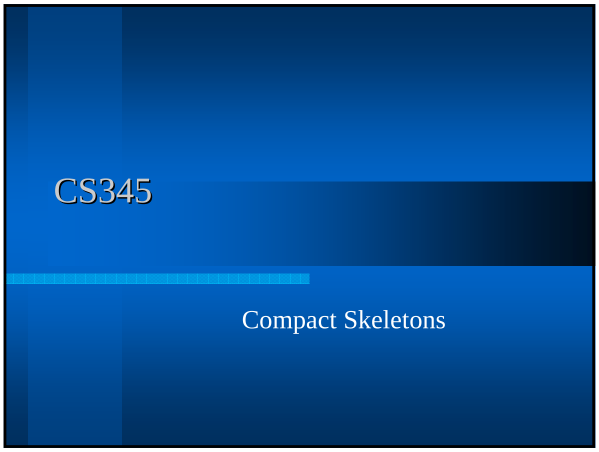
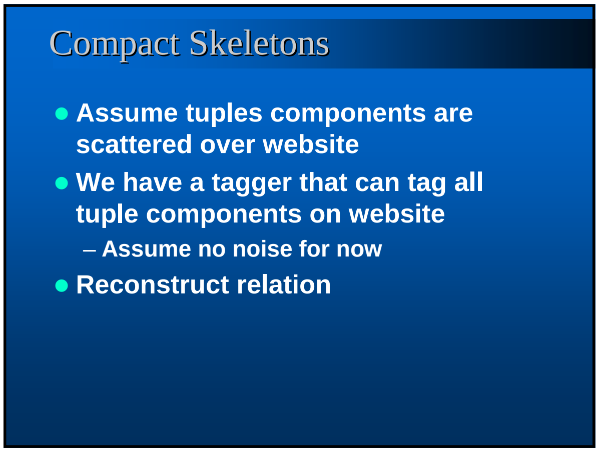


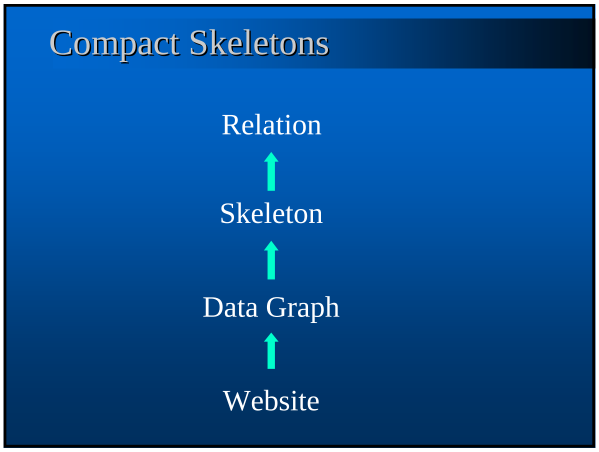
CS345

Compact Skeletons



Compact Skeletons

- Assume tuples components are scattered over website
- We have a tagger that can tag all tuple components on website
  - Assume no noise for now
- Reconstruct relation



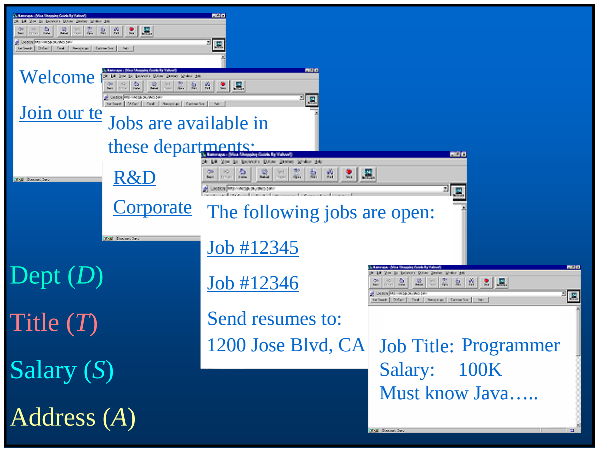
Compact Skeletons

Relation

Skeleton

Data Graph

Website



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Jobs are available in these departments:

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The following jobs are open:

Job #12345

Job #12346

Send resumes to:
1200 Jose Blvd, CA

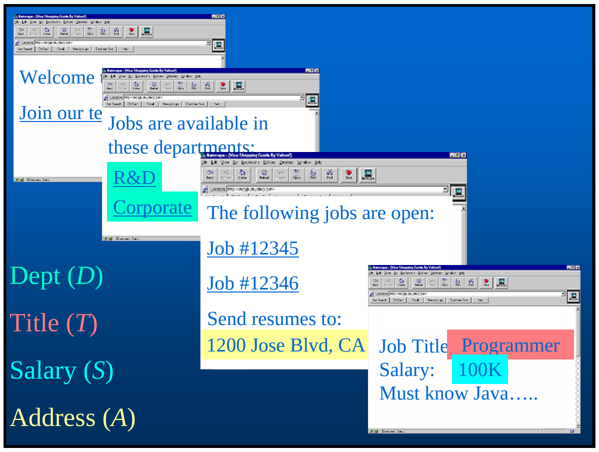
Job Title: Programmer
Salary: 100K
Must know Java…..

