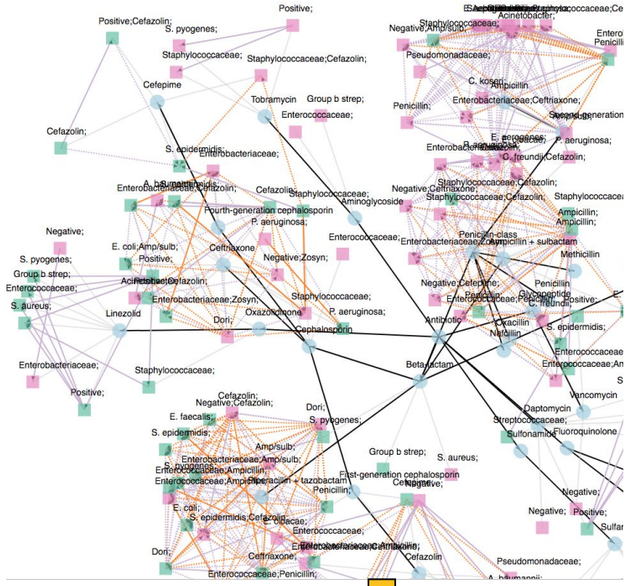
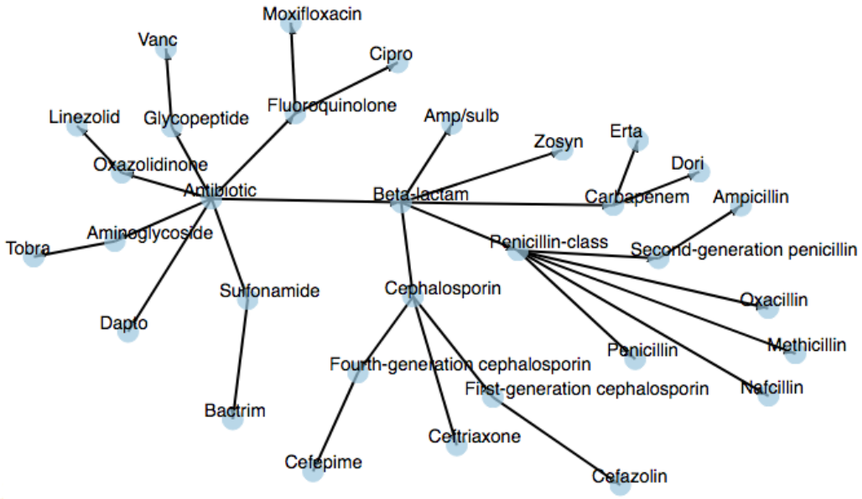
Navigation View

- All rules at once overwhelm user
- Collapse rules by result-sets
- Nodes expand in-place to reveal rules
- User controls amount of information



