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# Rule-based Mobile Resource Learner for Field Scheduling Applications

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November 2013



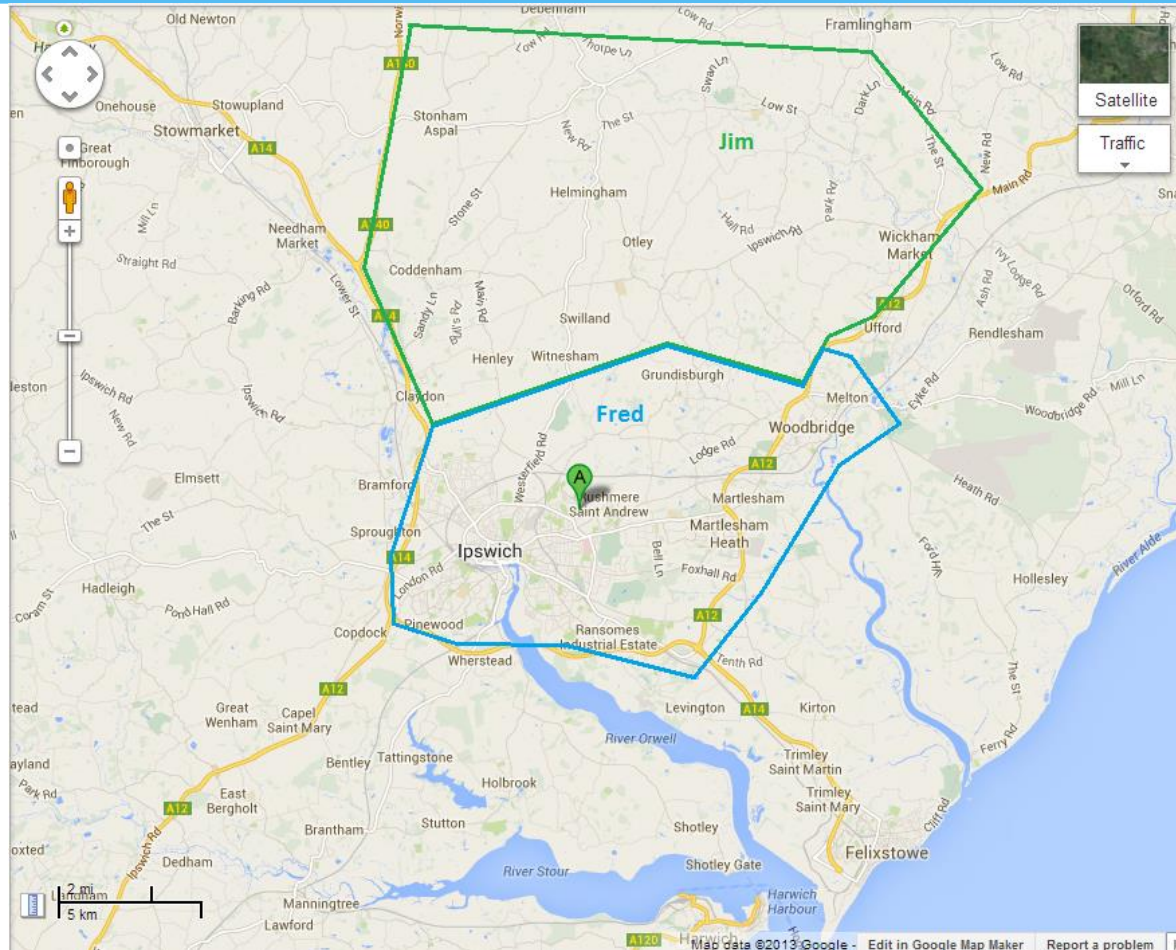
# Outline

- \* Motivational Business Cases
- \* Why Use Learning?
- \* What Problem Characteristics to Learn?
- \* An Example of Learning Infrastructure
- \* Using Rules for Learning
- \* Further Extensions