Dept (*D*)

Title (*T*)

Salary (*S*)

Address (*A*)



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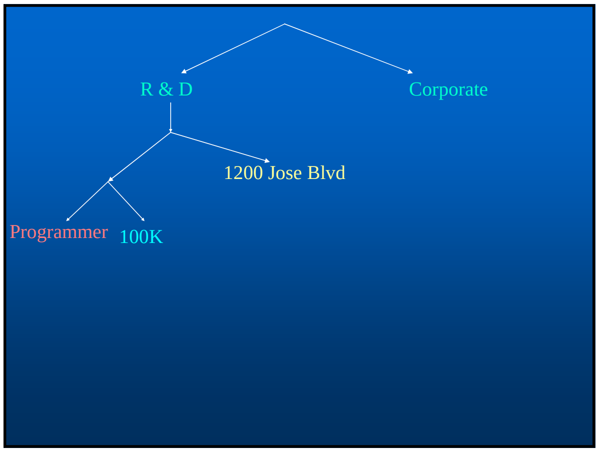


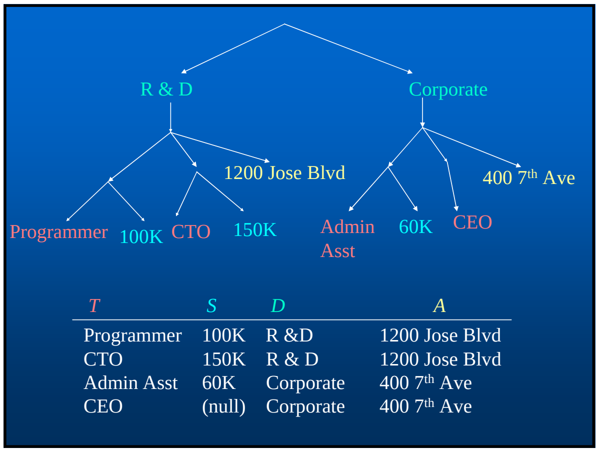
R & D

Corporate

1200 Jose Blvd

Programmer

100K



R & D

Corporate

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Programmer

100K

CTO

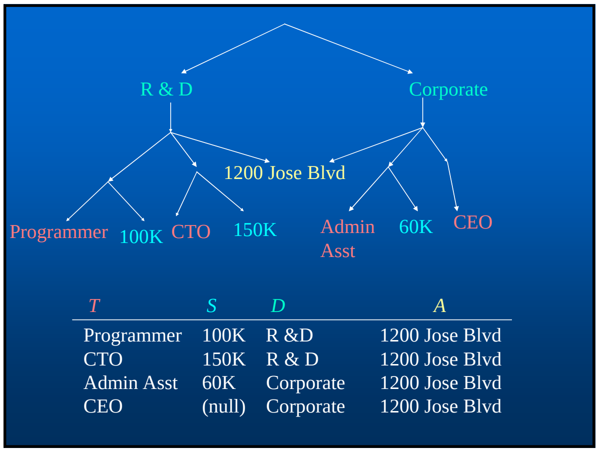
150K

Admin Asst

60K

CEO

T	*S*	*D*	*A*
Programmer	100K	R &D	1200 Jose Blvd
CTO	150K	R & D	1200 Jose Blvd
Admin Asst	60K	Corporate	400 7th Ave
CEO	(null)	Corporate	400 7th Ave



R & D

Corporate

1200 Jose Blvd

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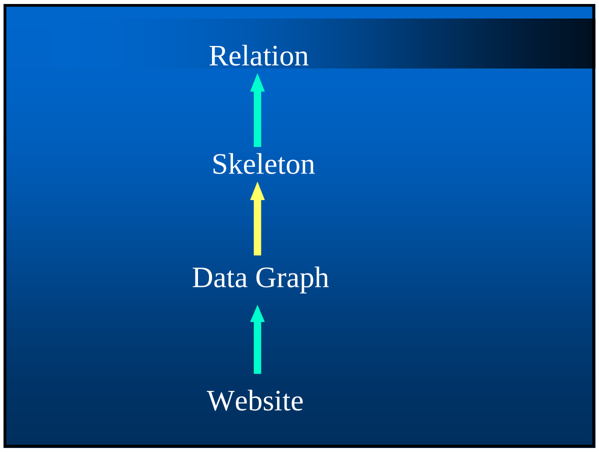
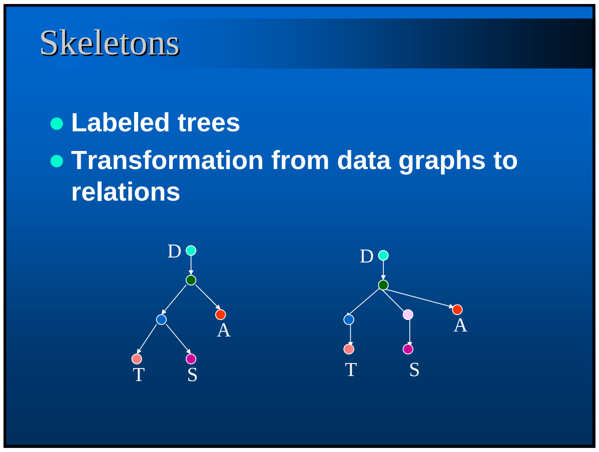


