Parallel algorithm design

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Parallel algorithm design

- how do we identify concurrency in our algorithms?
- how do we assign work to processes?
- how do we distribute data to processes?

Problem decomposition

- the process of dividing the computation into smaller pieces of work, i.e., *tasks*
- tasks are programmer defined

Example — dense matrix-multiplication

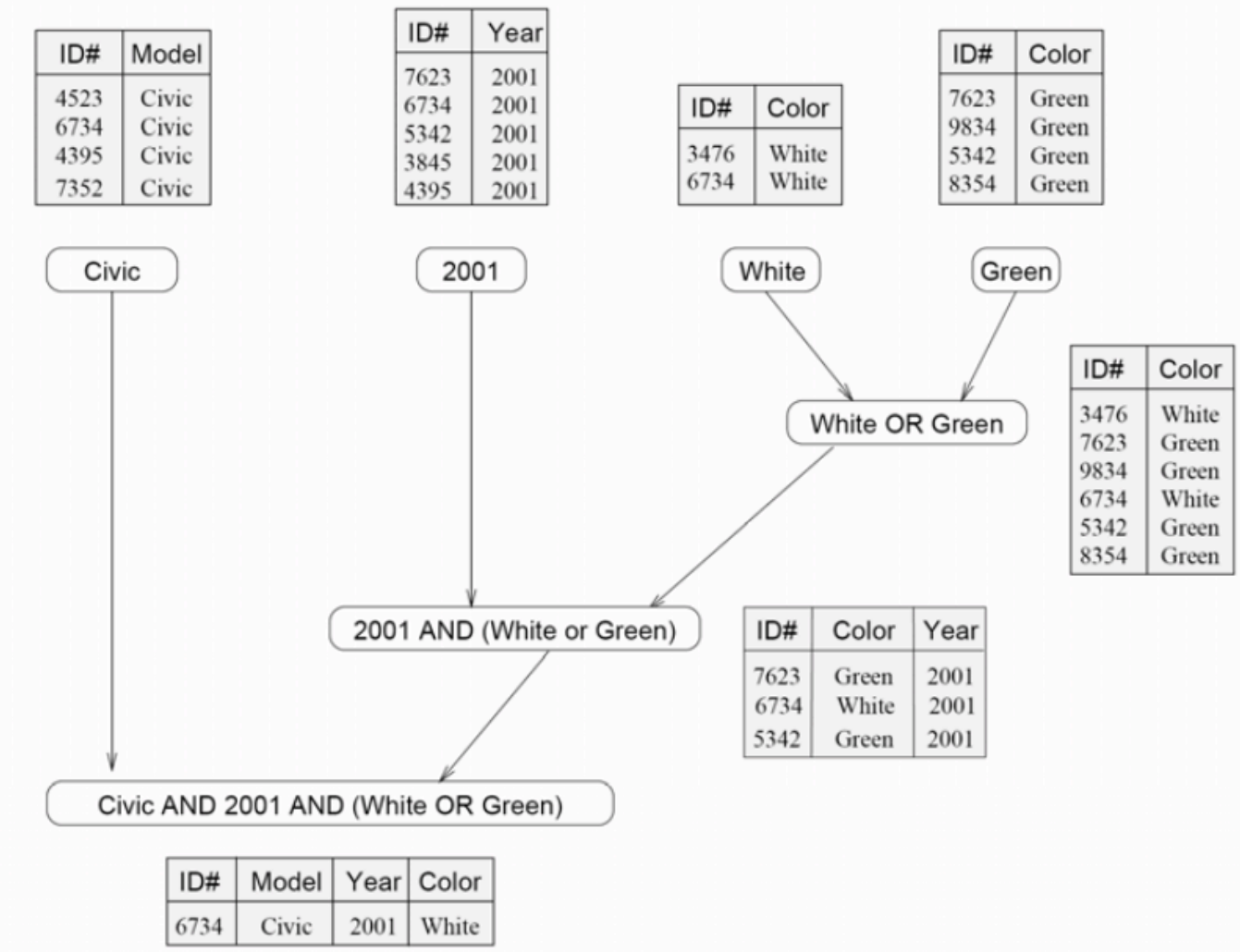
Example — query processing

ID#	Model	Year	Color	Dealer	Price