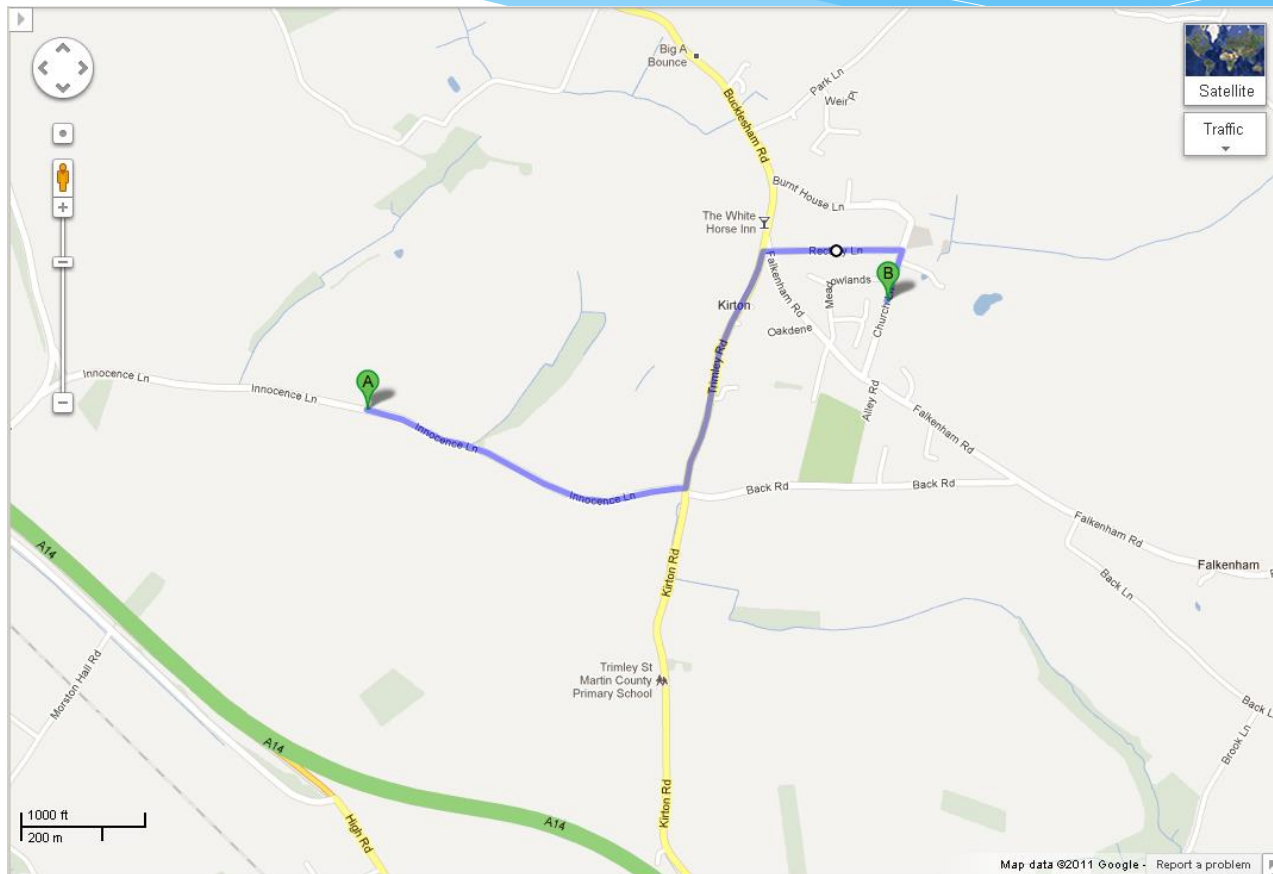
# Caveat

\* Patent Pending...

