

FUNDAMENTALS OF

Database Systems

SIXTH EDITION

Ramez Elmasri

*Department of Computer Science and Engineering
The University of Texas at Arlington*

Shamkant B. Navathe

*College of Computing
Georgia Institute of Technology*

Addison-Wesley

Boston Columbus Indianapolis New York San Francisco Upper Saddle River
Amsterdam Cape Town Dubai London Madrid Milan Munich Paris Montreal Toronto
Delhi Mexico City Sao Paulo Sydney Hong Kong Seoul Singapore Taipei Tokyo

Editor in Chief: *Michael Hirsch*
Acquisitions Editor: *Matt Goldstein*
Editorial Assistant: *Chelsea Bell*
Managing Editor: *Jeffrey Holcomb*
Senior Production Project Manager: *Marilyn Lloyd*
Media Producer: *Katelyn Boller*
Director of Marketing: *Margaret Waples*
Marketing Coordinator: *Kathryn Ferranti*
Senior Manufacturing Buyer: *Alan Fischer*
Senior Media Buyer: *Ginny Michaud*
Text Designer: *Sandra Rigney and Gillian Hall*
Cover Designer: *Elena Sidorova*
Cover Image: *Lou Gibbs/Getty Images*
Full Service Vendor: *Gillian Hall, The Aardvark Group*
Copyeditor: *Rebecca Greenberg*
Proofreader: *Holly McLean-Aldis*
Indexer: *Jack Lewis*
Printer/Binder: *Courier, Westford*
Cover Printer: *Lehigh-Phoenix Color/Hagerstown*

Credits and acknowledgments borrowed from other sources and reproduced with permission in this textbook appear on appropriate page within text.

The interior of this book was set in Minion and Akzidenz Grotesk.

Copyright © 2011, 2007, 2004, 2000, 1994, and 1989 Pearson Education, Inc., publishing as Addison-Wesley. All rights reserved. Manufactured in the United States of America. This publication is protected by Copyright, and permission should be obtained from the publisher prior to any prohibited reproduction, storage in a retrieval system, or transmission in any form or by any means, electronic, mechanical, photocopying, recording, or likewise. To obtain permission(s) to use material from this work, please submit a written request to Pearson Education, Inc., Permissions Department, 501 Boylston Street, Suite 900, Boston, Massachusetts 02116.

Many of the designations by manufacturers and sellers to distinguish their products are claimed as trademarks. Where those designations appear in this book, and the publisher was aware of a trademark claim, the designations have been printed in initial caps or all caps.

Library of Congress Cataloging-in-Publication Data

Elmasri, Ramez.

Fundamentals of database systems / Ramez Elmasri, Shamkant B. Navathe.—6th ed.

p. cm.

Includes bibliographical references and index.