4523	Civic	2002	Blue	MN	$18,000
3476	Corolla	1999	White	IL	$15,000
7623	Camry	2001	Green	NY	$21,000
9834	Prius	2001	Green	CA	$18,000
6734	Civic	2001	White	OR	$17,000
5342	Altima	2001	Green	FL	$19,000
3845	Maxima	2001	Blue	NY	$22,000
8354	Accord	2000	Green	VT	$18,000
4395	Civic	2001	Red	CA	$17,000
7352	Civic	2002	Red	WA	$18,000

A database storing information about used vehicles.

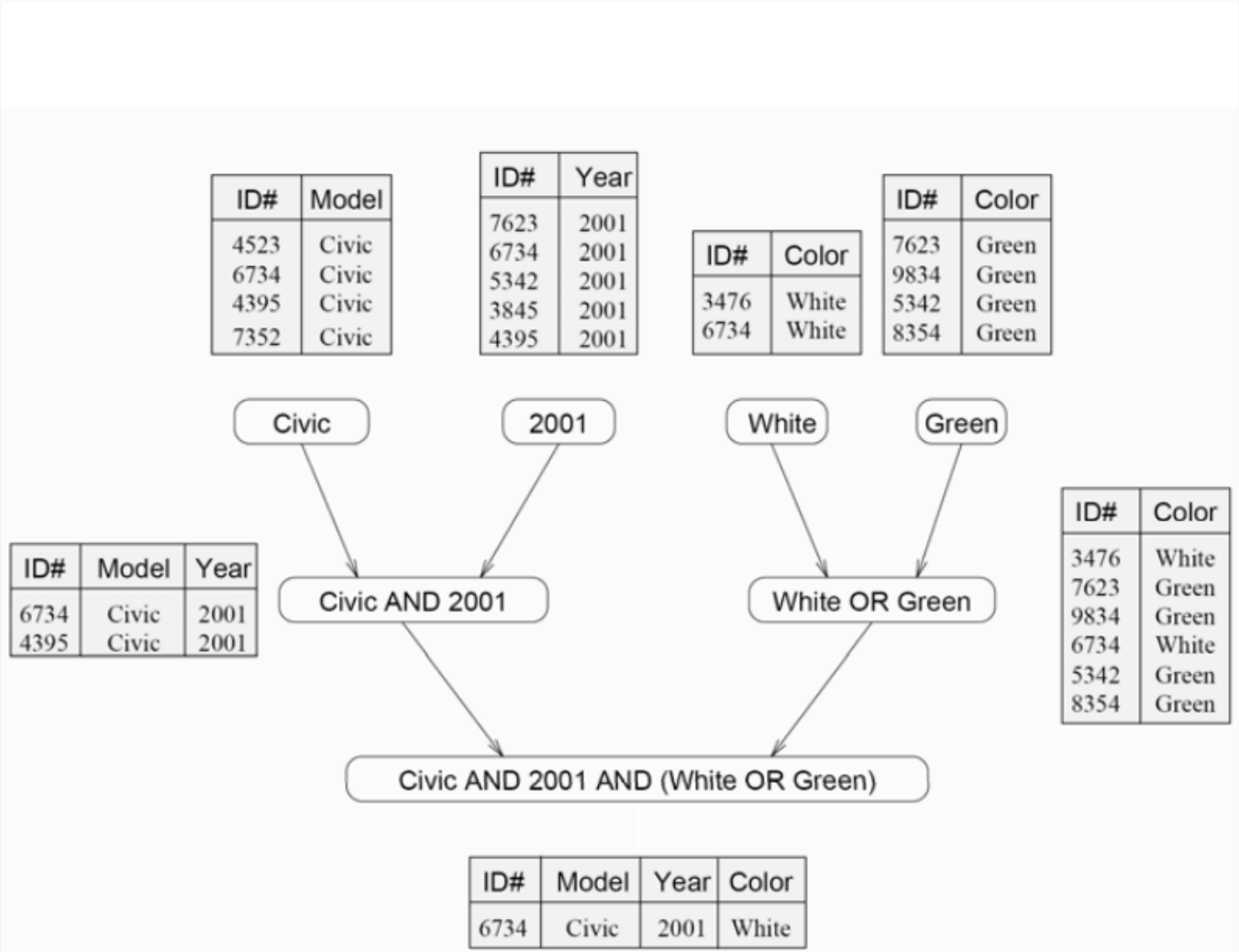
MODEL="Civic" AND YEAR="2001" AND (COLOR="Green" OR COLOR="White")