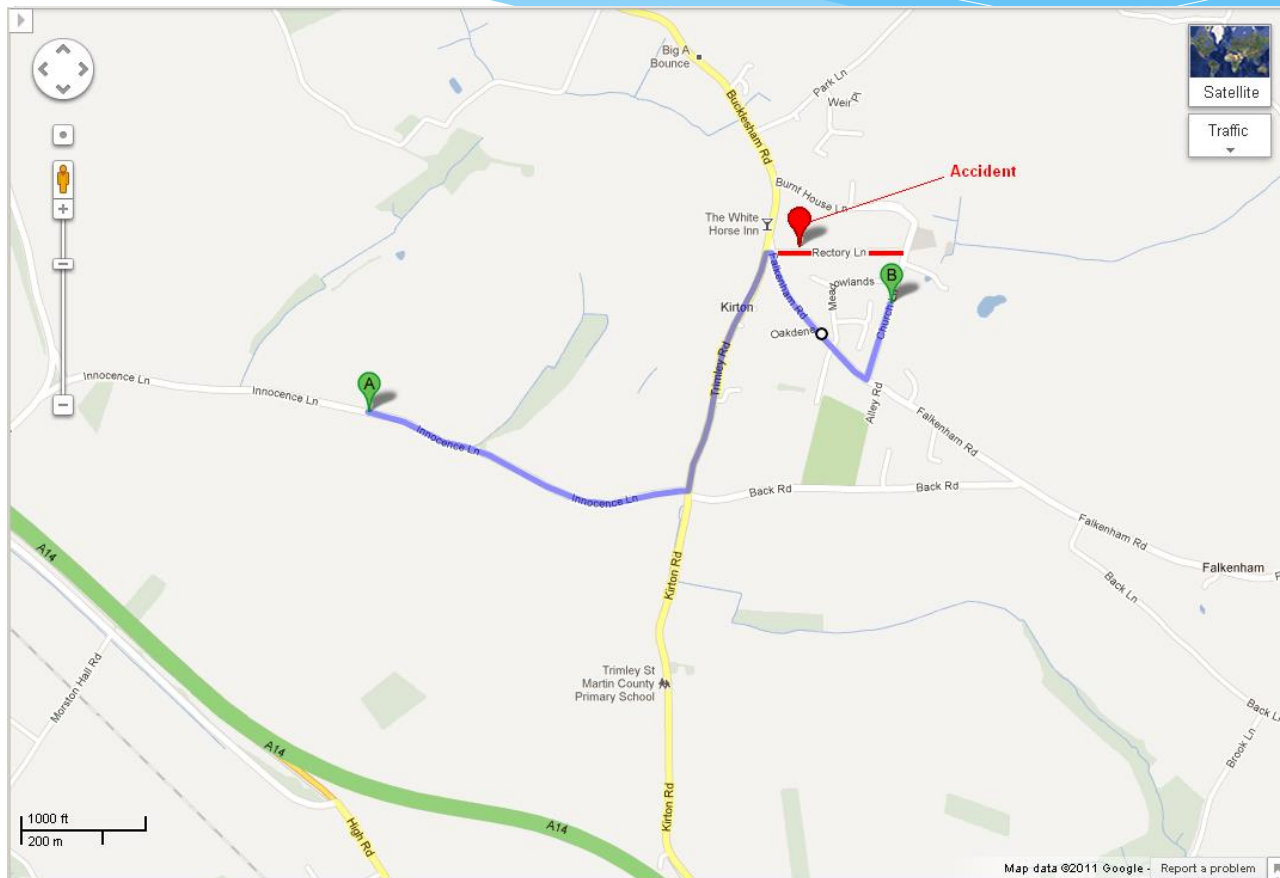
# Business Scenario I: Best Tech



# Business Scenario II: Safest Route



# Business Scenario II: Safest Route



# Business Scenario III: Building workforce expertise

- \* Alice has been assigned boiler maintenance jobs
- \* Customer requests boiler repair
- \* Tim is expert at repairing this brand but lives far
- \* Shall we assign it to Alice or Tim?

# Business Scenario IV: an Imperfect World

- \* Operator constructed a perfect schedule yesterday
- \* Jim is stuck in traffic on his first job
- \* Fred asks for sick leave
- \* Customers not on premises, workforce is idle
- \* Main road is flooded, detour takes a lot of time
- \* Spare parts are missing



# Field Service Scenarios

- \* Large Scale
- \* Complex
- \* Dynamic
- \* Frequent Exceptional Situations
- \* Inaccurate Data
- \* Changing Business Objectives

# Current State

- \* Customers have ad hoc solutions involving manual intervention
  - \* Error-prone
  - \* Tiresome
  - \* Time consuming
  - \* Overly resource intensive
  - \* Expert knowledge required
  - \* Poor schedule quality

# To Learn or Not to Learn?

- \* Minimise time on data build and maintenance
- \* Mitigate risks of schedule disruptions
- \* Improve actual dispatched schedule quality