Relation

Skeleton

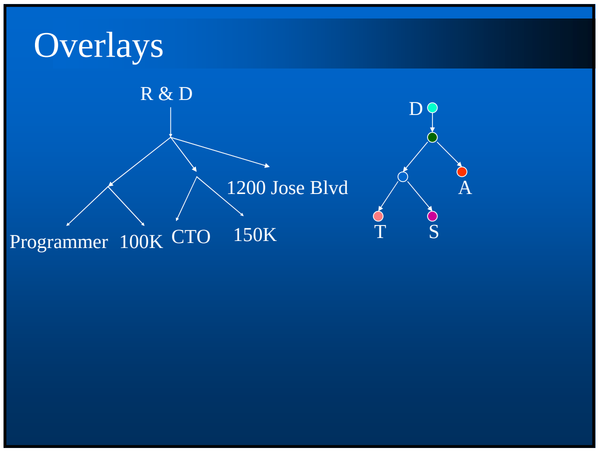
Data Graph

Website



Skeletons

- **Labeled trees**
- **Transformation from data graphs to relations**



Overlays

R & D

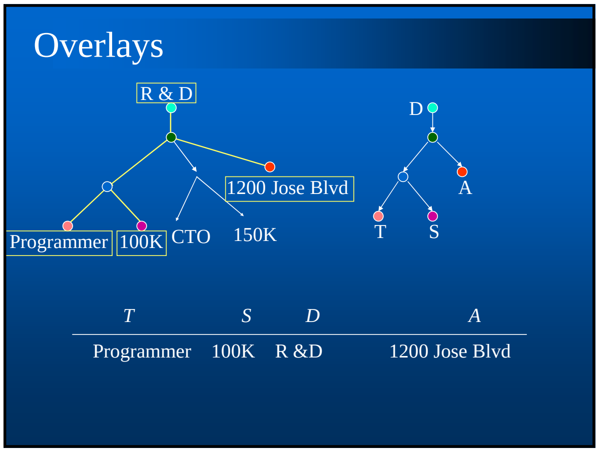
1200 Jose Blvd

Programmer

100K

CTO

150K



Overlays

R & D

1200 Jose Blvd

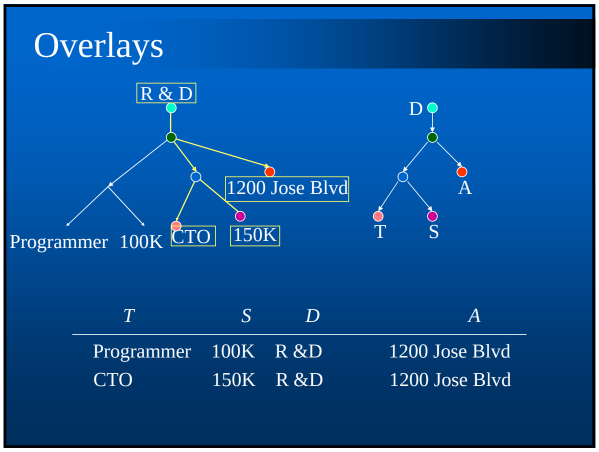
Programmer

100K

CTO

150K

T	*S*	*D*	*A*
Programmer	100K	R &D	1200 Jose Blvd



Overlays

R & D

1200 Jose Blvd

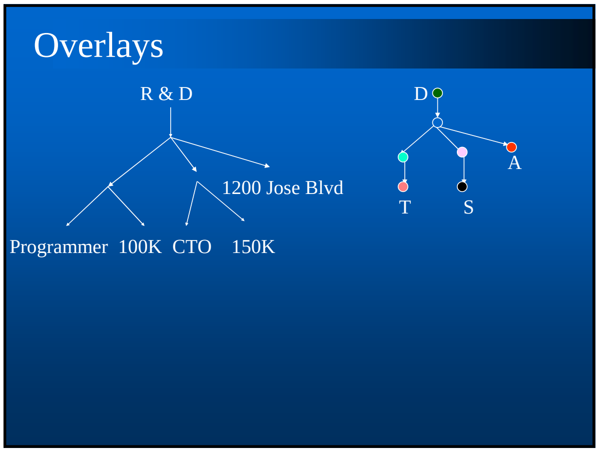
Programmer 100K CTO 150K

D

A

T S

T	*S*	*D*	*A*
Programmer	100K	R &D	1200 Jose Blvd
CTO	150K	R &D	1200 Jose Blvd



Overlays

R & D

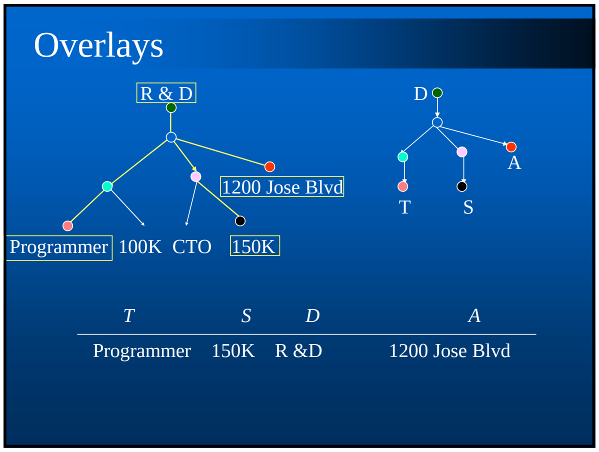
1200 Jose Blvd

Programmer 100K CTO 150K

D

A

T S



Overlays

R & D

1200 Jose Blvd

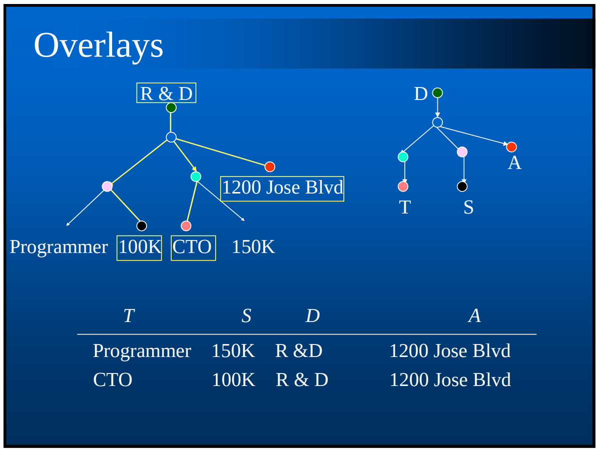
Programmer 100K CTO 150K

D

A

T S

