DATABASE SYSTEMS

CS – 355/CE – 373

Instructor: Maria N. Samad

December 2nd, 2024

RECORD INSERTION AND DELETION

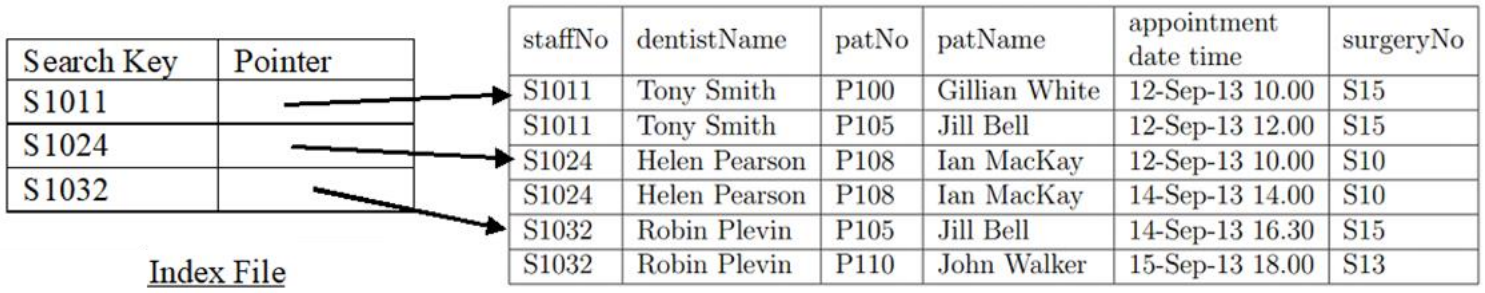
Types Of Indices	Dense	Sparse
Clustered	Single/Multi Level Insertion/Deletion	Single/Multi Level Insertion/Deletion
Nonclustered	Single/Multi Level Insertion/Deletion	Single/Multi Level Insertion/Deletion

RECORD INSERTION

- Whenever a record is inserted, its respective index entry must also be updated
- It is updated depending on the index structure being used:
  - Dense Indexing
    - Dense clustered indexing
    - Dense non clustered indexing
  - Sparse Indexing

RECORD INSERTION – DENSE INDEX

- If a new record is being inserted with no previous index reference in the index file, it is simply added to the index file in the appropriate position (remember, index files are sequentially ordered), and the pointer is inserted such that it is referring to the new record



Search Key	Pointer
S1011	
S1024	
S1032	

Index File

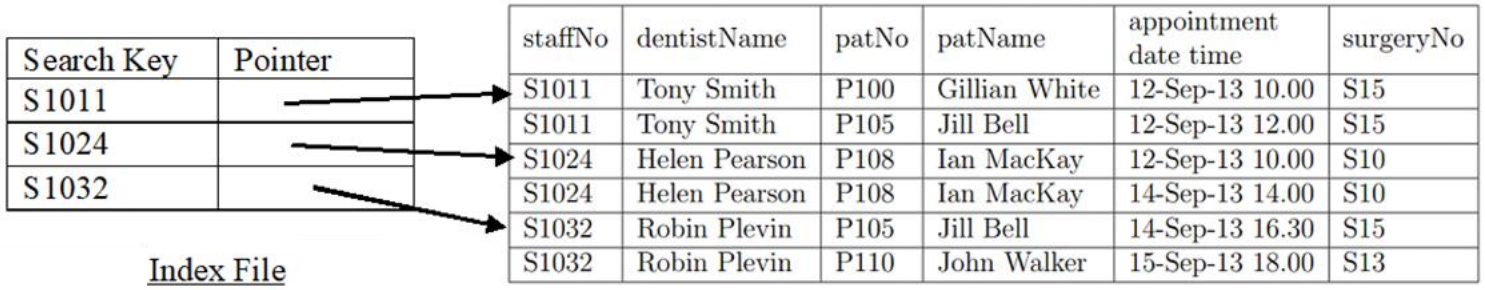
staffNo	dentistName	patNo	patName	appointment date time	surgeryNo
S1011	Tony Smith	P100	Gillian White	12-Sep-13 10.00	S15
S1011	Tony Smith	P105	Jill Bell	12-Sep-13 12.00	S15
S1024	Helen Pearson	P108	Ian MacKay	12-Sep-13 10.00	S10
S1024	Helen Pearson	P108	Ian MacKay	14-Sep-13 14.00	S10
S1032	Robin Plevin	P105	Jill Bell	14-Sep-13 16.30	S15
S1032	Robin Plevin	P110	John Walker	15-Sep-13 18.00	S13

RECORD INSERTION – DENSE INDEX

- If the new record already has a reference in the index file, then the record and index file are updated based on whether the dense index is clustered or non clustered