ISBN-13: 978-0-136-08620-8

1. Database management. I. Navathe, Sham. II. Title.

QA76.9.D3E57 2010

005.74—dc22

Addison-Wesley
is an imprint of



10 9 8 7 6 5 4 3 2 1—CW—14 13 12 11 10

ISBN 10: 0-136-08620-9

ISBN 13: 978-0-136-08620-8

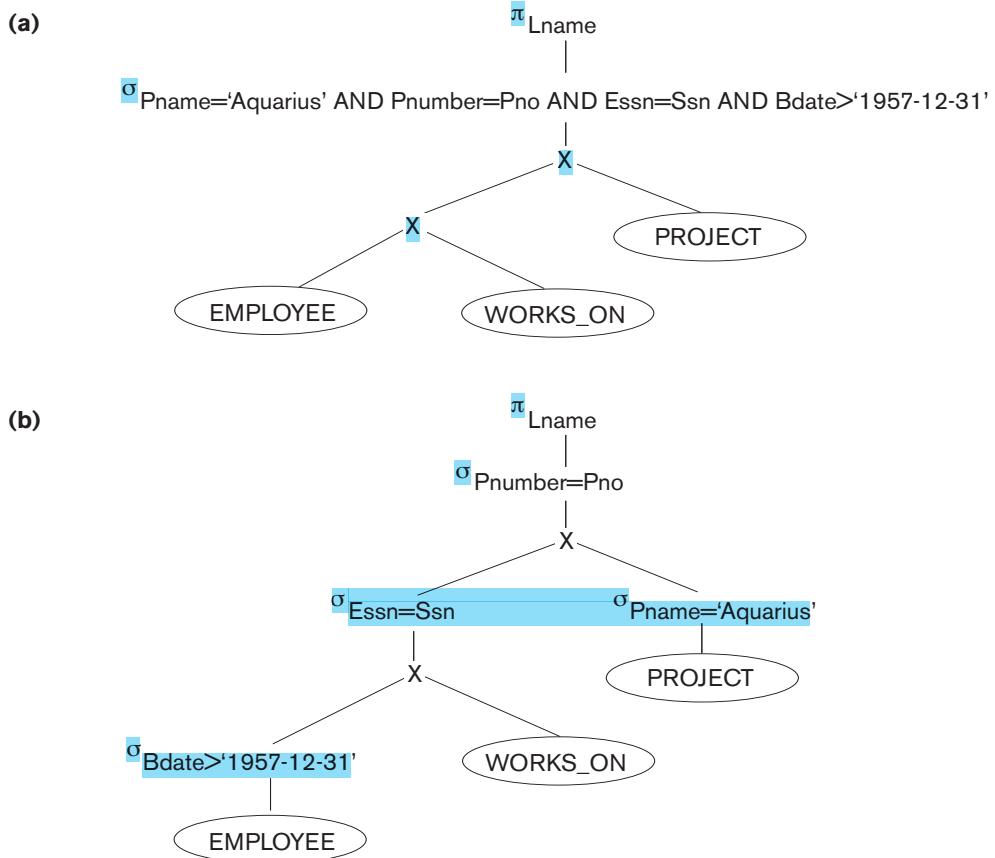
Q: **SELECT** Lname
FROM EMPLOYEE, WORKS_ON, PROJECT
WHERE Pname='Aquarius' **AND** Pnumber=Pno **AND** Essn=Ssn
AND Bdate > '1957-12-31';

The initial query tree for Q is shown in Figure 19.5(a). Executing this tree directly first creates a very large file containing the CARTESIAN PRODUCT of the entire EMPLOYEE, WORKS_ON, and PROJECT files. That is why the initial query tree is never executed, but is transformed into another equivalent tree that is efficient to

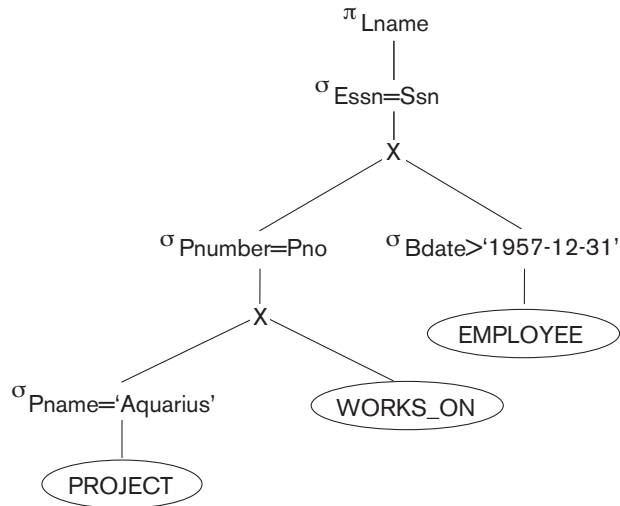
Figure 19.5

Steps in converting a query tree during heuristic optimization.

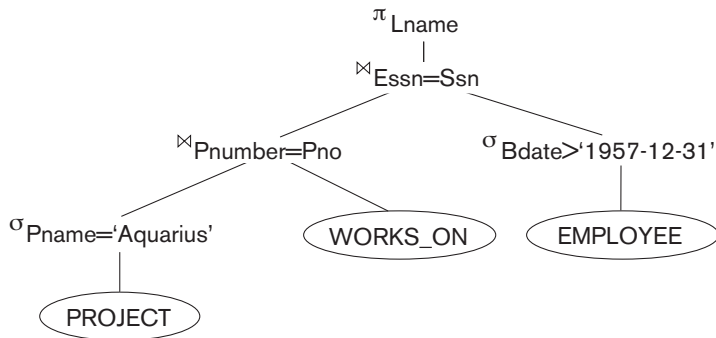
- (a) Initial (canonical) query tree for SQL query Q.
- (b) Moving **SELECT** operations down the query tree.
- (c) Applying the more restrictive **SELECT** operation first.
- (d) Replacing **CARTESIAN PRODUCT** and **SELECT** with **JOIN** operations.
- (e) Moving **PROJECT** operations down the query tree.



(c)



(d)



(e)