T	*S*	*D*	*A*
Programmer	150K	R &D	1200 Jose Blvd



Overlays

R & D

1200 Jose Blvd

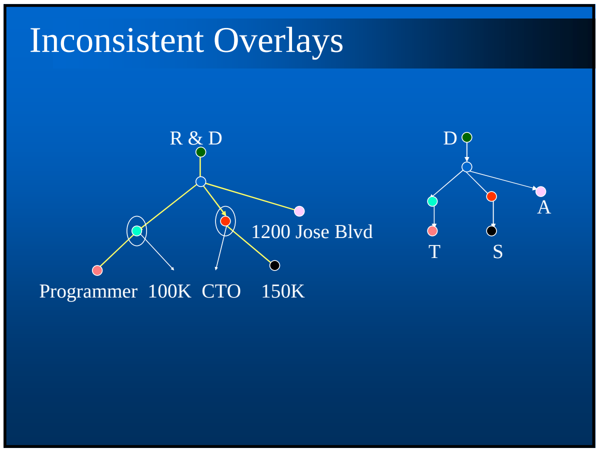
Programmer 100K CTO 150K

D

A

T S

T	*S*	*D*	*A*
Programmer	150K	R &D	1200 Jose Blvd
CTO	100K	R & D	1200 Jose Blvd



Inconsistent Overlays

R & D

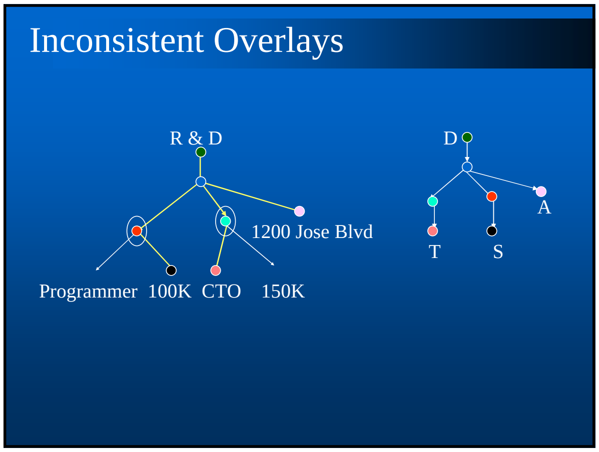
1200 Jose Blvd

Programmer 100K CTO 150K

D

A

T S



Inconsistent Overlays

R & D

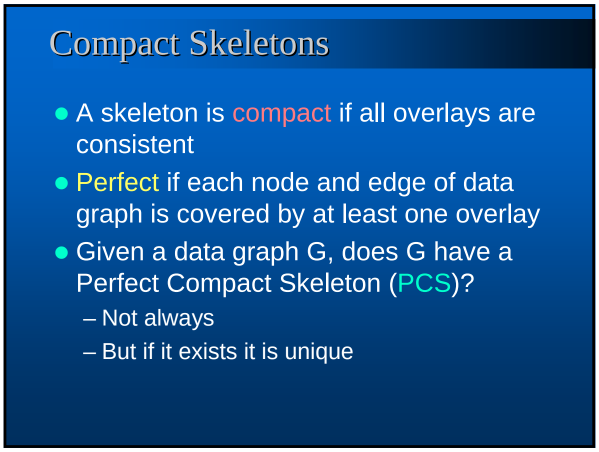
1200 Jose Blvd

Programmer 100K CTO 150K

D

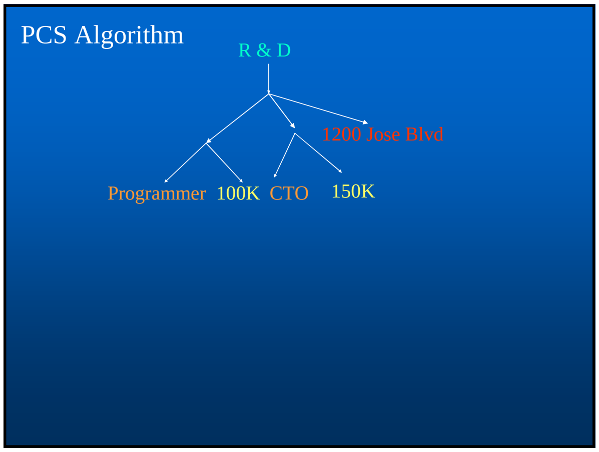
A

T S

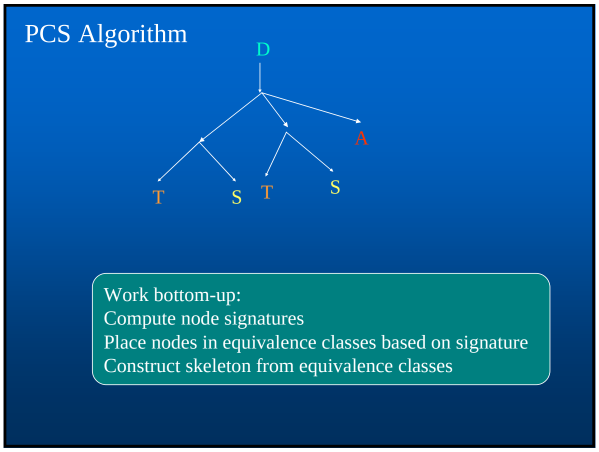


Compact Skeletons

- A skeleton is compact if all overlays are consistent
- Perfect if each node and edge of data graph is covered by at least one overlay
- Given a data graph G, does G have a Perfect Compact Skeleton (PCS)?
  - Not always
  - But if it exists it is unique