# What to Learn?

- \* Workforce
  - \* Where they operate geographically
  - \* What skills/preferences they have
- \* Workload
  - \* Typical job types and durations
  - \* Skill requirement distributions over time
- \* Travel Model
  - \* Street Level Routing engines provide answers dependent on time of query

# Why learn geo areas and skills?

- \* From experience:
  - \* Hardest to set up and maintain
  - \* Most error-prone
  - \* Most affected by having to rely on manual intervention
- \* Familiarity of workforce with areas
  - \* Minimize journey/parking times
- \* Workforce skill learning
  - \* Improve job execution success rates

# Learning for data setup



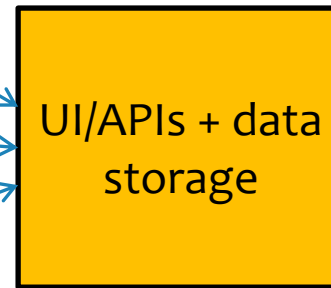
*Semi-static User Inputs:*  
Skills, Working Areas, ...



*Dynamic user inputs:*  
Dispatcher assignments  
(historic & real-time)

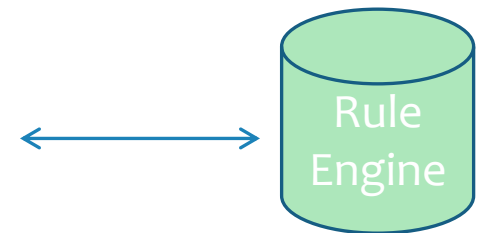


*Automated inputs:*  
Job & tracked Vehicle Stop  
Locations



Learn

Update Model



# Rule Based Learning of Geo Areas

- \* Capture dynamic nature of the problem
- \* Filter noise: notice only significant events
- \* Maintain a history of job assignments
- \* Maintain resource geo areas based on active historic assignments
  - \* Run learner periodically (e.g. before working day starts)

# History Extension Rules

**Bootstrapping Mode**

Condition					
Condition		Condition		Conclusion	
No. All Assignments		No. Assignments in a Cluster		Current Assignment State	
<	10			Is	Active
>=	10	>	3	Is	Active
>=	10	<=	3	Is	Inactive



# History State Maintenance Rules

Condition		Condition		Condition		Conclusion	
Current Assignment State		No. Other Assignments in Cluster		Current Assignment Expired		Current Assignment State	
Is	Inactive	>	3	Is	FALSE	Is	Active

