## Contents

1 Introduction ......................................................... 1
   1.1 Motivation .................................................. 4
   1.2 Problem Statement .......................................... 4
   1.3 Research Methodology ....................................... 5
   1.4 Dissertation Contributions ................................ 5
      1.4.1 A new knowledge-preserving watermarking scheme .... 6
      1.4.2 Usability constraints model for watermarking .......... 6
      1.4.3 Bandwidth-independent watermark decoding accuracy .... 6
   1.5 Organization of the Dissertation ........................... 7
      1.5.1 Chapter 2: A Comprehensive Survey of Watermarking Relational Databases Research ............................. 7
      1.5.2 Chapter 3: A Case Study for Knowledge-preserving watermarking of sensitive relational databases .......... 7
      1.5.3 Chapter 4: Knowledge-Preserving Usability Constraints Model for Watermarking ............................. 8
      1.5.4 Chapter 5: Right Protecting Databases with Robust Watermark and Minimum Distortions ...................... 8
      1.5.5 Chapter 6: Conclusions and Future Work ................ 9

2 A Comprehensive Survey of Watermarking Relational Databases Research 10
   2.1 Introduction .................................................. 10
      2.1.1 Attacks on watermark: Revisited ..................... 11
      2.1.2 Organization of the Chapter ............................ 11
   2.2 Motivations and Related Work ............................... 11
   2.3 A Generic Framework for Relational Database Watermarking Techniques ................................................ 12
      2.3.1 Watermark Encoding ...................................... 12
      2.3.2 Attacker Channel ......................................... 14
      2.3.3 Watermark Decoding ...................................... 14
   2.4 Watermarking/Fingerprinting Techniques Classification .................................................. 15
      2.4.1 Bit-resetting techniques ................................. 15
         2.4.1.1 Bit pattern based bit-resetting techniques .... 16
         2.4.1.2 Image based bit-resetting techniques .......... 25
         2.4.1.3 Bit-resetting fingerprinting techniques .... 27
      2.4.2 Data statistics-modifying techniques .................. 29
         2.4.2.1 Bit pattern based data statistics-modifying techniques 29
         2.4.2.2 Image based data statistics-modifying techniques 32
<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.4.3</td>
<td>Constrained Data Content-Modifying Techniques</td>
<td>33</td>
</tr>
<tr>
<td>2.4.3.1</td>
<td>Tuple based constrained data content-modifying techniques</td>
<td>33</td>
</tr>
<tr>
<td>2.4.3.2</td>
<td>Attribute based constrained data content-modifying techniques</td>
<td>37</td>
</tr>
<tr>
<td>2.4.3.3</td>
<td>Image based constrained data content-modifying techniques</td>
<td>39</td>
</tr>
<tr>
<td>2.5</td>
<td>Comparison of Techniques and Directions for Future Work</td>
<td>41</td>
</tr>
<tr>
<td>2.6</td>
<td>Summary</td>
<td>43</td>
</tr>
</tbody>
</table>

3 A Case Study for Knowledge-preserving Watermarking of Sensitive Relational Databases

3.1 Introduction

3.1.1 Organization of the Chapter

3.2 The Proposed Information-Preserving Watermarking Technique

3.2.1 Watermark Encoding Phase

3.2.1.1 Ranking Features for Accurate Medical Diagnosis

3.2.1.2 Watermark Range Calculation

3.2.2 Watermark Creation

3.2.2.1 Particle Swarm Optimization Algorithm

3.2.2.2 Watermark Creation Algorithm

3.2.3 Watermark Embedding

3.2.4 Watermark Decoding

3.2.5 Watermark Decoder

3.2.6 Example

3.2.6.1 Watermark Encoding

3.2.6.2 Watermark Decoding

3.3 Experiments and Results

3.3.1 Watermark Imperceptibility and Data Quality

3.3.2 Preserving Classification Potential of High Ranking Features

3.3.3 Resilience to Various Attacks

3.3.4 Insertion Attacks

3.3.5 Deletion Attacks

3.3.6 Alteration Attacks

3.4 Summary

4 Knowledge-preserving Usability Constraints Model for Watermarking

4.1 Introduction

4.1.1 Organization of the Chapter

4.2 Approach Overview

4.3 A Formal Model for “Usability Constraints”

4.4 Watermarking Scheme

4.4.1 Watermarking Encoding

4.4.1.1 Feature Ranking

4.4.1.2 Classification potential threshold computation

4.4.1.3 Data Grouping

4.4.1.4 Refined Usability Constraints

4.4.1.5 Selecting Data for Watermarking