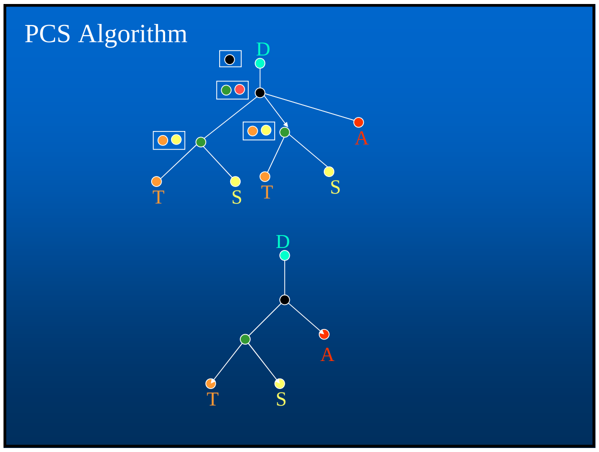


PCS Algorithm

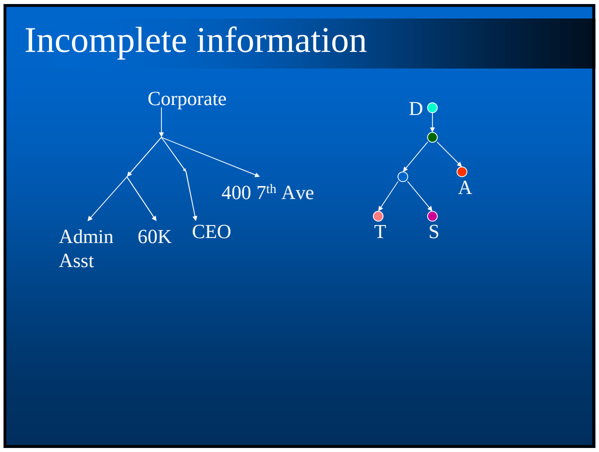


PCS Algorithm

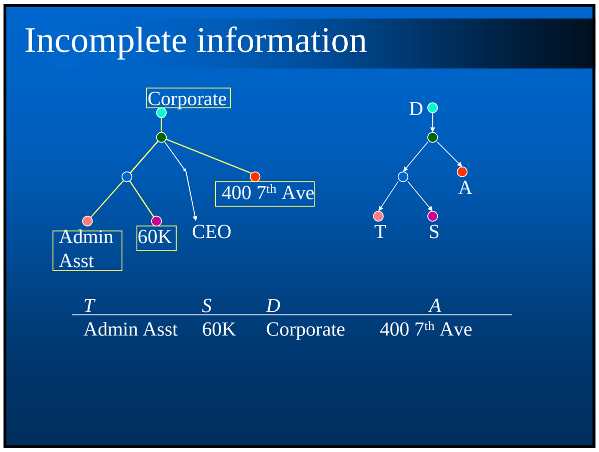
Work bottom-up:
Compute node signatures
Place nodes in equivalence classes based on signature
Construct skeleton from equivalence classes



PCS Algorithm

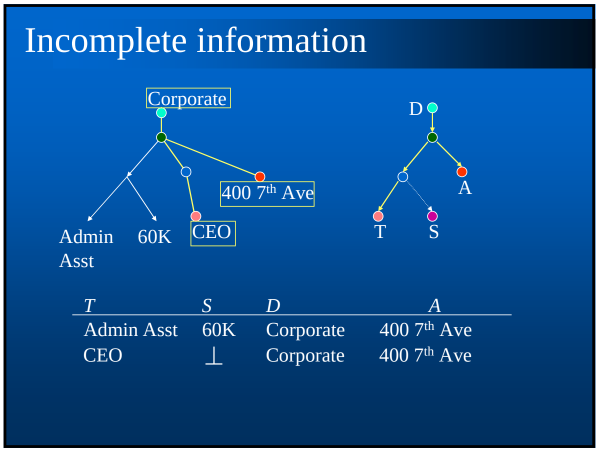


Incomplete information



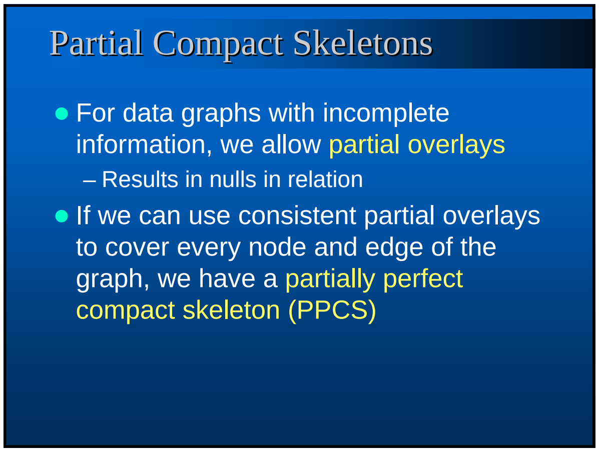
Incomplete information

T	*S*	*D*	*A*
Admin Asst	60K	Corporate	400 7th Ave



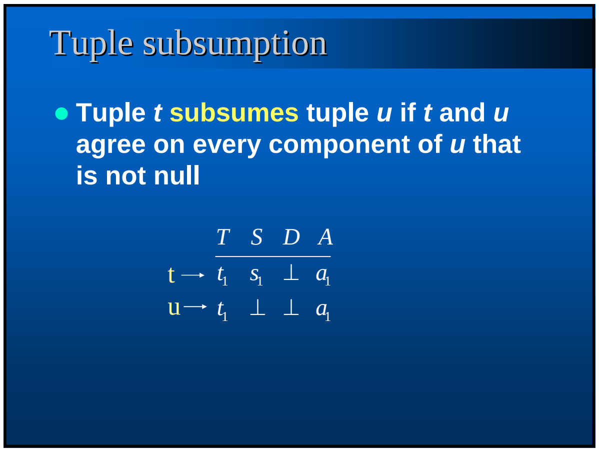
Incomplete information

T	*S*	*D*	*A*
Admin Asst	60K	Corporate	400 7th Ave
CEO	⊥	Corporate	400 7th Ave



Partial Compact Skeletons

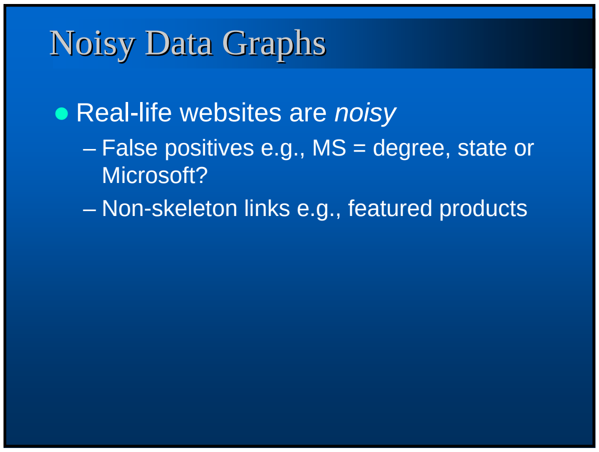
- For data graphs with incomplete information, we allow partial overlays
  - Results in nulls in relation
- If we can use consistent partial overlays to cover every node and edge of the graph, we have a partially perfect compact skeleton (PPCS)