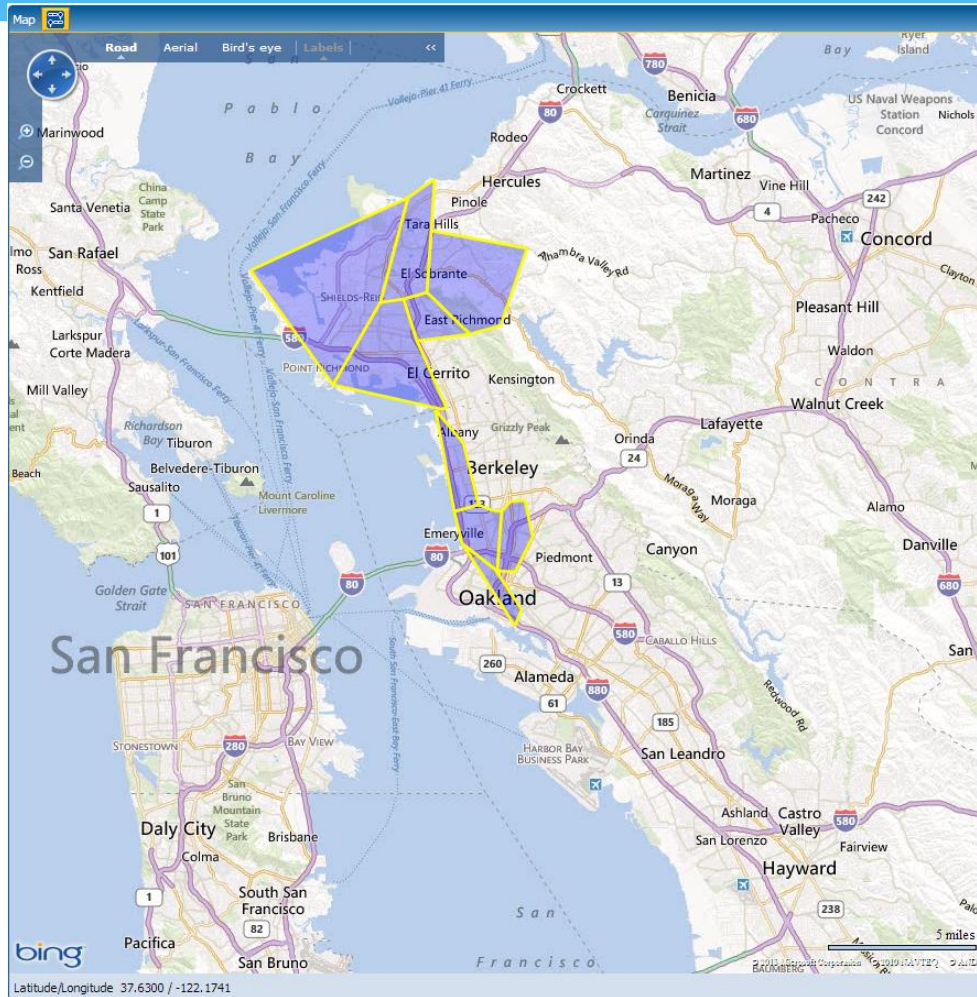
# History State Maintenance Rules

History State Maintenance Rules									
Condition		Condition		Condition		Conclusion		Conclusion	
No. Active Assignments		Current Assignment State		No. Days Since Current Assignment		Current Assignment Expired		Current Assignment State	
≥	50	Is	Active	≥	365	Is	TRUE	Is	Inactive