RECORD INSERTION – DENSE INDEX

- ***Dense Clustered Index***:
  - If the pointer in the index entry points to ONLY the first record of the relation, while others are sequentially searched, then the record is only added to the database, and no update is required in the index file



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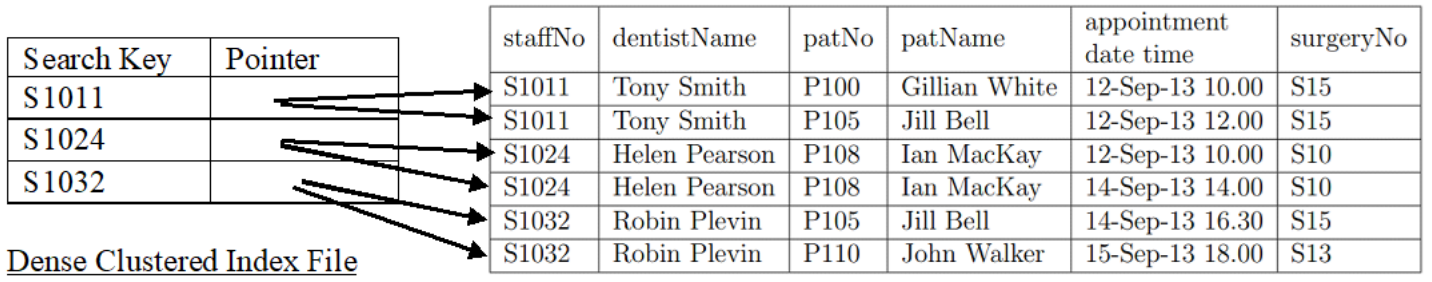
RECORD INSERTION – DENSE INDEX

- ***Dense Clustered Index***:
  - If there are pointers to every entry, then the record is still added to the database, but the update is also required in the index file by adding a new pointer to the new record in the same index entry



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Dense Clustered Index File

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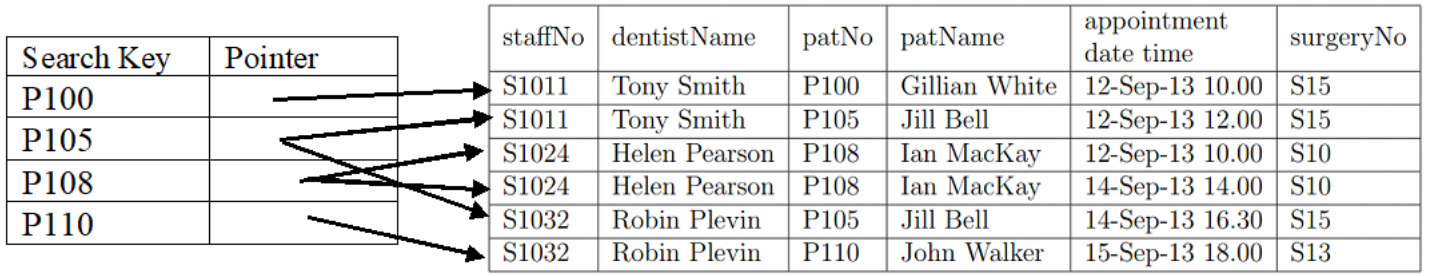
RECORD INSERTION – DENSE INDEX

- ***Dense Non clustered Index:***
  - There are multiple pointers with the index entry pointing to all the records in the relation, as they are not clustered together
  - In such cases, the record will be inserted into the table, but the index entry should introduce another pointer referring to this new record



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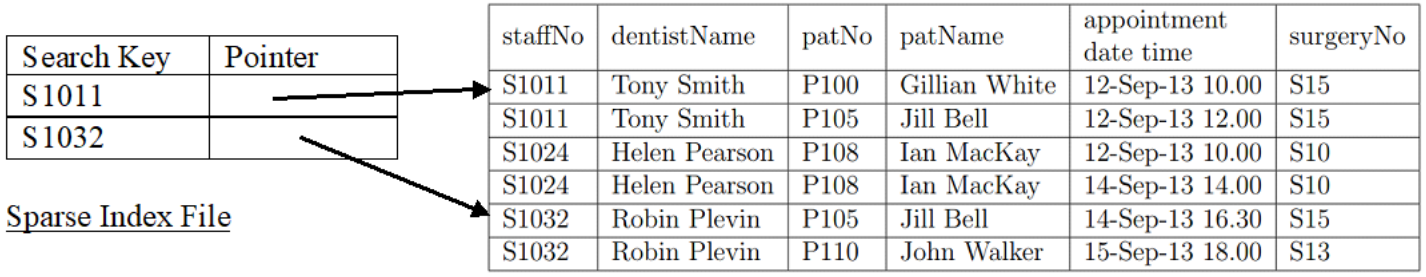
Dense Non-Clustered Index File