Tuple subsumption

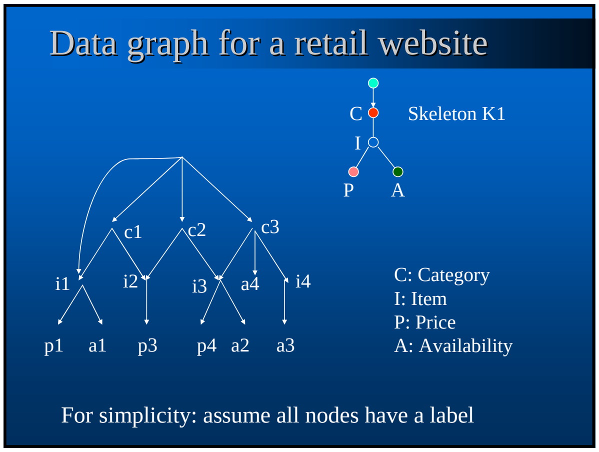
- **Tuple *t* subsumes tuple *u* if *t* and *u* agree on every component of *u* that is not null**

	T	*S*	*D*	*A*
t →	t_1	s_1	⊥	a_1
u →	t_1	⊥	⊥	a_1



Noisy Data Graphs

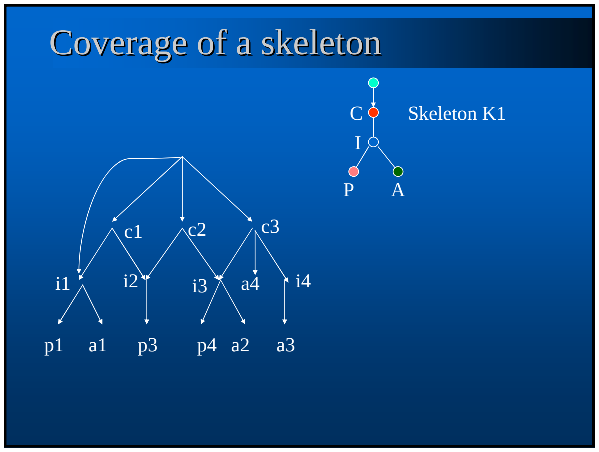
- Real-life websites are *noisy*
  - False positives e.g., MS = degree, state or Microsoft?
  - Non-skeleton links e.g., featured products



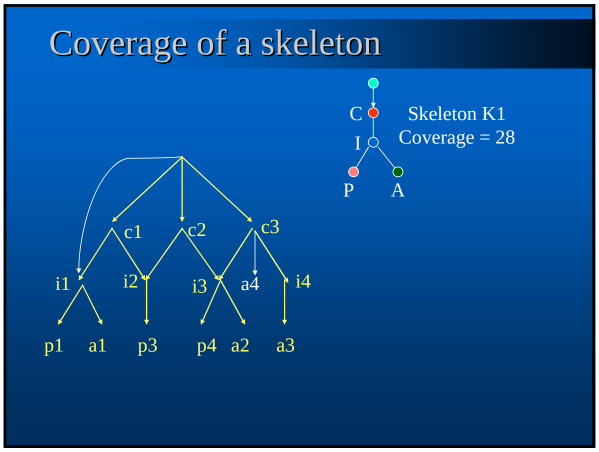
Data graph for a retail website

C: Category
I: Item
P: Price
A: Availability

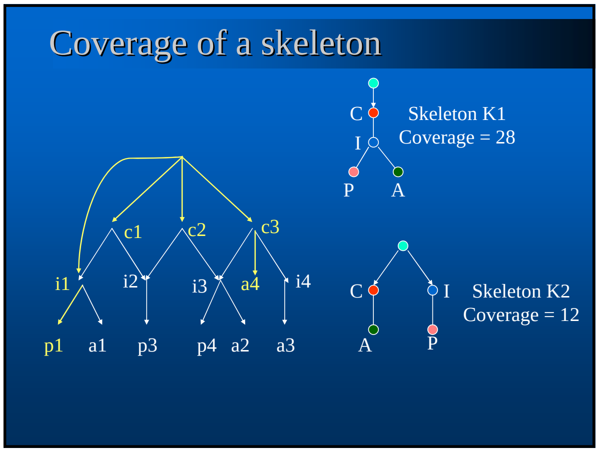
For simplicity: assume all nodes have a label



