DRACO: TOP-DOWN DIAGNOSIS OF LARGE-SCALE VOIP NETWORKS
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PROBLEM STATEMENT
- Business VoIP services growing rapidly
- Millions of calls per day
- Call volumes doubled in last year
- Faults cause call defects (blocked or cut-off calls)
- Major incidents often occur after failed upgrades
- Typically misconfigurations, or software bugs

Research question
- How do we diagnose faults that:
  1. Have never happened before?

OVERVIEW OF VoIP SYSTEMS
- Network elements record outcome
- Timestamp, name of network element, service type
- Outcome of call (successful, blocked, or cut-off)

DRACO: TOP-DOWN DIAGNOSIS
1. Represent calls as truth table

<table>
<thead>
<tr>
<th>SVR1</th>
<th>SVR2</th>
<th>SVR3</th>
<th>PHONE1</th>
<th>OUTCOME</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

2. Model distribution of each call attribute

Successful calls
Failed calls

SRV3 more likely to occur in failed calls

3. Build diagnostic tree and rank output

SVR3 best explains failed calls
Model distributions for co-occurring attributes (SVR3 and PHONE1)
Expand tree and select branch with highest score

Defect Signature 1
SVR3 and PHONE1
Frequency

Defect Signature 2
Filter out calls matching SVR3 and PHONE1

DIAGNOSIS OF REAL WORLD INCIDENTS
- Draco correctly diagnosed 8 out of 10 incidents
- 2 incidents not diagnosed were due to brief outages
- Currently working on online version of algorithm

Examples of real-world incidents
Rank
Configuration problem incorrectly routes calls from a certain make of phones.  3
Bug in third-party software causes call rejection.  1
Server overload leads to blocked calls.  1
Race condition leads to blocked calls.  10
Application server run out of memory.  1
Customers use wrong codec to send faxes.  4
Debug logs overload servers during peak traffic.  15
Blocked circuit ID codes on trunk group.  1-8
Server crash causes brief outage.  -
Intermittent problem due to software bug.  -