ECE 220

Lecture x000F - 10/17

Recap/reminders

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- Last time

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- Last time
    - Streams & buffers

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Recap/reminders

- Last time
  - Streams & buffers
  - File I/O
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  - Examples
- Reminders
  - This lecture concludes material for MT2
  - MT2 is on 10/31, plan ahead
  - Drop-deadline is tomorrow

Exercise

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- The input matrix is in file `mat.csv` with the first line specifying the number of rows and columns in the matrix.

- Write output to file `t_mat.csv.`

Introduction to `structs`

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  - A student could have a name (`char[80]`), UIN (`unsigned long int`), year (`unsigned int`) and GPA (`float`)

Introduction to `structs`

- Often useful to the programmer to combine pieces of information into a single abstract unit
- Example(s)
    - A student could have a name (`char[80]`), UIN (`unsigned long int`), year (`unsigned int`) and GPA (`float`)
    - A flight could have an altitude (`unsigned int`), latitude (`float`), longitude (`float`), airspeed (`float`) and airline code (`char[20]`)

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struct student{
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- Examples:

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struct flightType{
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Defining structs

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Defining structs

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However … no memory allocated yet!

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Using `structs`

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Using `structs`

- Memory is only allocated when variables are created using the newly defined type.

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struct flightType plane;
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struct flightType plane;
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struct student s1 = {“Garfield”,
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struct student BL3[2] = {s1,
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printf(“Name is %s”, BL3[1].name);
```

Memory mapping

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- How many bytes of memory should one *instance* of `student` take?

```
struct student{
    char name[80];
    unsigned long UIN;
    unsigned int year;
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G	s1.name[0]
a	s1.name[1]
…	…
…	s1.name[78]
…	s1.name[79]
123456	s1.UIN
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80 + 8 + 4 + 4