Collapse

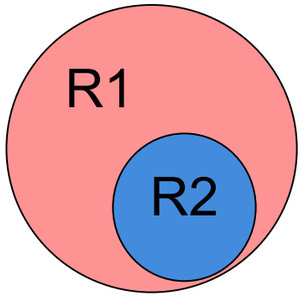


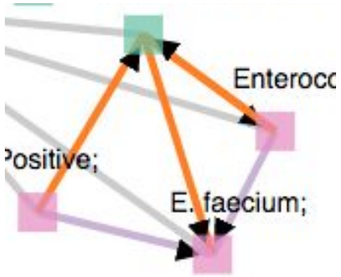
Preview Impact on Data

- Data summary pop-up
- Distribution after rule application in last bar

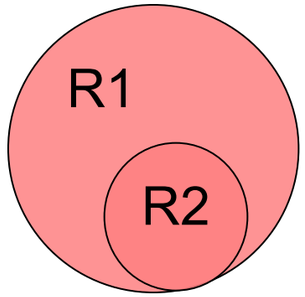
Rule Relationships

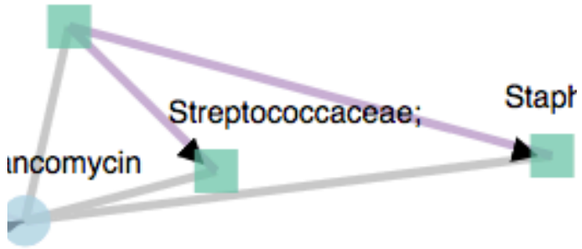
Conflict



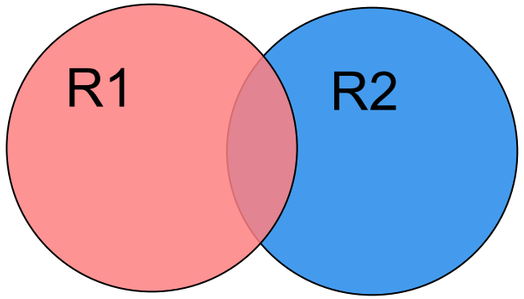


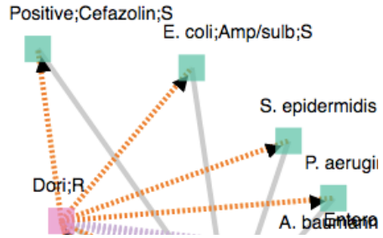
Subsumes



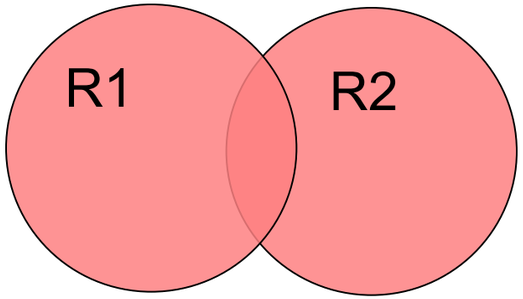


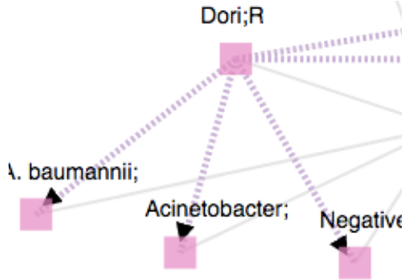
Partial Conflict



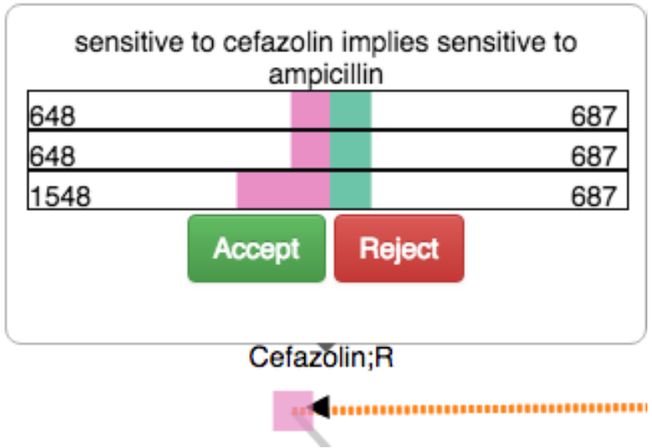


Overlap



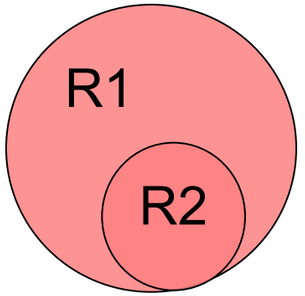


Editing Rule Sets



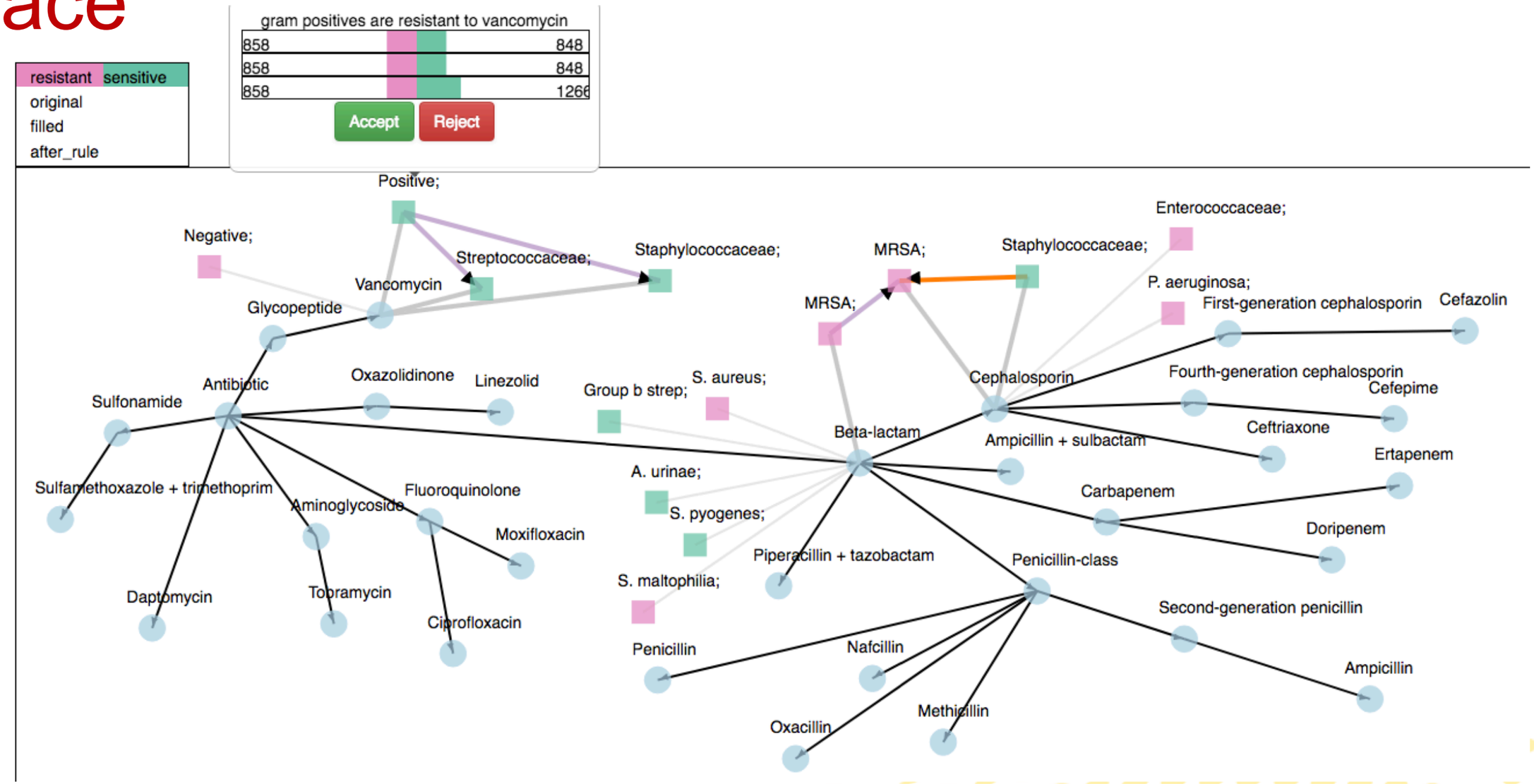
- Accept Rule
  - Remove conflicting and subsuming rules
  - Update data summaries of partial conflicts and overlaps

- Reject Rule
  - Remove rules that subsume rejected rule



Reject R2 implies reject R1

Interface


resistant sensitive
original
filled
after_rule
gram positives are resistant to vancomycin
858 848
858 848
858 1266
Accept
Reject
Positive;
Negative;
Streptococcaceae;
Staphylococcaceae;
Vancomycin
Glycopeptide
Antibiotic
Oxazolidinone
Linezolid
Sulfonamide
Group b strep;
S. aureus;
Sulfamethoxazole + trimethoprim
Aminoglycoside
Fluoroquinolone
Moxifloxacin
Daptomycin
Tobramycin
Ciprofloxacin
Enterococcaceae;
MRSA;
Staphylococcaceae;
MRSA;
P. aeruginosa;
First-generation cephalosporin
Cefazolin
Cephalosporin
Fourth-generation cephalosporin
Cefepime
Ceftriaxone
Ampicillin + sulbactam
Beta-lactam
Ertapenem
A. urinae;
Carbapenem
S. pyogenes;
Doripenem
Piperacillin + tazobactam
Penicillin-class
S. maltophilia;
Second-generation penicillin
Penicillin
Nafcillin
Ampicillin
Oxacillin
Methicillin

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