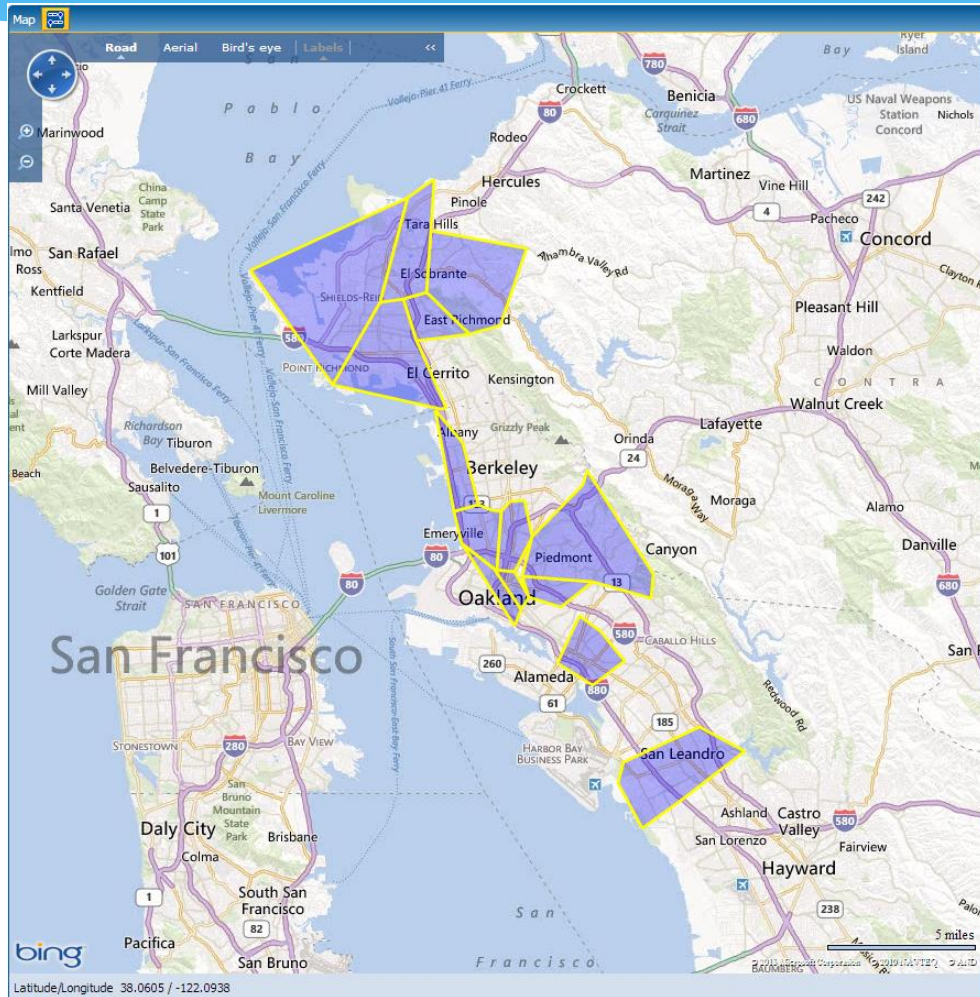




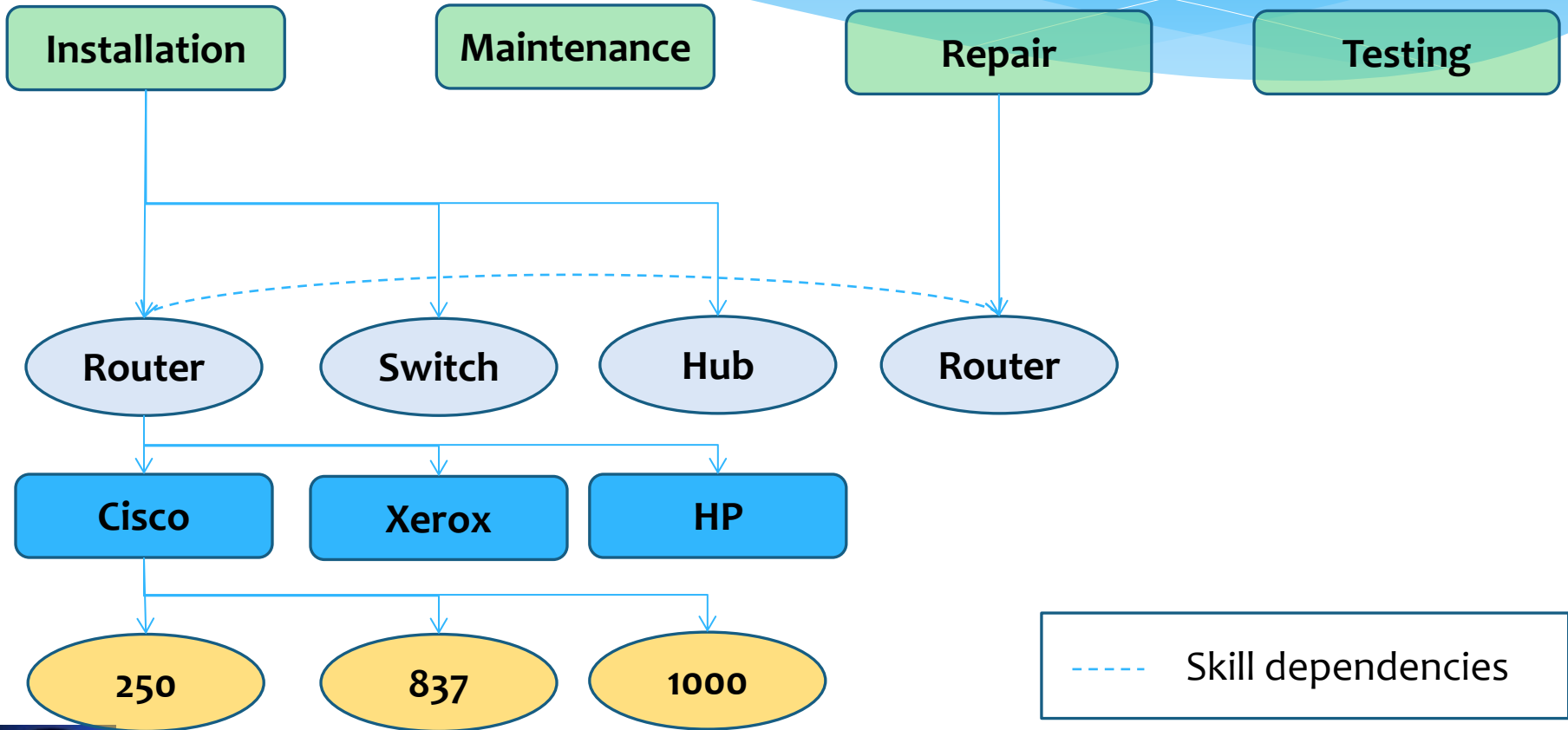
# Learning Technicians' Geo Areas



# Learning Technicians' Geo Areas



# Learning Resource Skills



# Learning Resource Skills

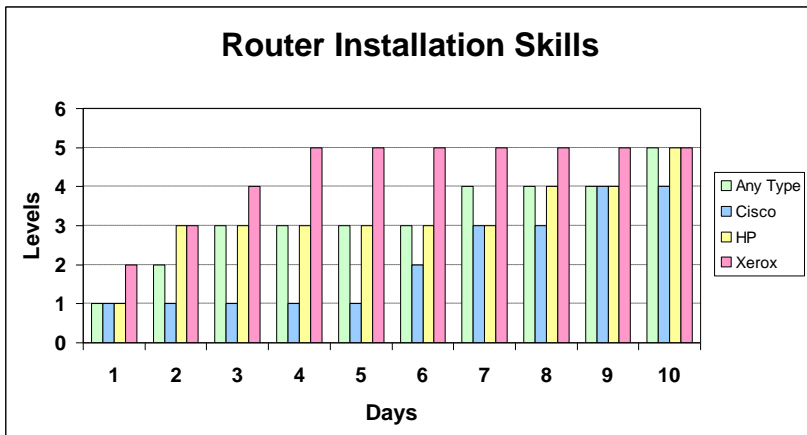
Condition		Conclusion	
No. Installation Assignments		Minimum Installation Proficiency Level	
Within	[1,6)	Is	Inexperienced
Within	[6,10)	Is	Moderately Experienced