Memory mapping

- What if we change the definition to this one?

```c
struct student{
    char name[74];
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~~80~~ 74 + 8 + 4 + 4 = ?

Let us check using `sizeof` function.

What happened?

Memory mapping

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Let us check using `sizeof` function.

What happened?

Compilers will often perform "padding" to *align* memory.

Use the `sizeof` operator to get accurate results!

https://en.cppreference.com/w/c/language/object#Alignment

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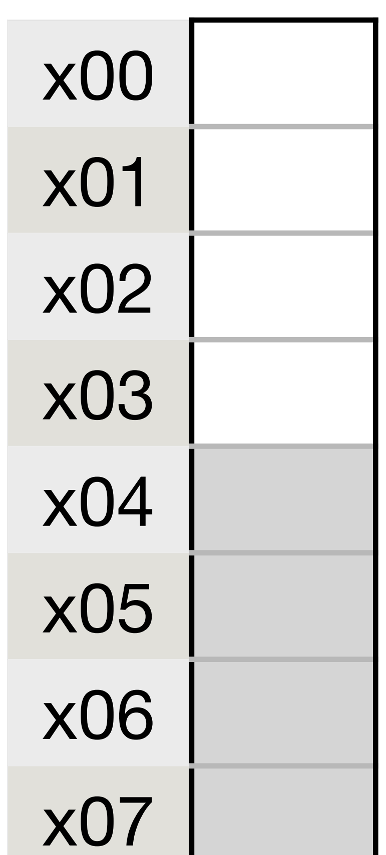