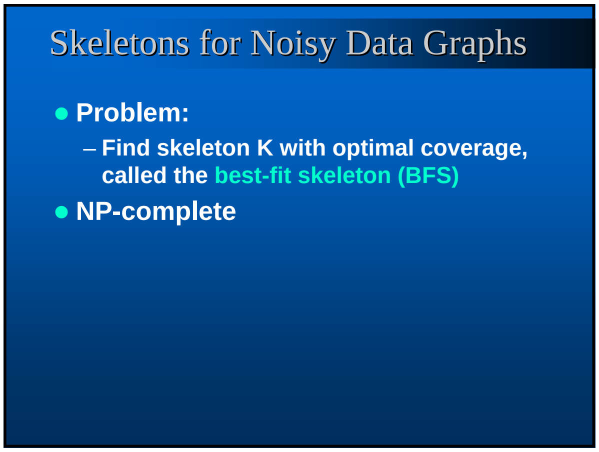
Coverage of a skeleton



Coverage of a skeleton

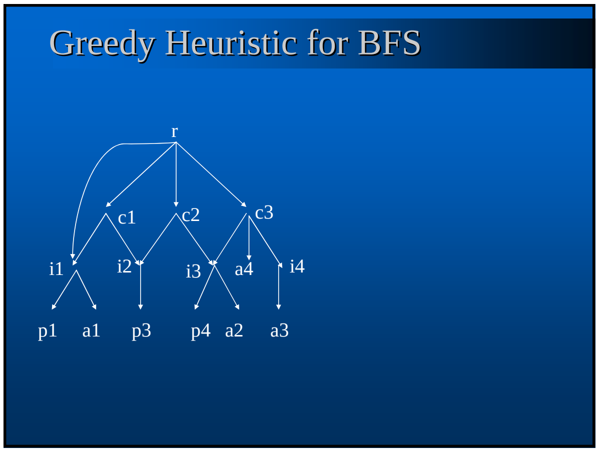


Coverage of a skeleton

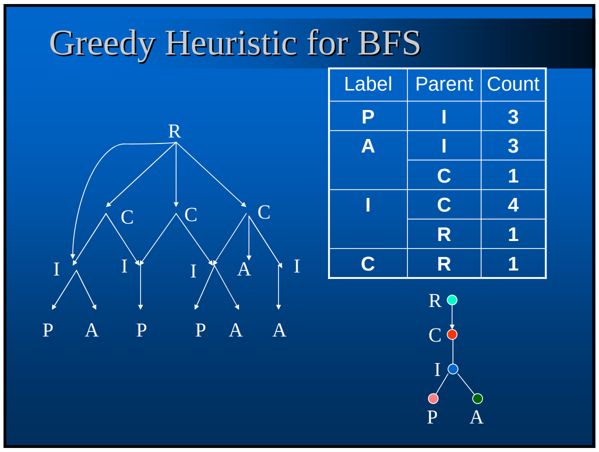


Skeletons for Noisy Data Graphs

- **Problem:**
  - **Find skeleton K with optimal coverage, called the best-fit skeleton (BFS)**
- **NP-complete**

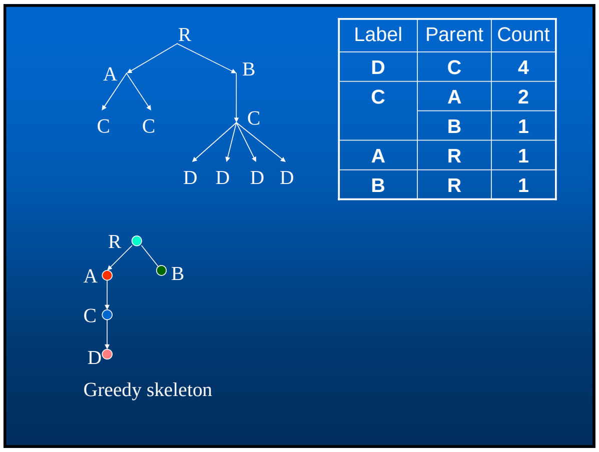


Greedy Heuristic for BFS



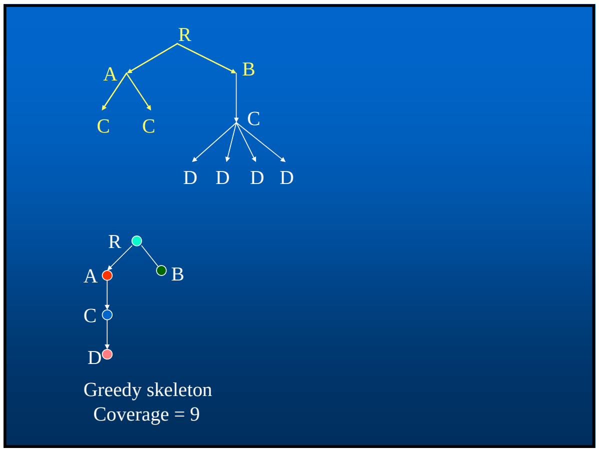
Greedy Heuristic for BFS

Label	Parent	Count
P	**I**	**3**
A	**I**	**3**
	C	**1**
I	**C**	**4**
	R	**1**
C	**R**	**1**

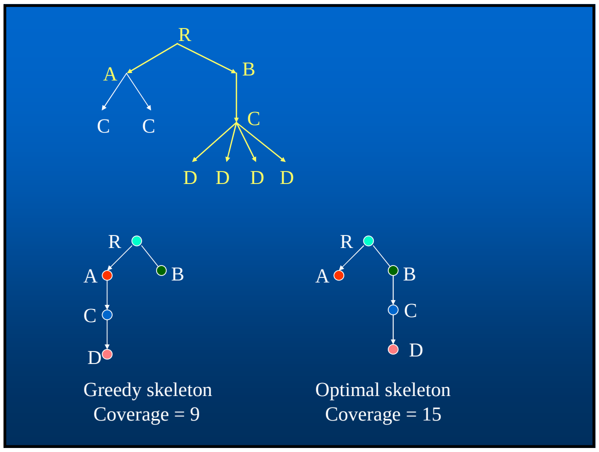


Label	Parent	Count
D	**C**	**4**
C	**A**	**2**
	B	**1**
A	**R**	**1**
B	**R**	**1**