RECORD INSERTION – SPARSE INDEX

- Sparse indices do not contain reference to every record in the relation
- If the new record being inserted has a smaller search key value than the smallest value of the index file, then the record is inserted in the beginning of the table, and the index file is updated with its first entry now containing reference to this new record's search key value
- Otherwise, index file needs no update as the record will be entered sequentially and there will be a pointer reference for it from before



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S1032	

Sparse Index File

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RECORD DELETION

- Whenever a record is being deleted, its respective index entry must also be removed/updated
- It is updated depending on the index structure being used:
  - Dense Indexing
    - Dense clustered indexing
    - Dense non clustered indexing
  - Sparse Indexing

RECORD DELETION – DENSE INDEX

- If the record to be deleted is the only record with its search key value in the index file (i.e. the case of primary keys), both records and its index entry are deleted

Search Key	Pointer
101	
102	
103	
104	
105	
106	
107	
108	
109	
110	

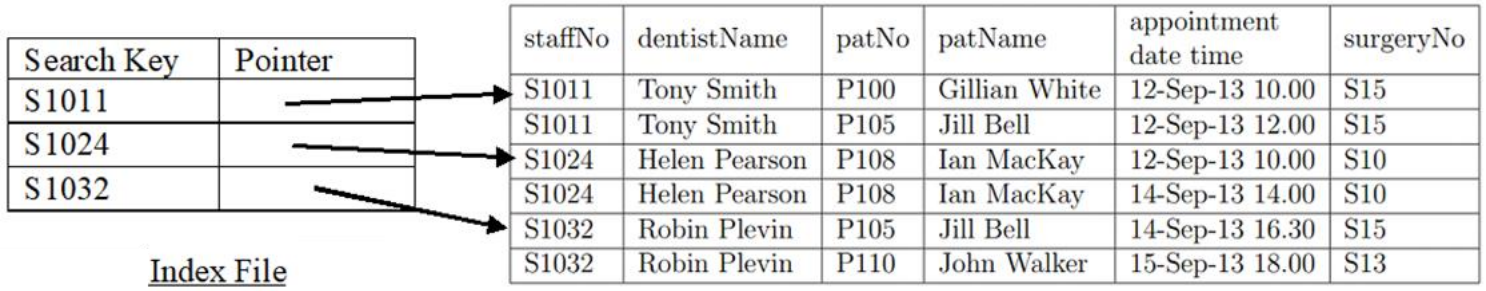
BookID	Title	Author	Publication Year	Genre
101	The Great Gatsby	F. Scott Fitzgerald	1925	Fiction
102	This Side of Paradise	F. Scott Fitzgerald	1920	Romance
103	The curious case of Benjamin Button	F. Scott Fitzgerald	1922	Mystery
104	To Kill a Mockingbird	Harper Lee	1960	Thriller
105	A Brief History of Time	Stephen Hawking	1988	Science
106	Theory of Everything	Stephen Hawking	2002	Documentary
107	Inferno	Dan Brown	2013	Mystery
108	The Da Vinci Code	Dan Brown	2003	Mystery
109	Harry Potter and the Philosopher's Stone	J.K. Rowling	1997	Fantasy
110	The Running Grave	Robert Galbraith	2023	Thriller

RECORD DELETION – DENSE INDEX

- If the record has multiple references then how to delete depends on whether it’s clustered or non clustered

RECORD DELETION – DENSE INDEX

- ***Dense Clustered Index:***
  - If index entry point is pointing only to the first record of search key:
    - The record is deleted from the table and the pointer is updated in the index file to point to the next record in that cluster
    - If this happens to be the only record in the cluster, then simply remove the record from the relation, as well as the index entry from the index file
    - If the record to be deleted is in a cluster but the index entry is not pointing to it, then only the record gets deleted from the table, and no changes are made to the index file



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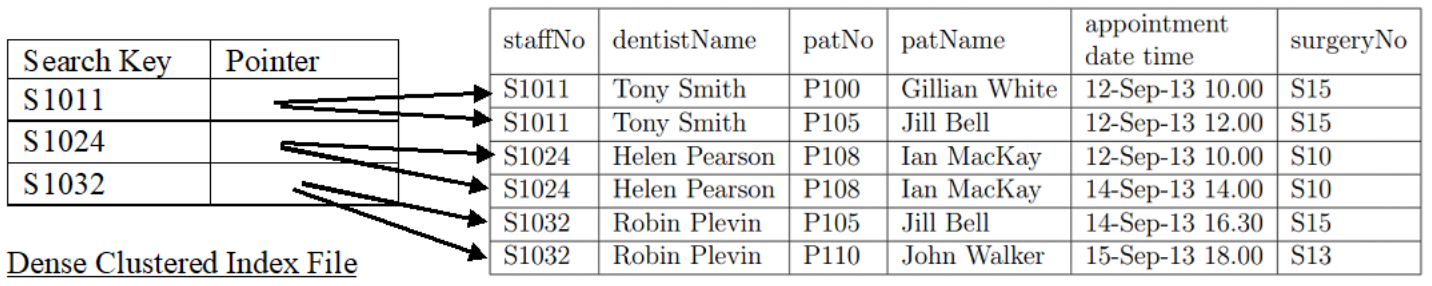
RECORD DELETION – DENSE INDEX