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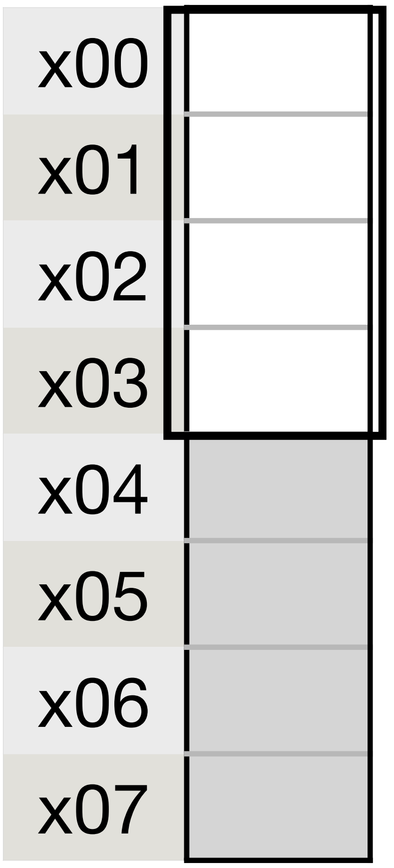

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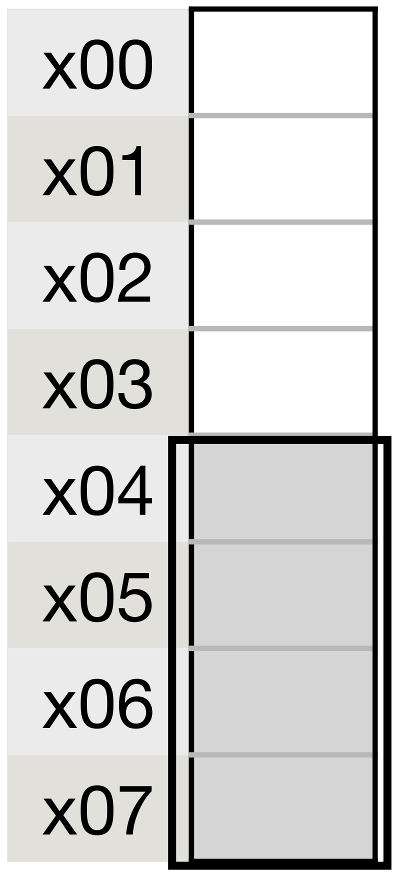

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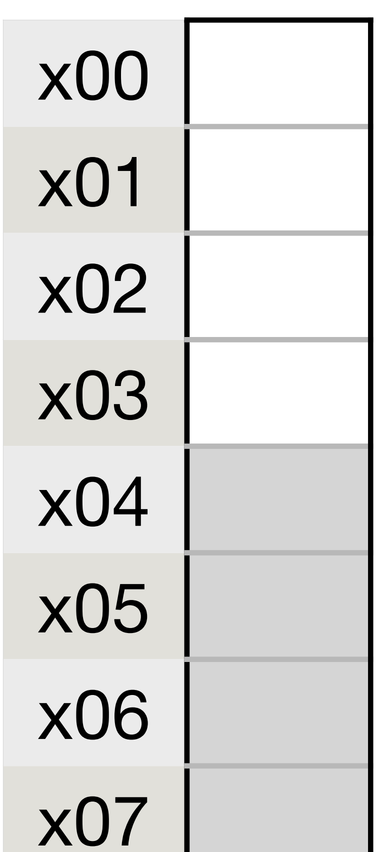