Greedy skeleton



Greedy skeleton
Coverage = 9

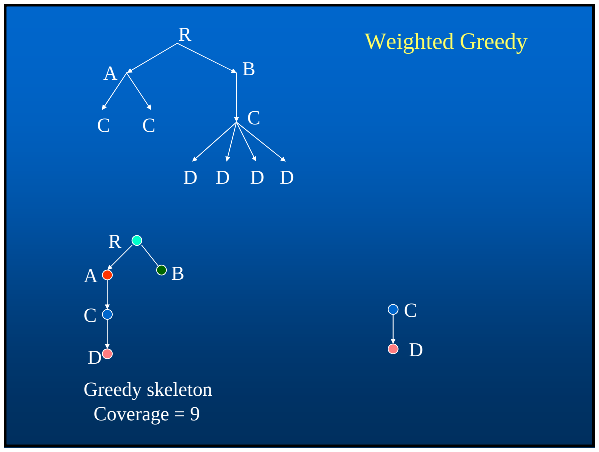


Greedy skeleton
Coverage = 9

Optimal skeleton
Coverage = 15

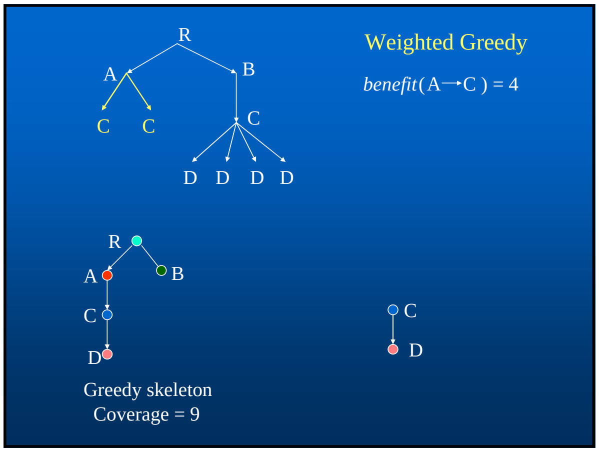
Weighted Greedy Heuristic

- Simple Greedy heuristic uses parent counts
  - "Memory-less"
- Weighted Greedy heuristic takes into account past selections to improve simple greedy selection
  - Computes "benefit" of each decision at every stage



Weighted Greedy

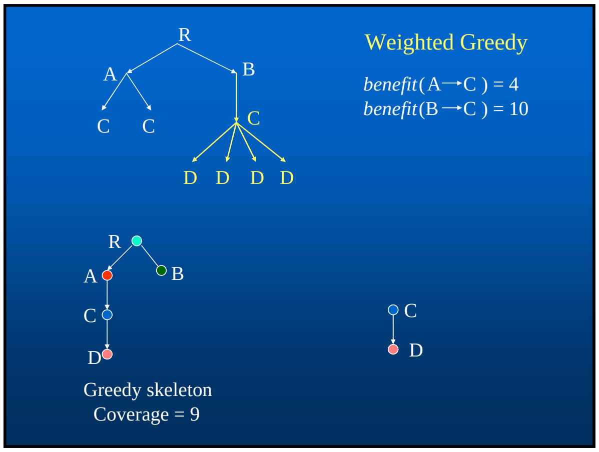
Greedy skeleton
Coverage = 9



Weighted Greedy

benefit(A→C) = 4

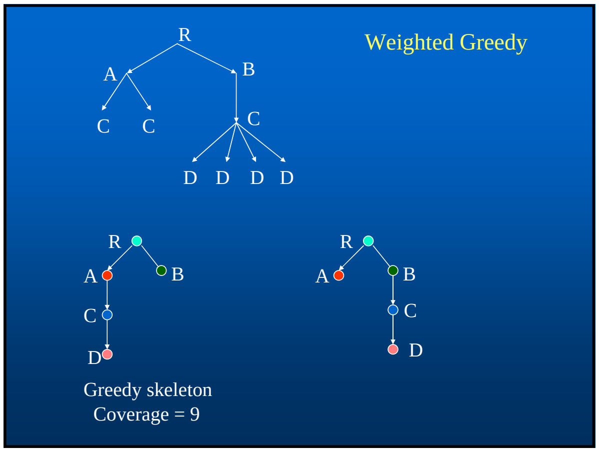
Greedy skeleton
Coverage = 9



Weighted Greedy

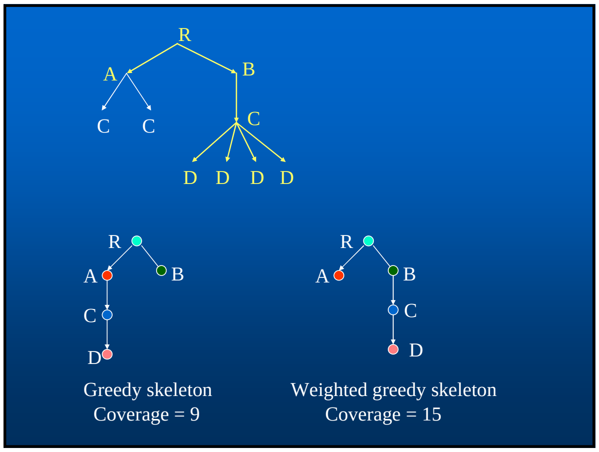
benefit(A→C) = 4
benefit(B→C) = 10

Greedy skeleton
Coverage = 9



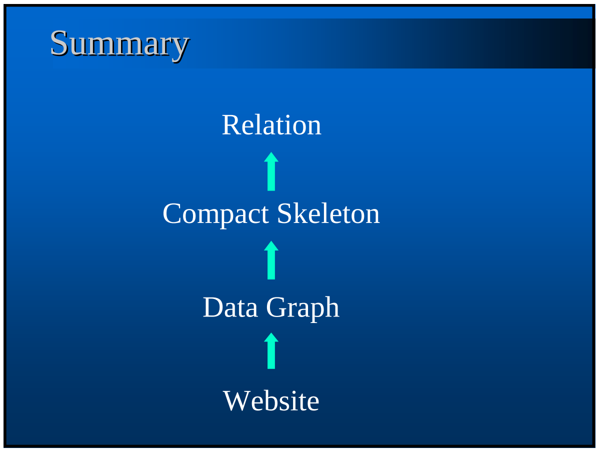
Weighted Greedy

Greedy skeleton
Coverage = 9



Greedy skeleton
Coverage = 9

Weighted greedy skeleton
Coverage = 15



Summary

Relation

Compact Skeleton

Data Graph

Website