Within	[10,20)	Is	Experienced
≥	[20,40)	Is	Expert



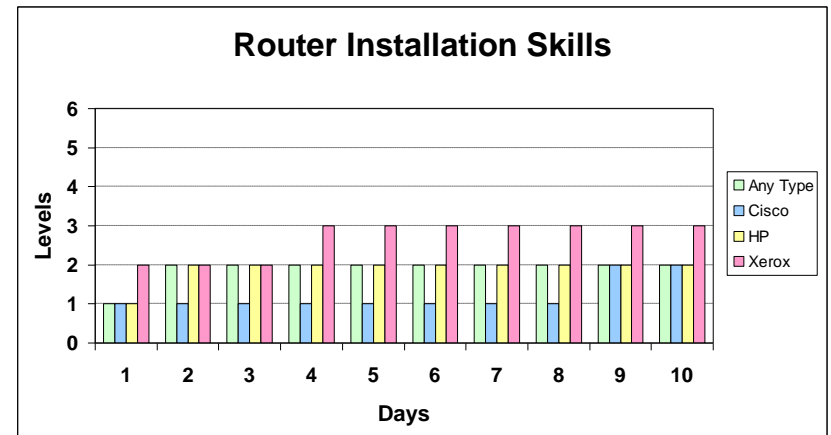
# Learning Resource Skills

Condition		Condition		Conclusion	
Cisco Repair Proficiency Level		Cisco Maintenance Proficiency Level		Cisco Minimum Testing Proficiency Level	
Is	Experienced	Is	Experienced	Is	Moderately Experienced
Is	Expert	Is	Experienced	Is	Moderately Experienced
Is	Expert	Is	Expert	Is	Experienced