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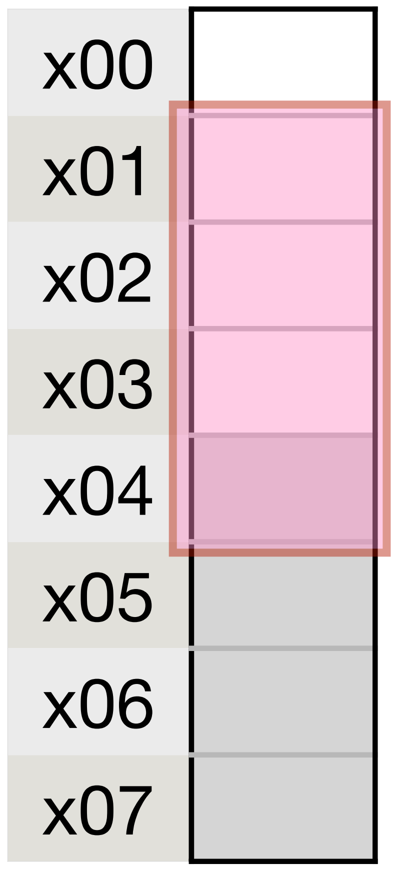

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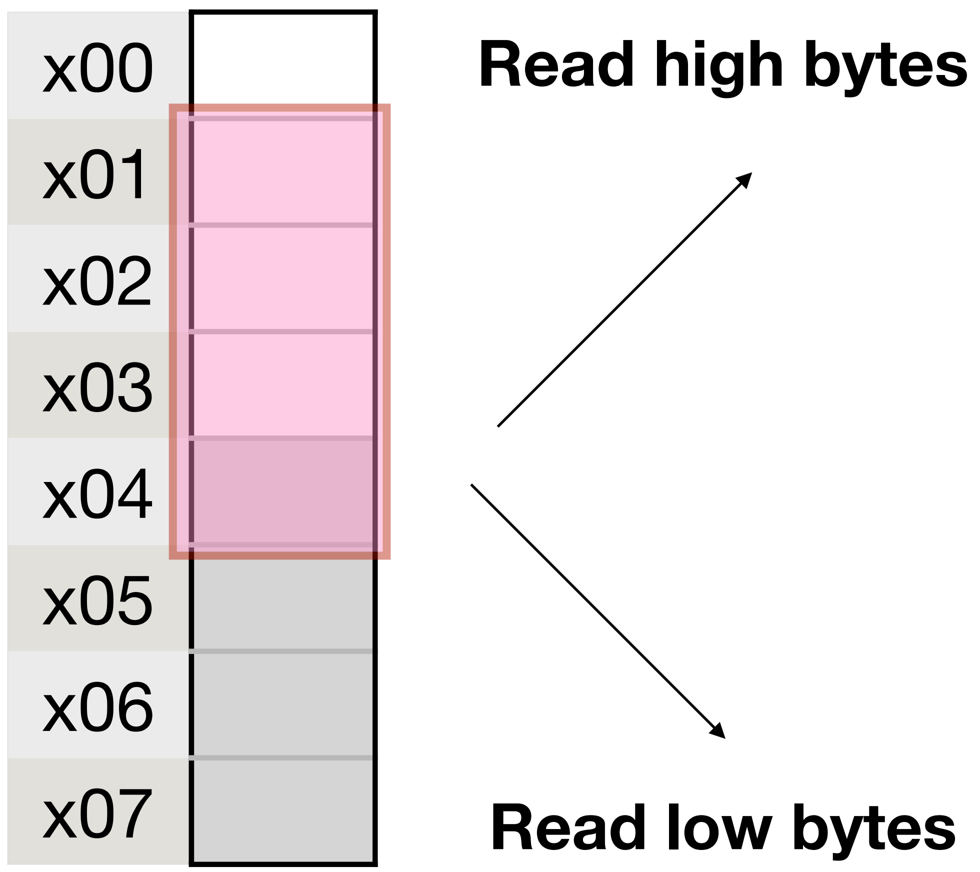

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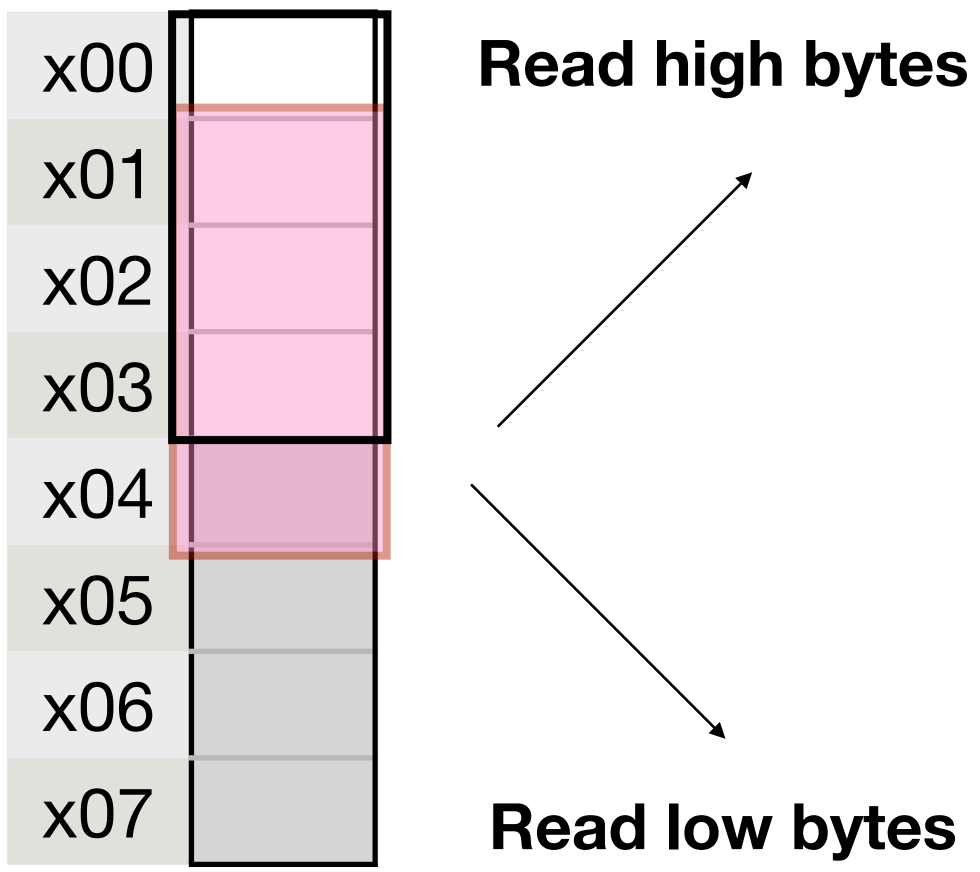

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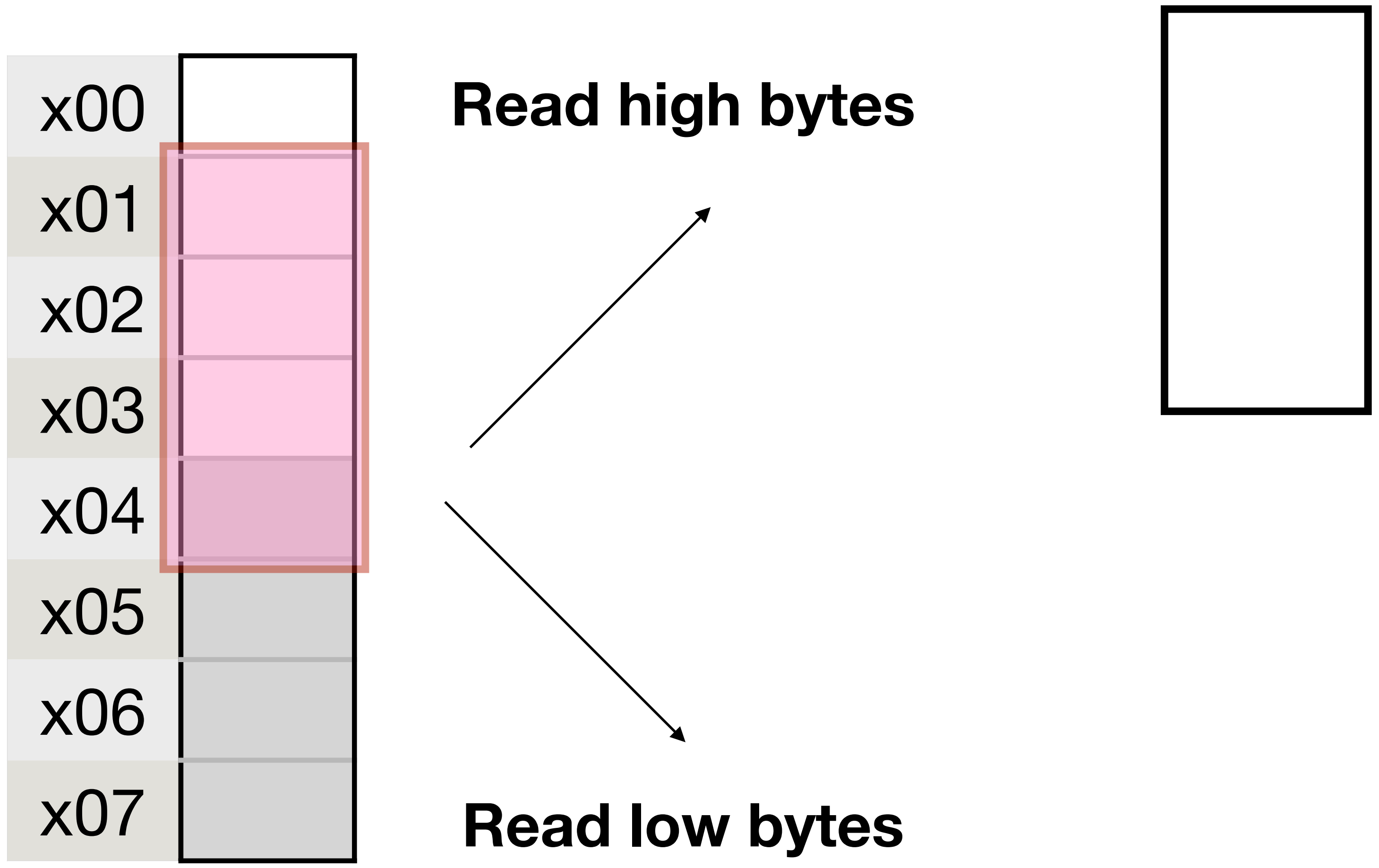