- ***Dense Clustered Index:***
  - If the index entry point is to all the records of the search key:
    - If the record to be deleted is the first record to which the pointer is pointing, then the record is deleted as well as the pointer from the index file
    - If this happens to be the only record in the cluster, then simply remove the record from the relation, as well as the index entry from the index file



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Dense Clustered Index File

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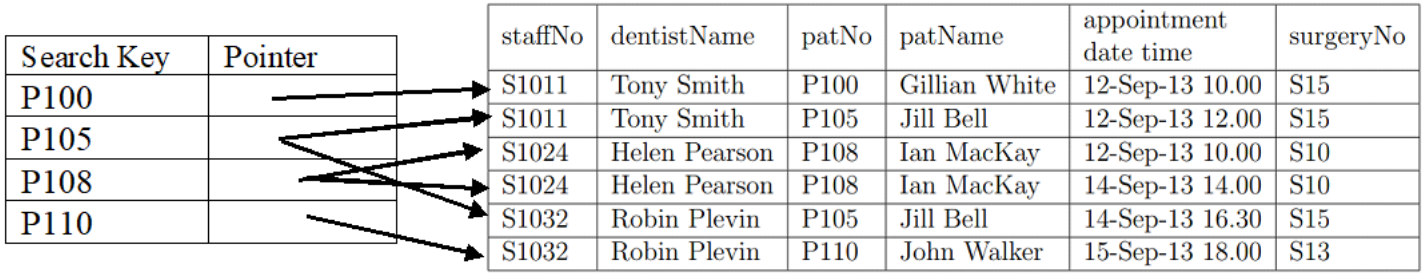
RECORD DELETION – DENSE INDEX

- ***Dense Non Clustered Index:***
  - In a non clustered index, the index file has multiple references to the records containing the same search-key value
  - If there are multiple references, then the record is deleted from the relation, and only the pointer in the index file referring to this index is removed, while the index entry remains
  - If this happens to be the only reference, then both record and index entry are deleted



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Dense Non-Clustered Index File

RECORD DELETION – SPARSE INDEX

- If the record to be deleted has no reference in the index file (because the index file is sparse), then only the record is deleted without changing the index file

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101	
104	
107	

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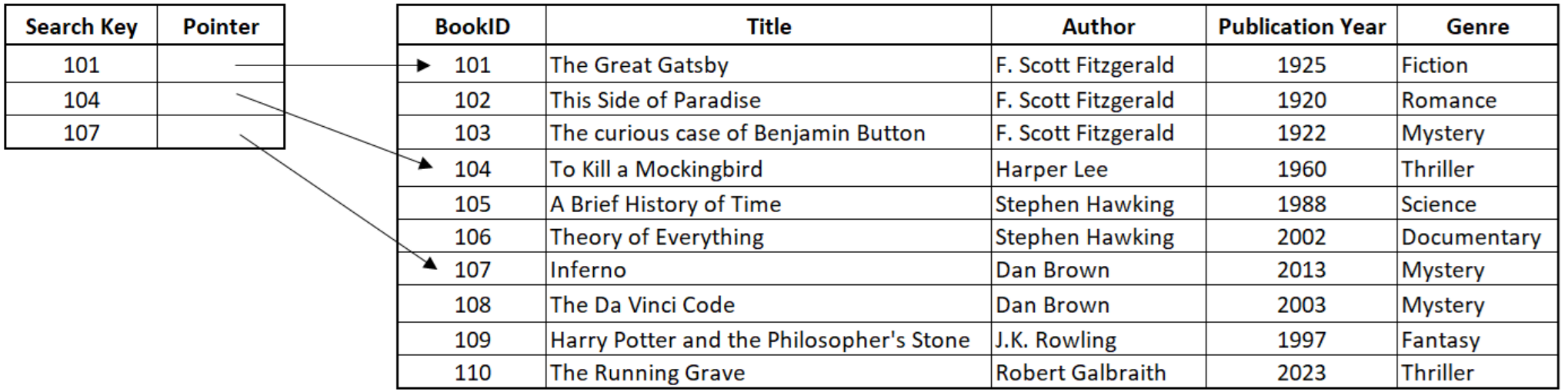
RECORD DELETION – SPARSE INDEX

- If the record to be deleted has the reference in the index file, the reference to the record is deleted and the index entry is replaced with the pointer to the next record available
- If this happens to be the last record or the next available record already has a pointer, it deletes the index entry as well



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