Example — query processing cont'd



The different tables and their dependencies in a query processing operation.

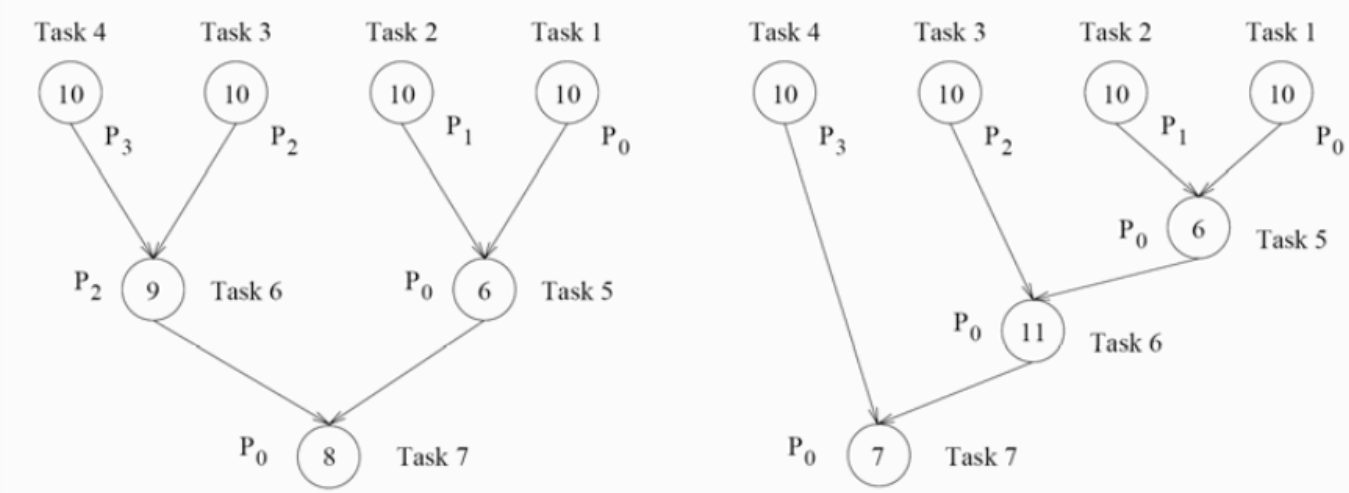
Example — query processing cont'd



The different tables and their dependencies in a query processing operation.

Task-dependency graph

- represented using a directed acyclic graph (DAG)



Task-dependency graphs and their mappings onto four processes for query processing.

useful metrics

- degree of concurrency
- critical path

Common decomposition methods

- data decomposition
- recursive decomposition
- exploratory decomposition
- speculative decomposition
- hybrid decomposition

