

1 3.1 Page Class Design

The **Page** class is a fundamental component of the database system, encapsulating both the structure and behavior of a single page within a type file. Its primary purpose is to manage the storage, retrieval, and modification of records at the page level, ensuring that the physical layout and integrity of data are consistently maintained.

Attributes

- **page_id**: Unique identifier for the page.
- **bitmap**: A 10-bit array representing the occupancy status of each record slot (1 for occupied, 0 for free).
- **record_slots**: A list containing up to 10 fixed-size records.

Methods

- **insert_record(record)**: Finds the first available (empty) slot, inserts the given record, and updates the bitmap to reflect the new occupancy.
- **delete_record(pk)**: Searches for a record by its primary key, clears the corresponding slot if found, and updates the bitmap to mark the slot as free.
- **serialize()**: Converts the entire page, including the header, bitmap, and records, into a byte sequence suitable for disk storage.
- **deserialize(data)**: Reconstructs a **Page** object from a binary data buffer, restoring all attributes and record contents.

The **Page** class is responsible for all record-level operations within a page, including insertion, deletion, and serialization. By encapsulating these behaviors, the class ensures that the layout of records and metadata remains consistent and efficient throughout the system.

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2 3.2 Record Class Structure

The **Record** class models a single fixed-length record as stored in a page slot. It encapsulates both the data fields and the metadata necessary for efficient storage, retrieval, and schema enforcement.

Attributes

- **validity_flag**: Boolean value indicating whether the record is valid (not deleted).
- **field_values**: List containing the values of each field in the record.
- **field_types**: List of field types (e.g., **int**, **str**) as defined in the system catalog for the record's type.

Methods

- **serialize()**: Converts the record, including the validity flag and all field values, into a fixed-length byte sequence for storage.
- **deserialize(data)**: Reads a fixed-length byte sequence and reconstructs the record's field values and validity flag.
- **match_pk(value)**: Checks whether the provided value matches the record's primary key field.

Each **Record** instance must conform to the schema specified in the system catalog, ensuring that the number, order, and types of fields are consistent with the type definition. The size of each record is constant and determined by the schema, enabling direct access and efficient slot management within pages. “