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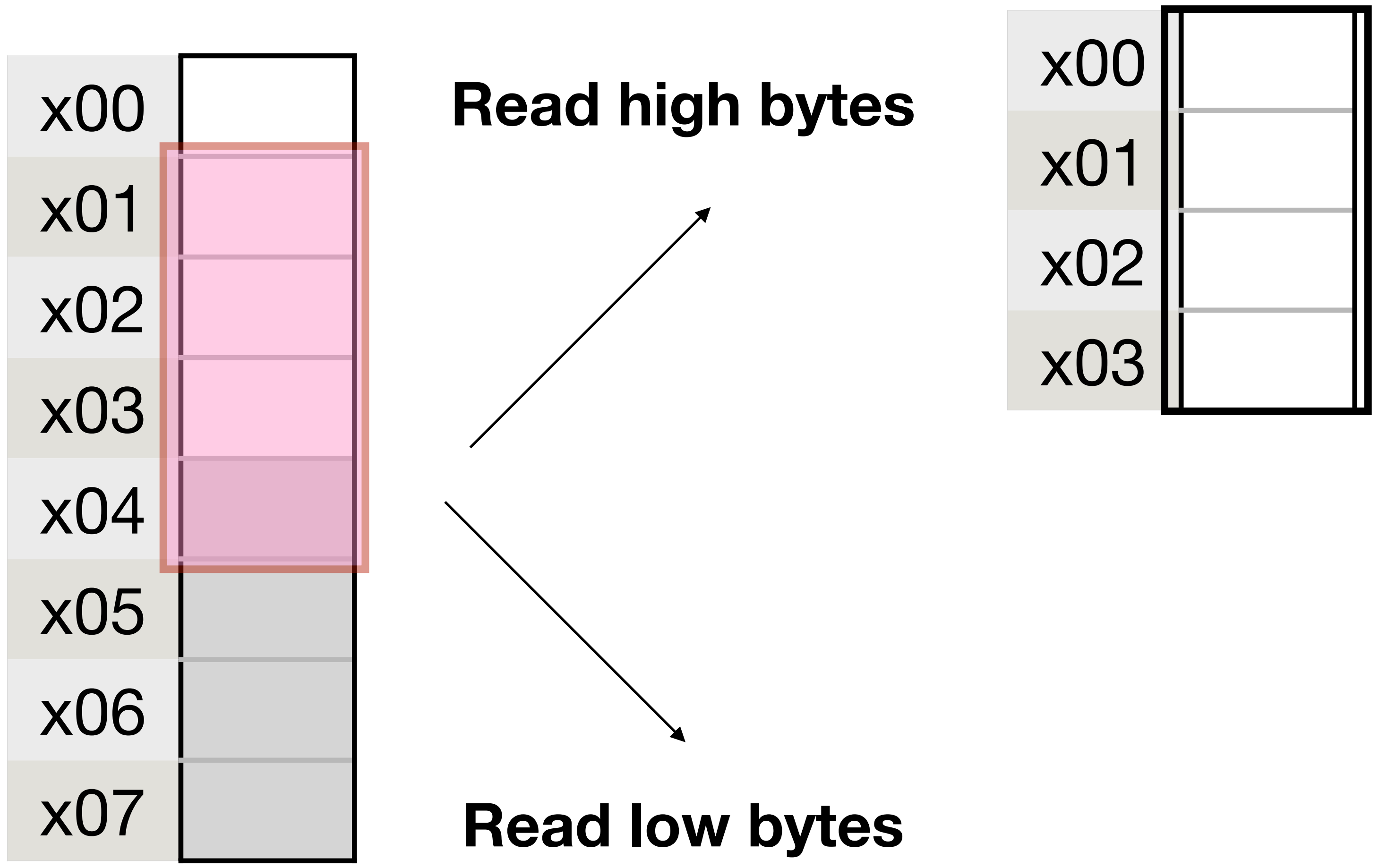

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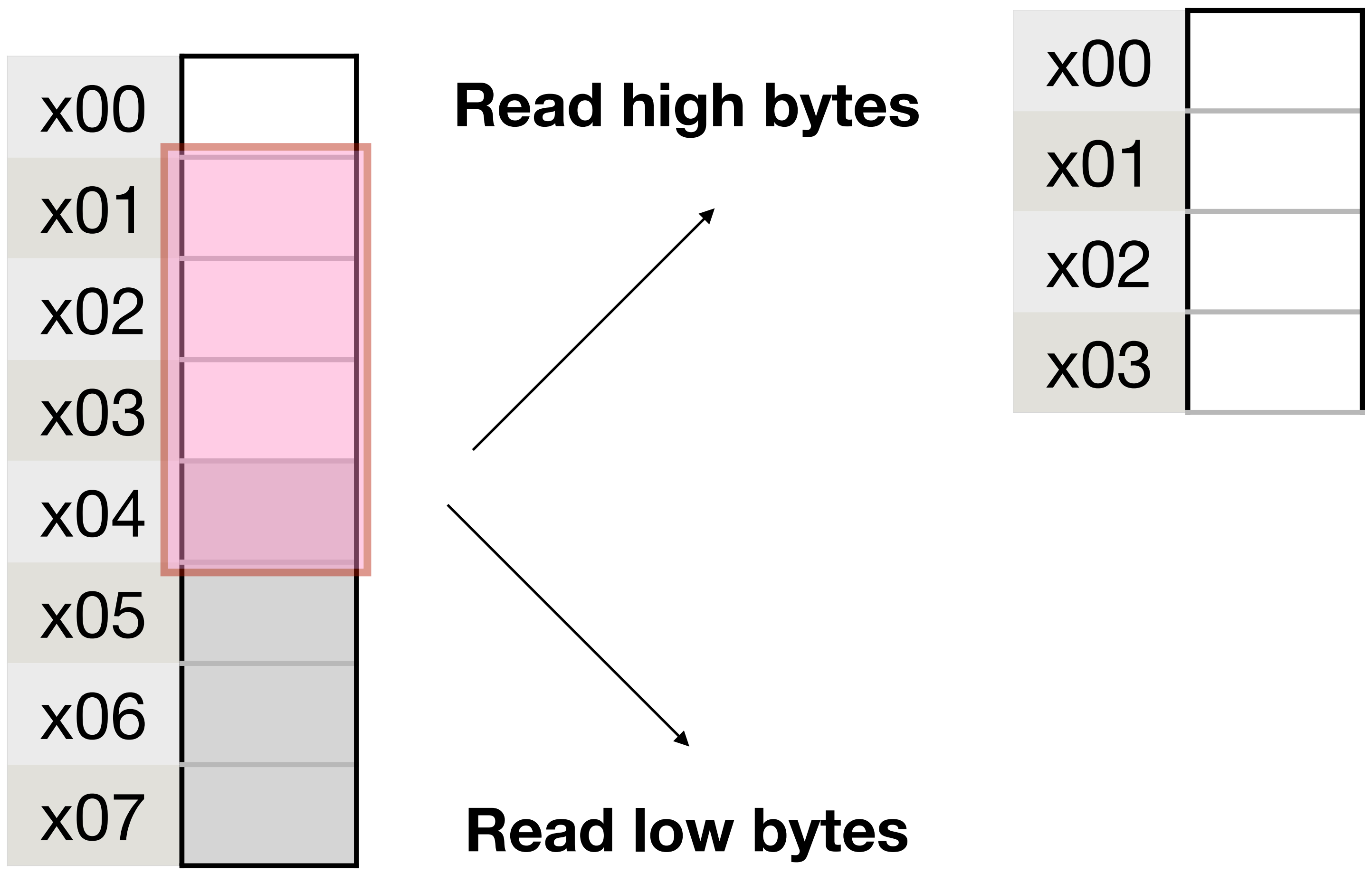

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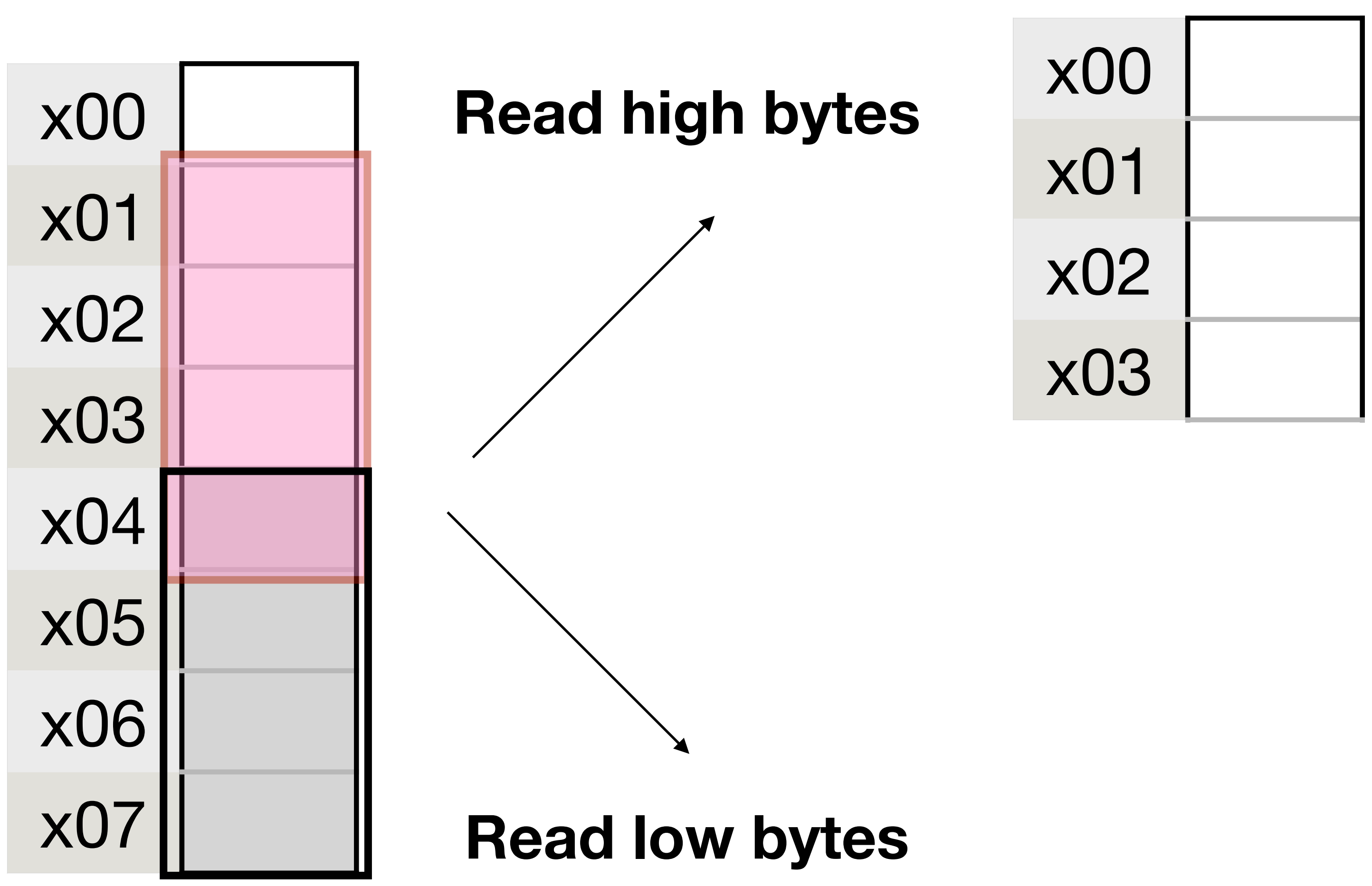