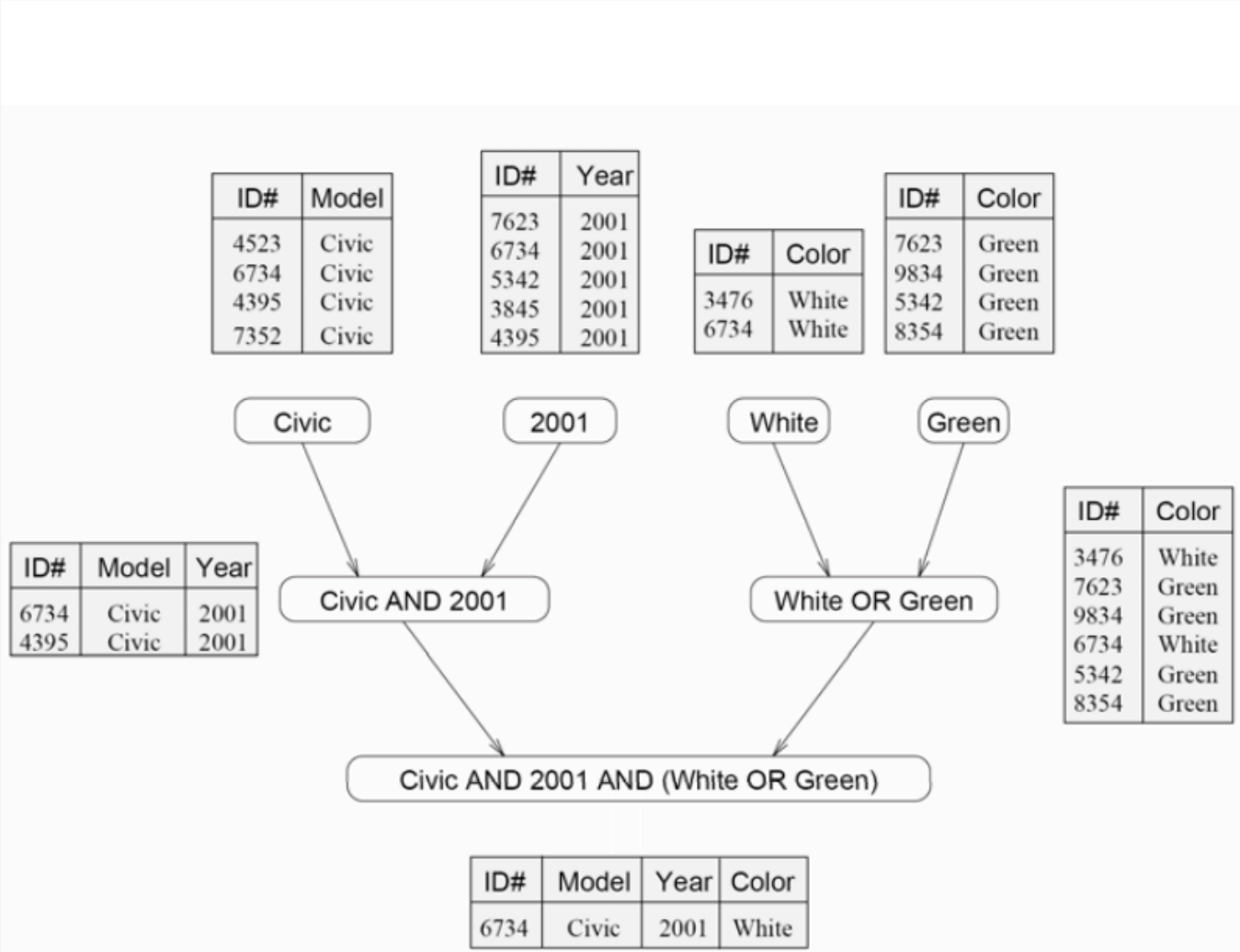
Data decomposition

- derive the tasks by focusing on the multiplicity of the data
- consists of two steps:
  1. partition the data
  2. derive tasks from the data partitioning
- common data decompositions
  - input
  - output
  - intermediate
- owner computes rule

Input decomposition

Output decomposition

Example — query processing



The different tables and their dependencies in a query processing operation.

Intermediate decomposition

coming soon...