# Skills Dynamics



With Skill Dependencies

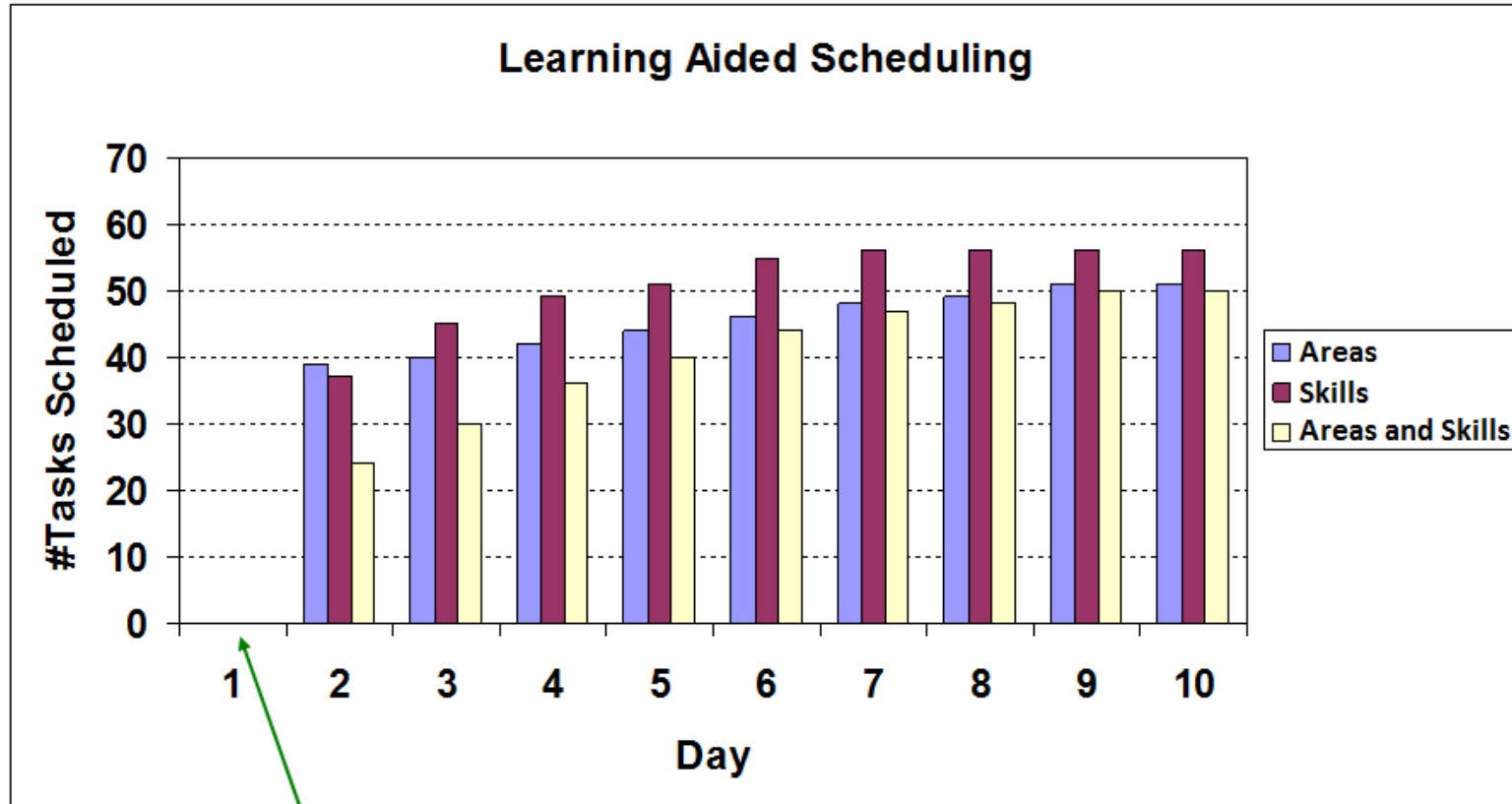


Without Skill Dependencies

# Learning Aided Scheduling

- \* Use learned resource-job associations
  - \* Directly to make assignments
  - \* Heuristically to prefer using resources with enough expertise
    - \* Satisfy job skill requirements to increase job success rate
    - \* Spare highly qualified resources for jobs demanding high skills

# Learning Aided Scheduling



No Candidate Info, Learning Has Not Started Yet...

# Intuitive Extensions

- \* Learning about:
  - \* Travel data from Street Level Routing data providers
  - \* Workload temporal patterns
  - \* Optimum algorithm parameter settings

# Wrap up

- \* Learning can greatly facilitate data build and maintenance in field service applications
- \* Rules can be a clear, easy-to-code and easy-to-maintain interface between the learner and the problem model

# Thank you!