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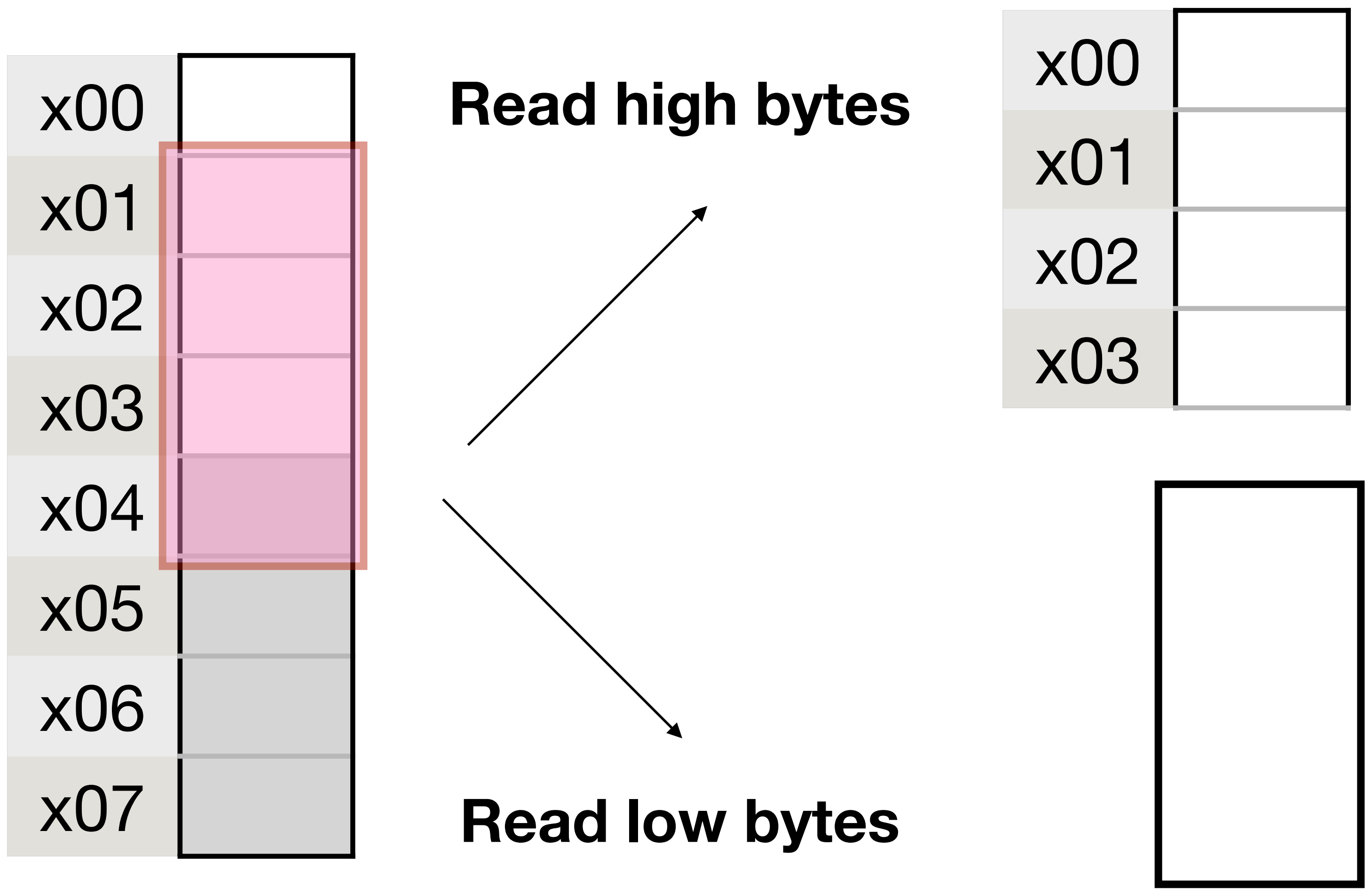

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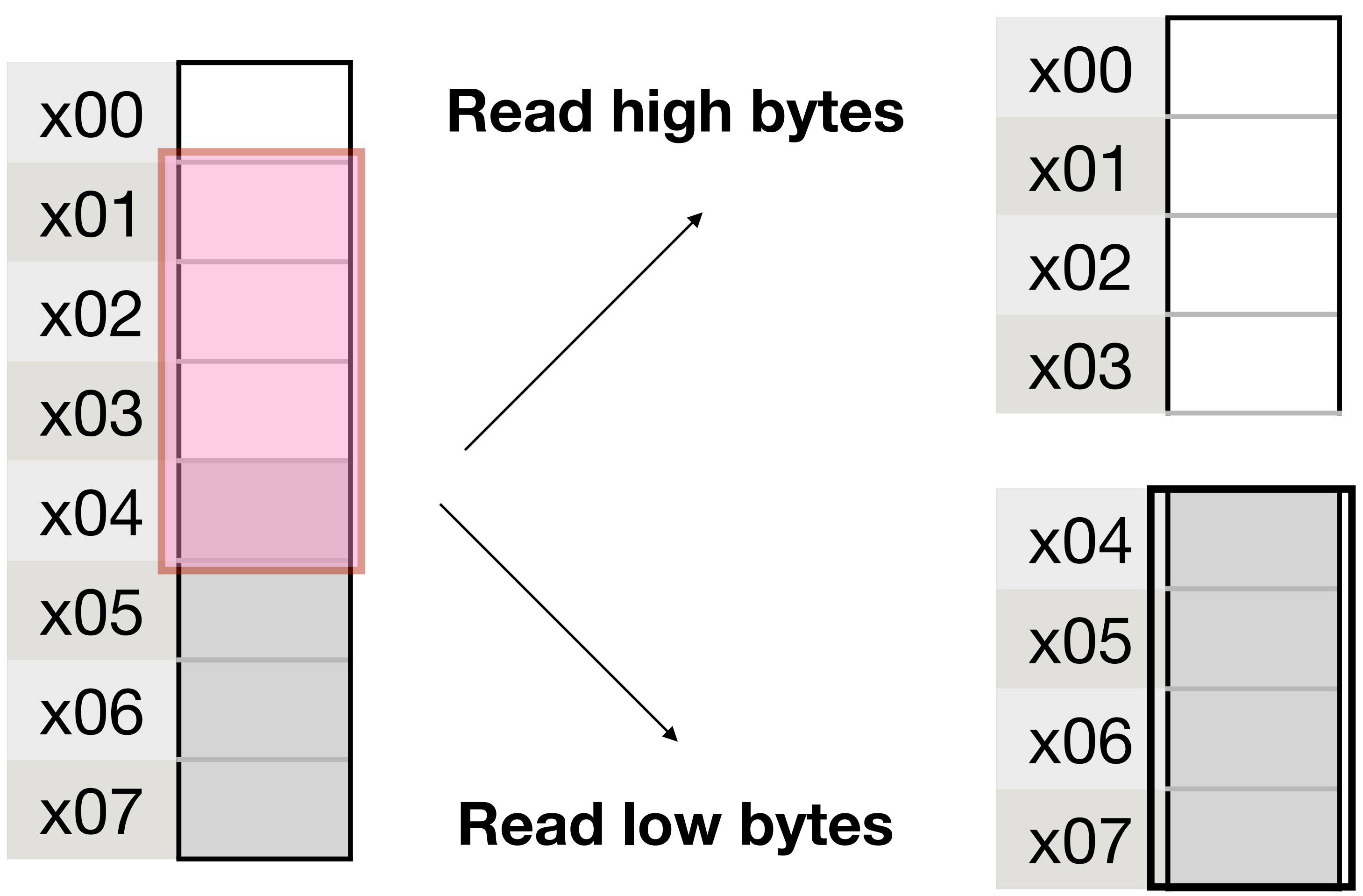

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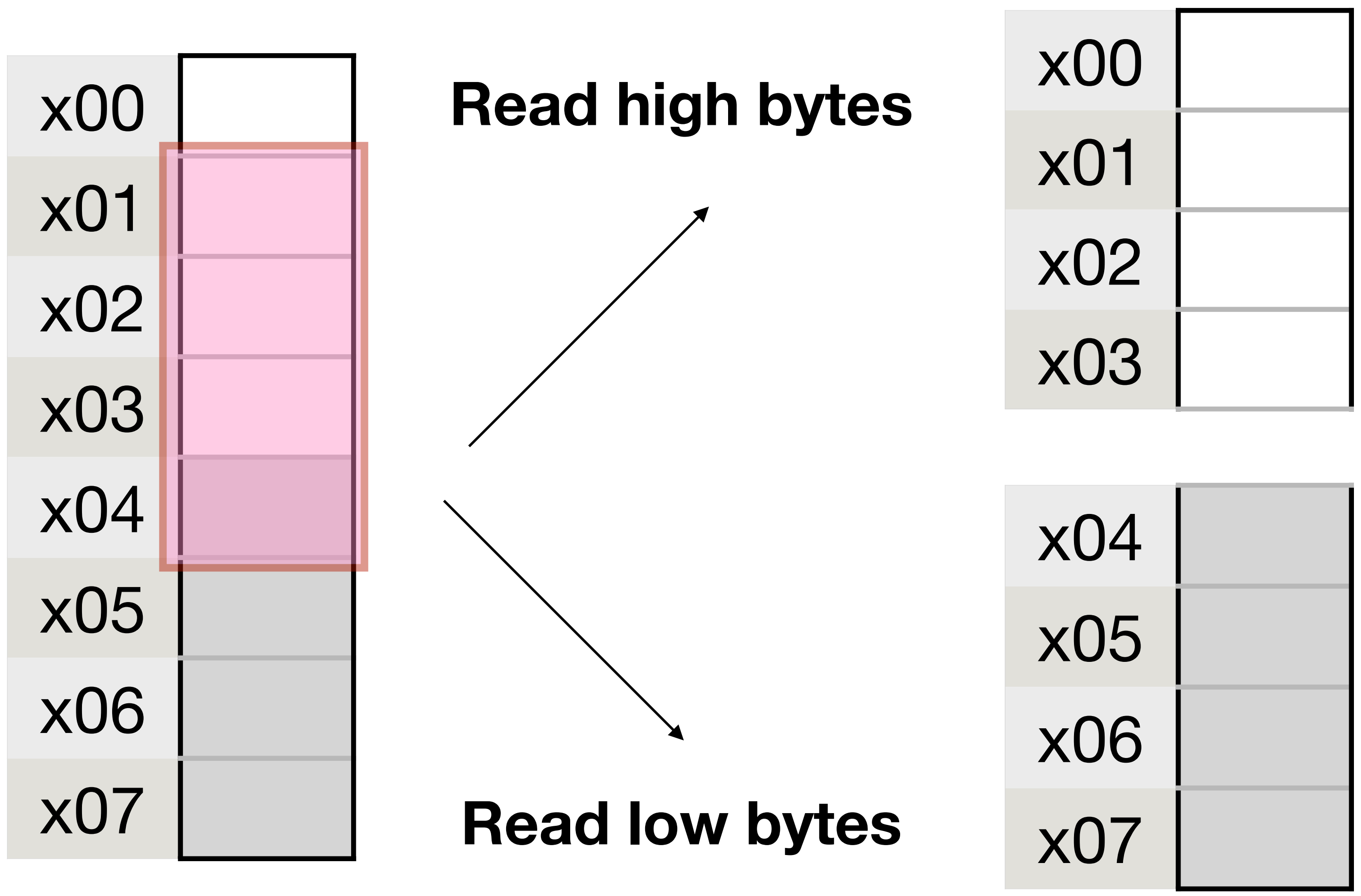

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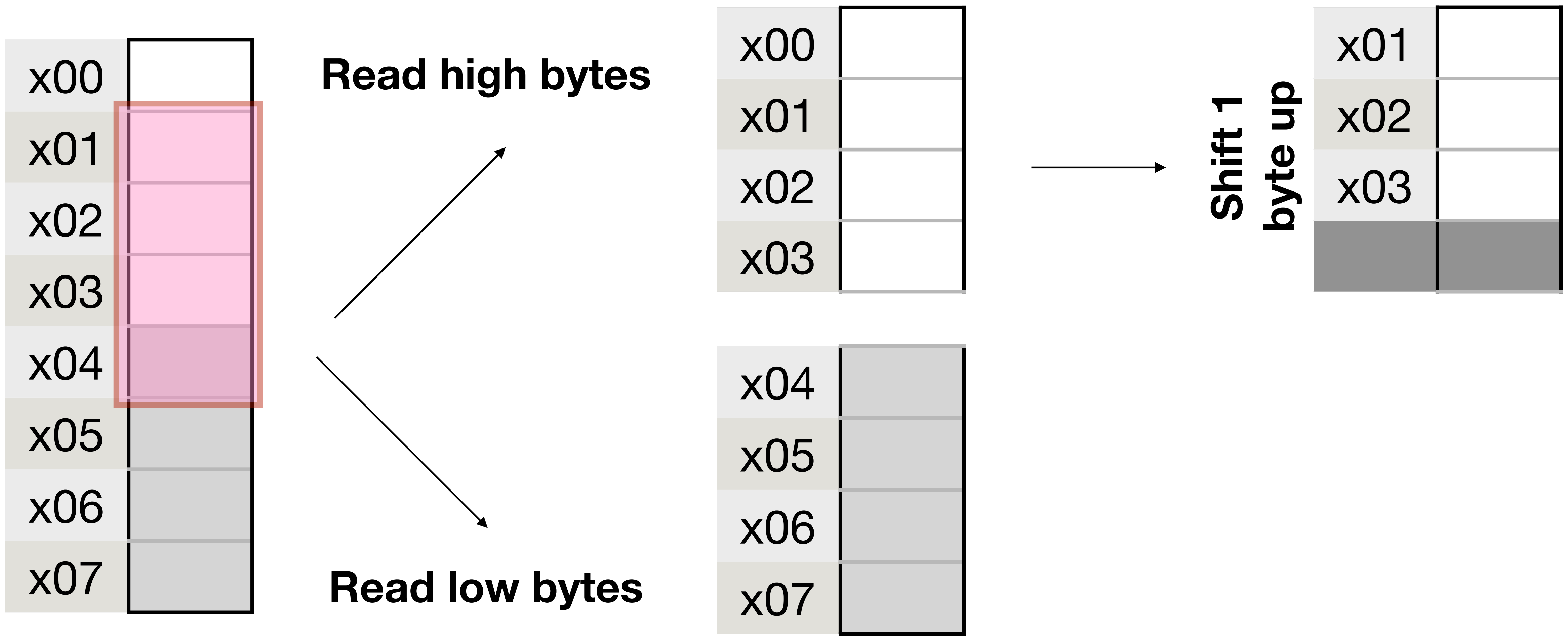

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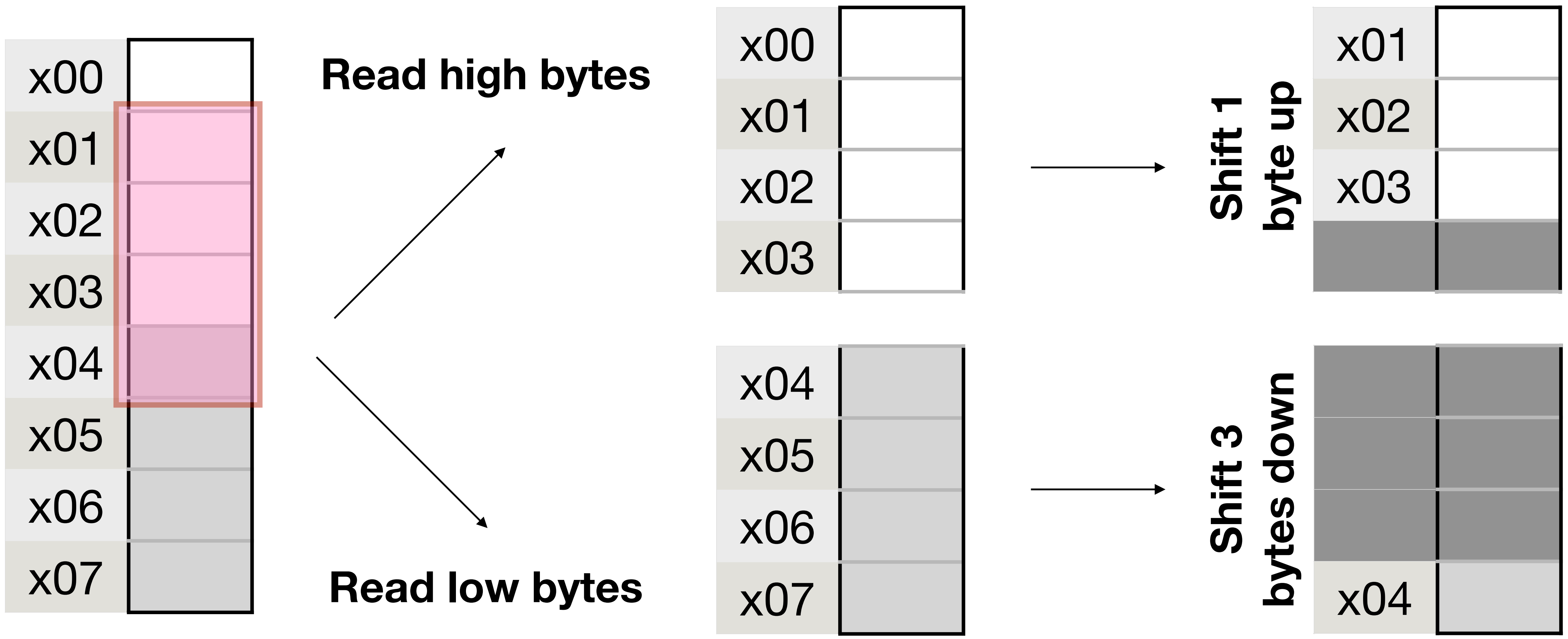

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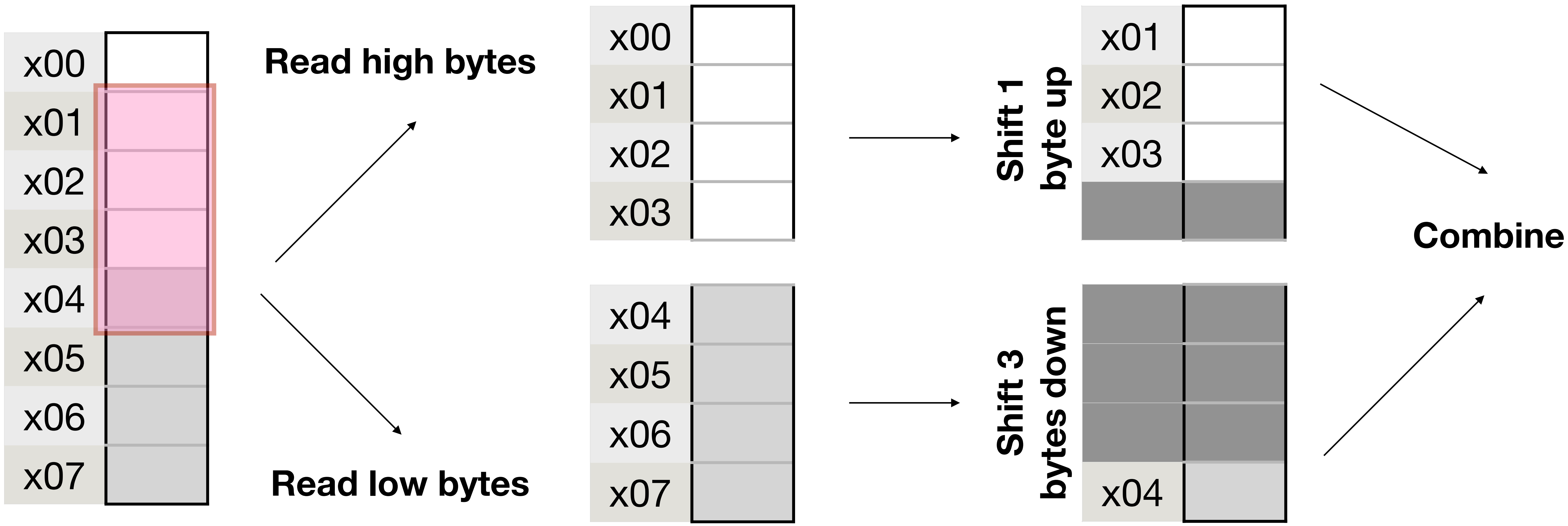

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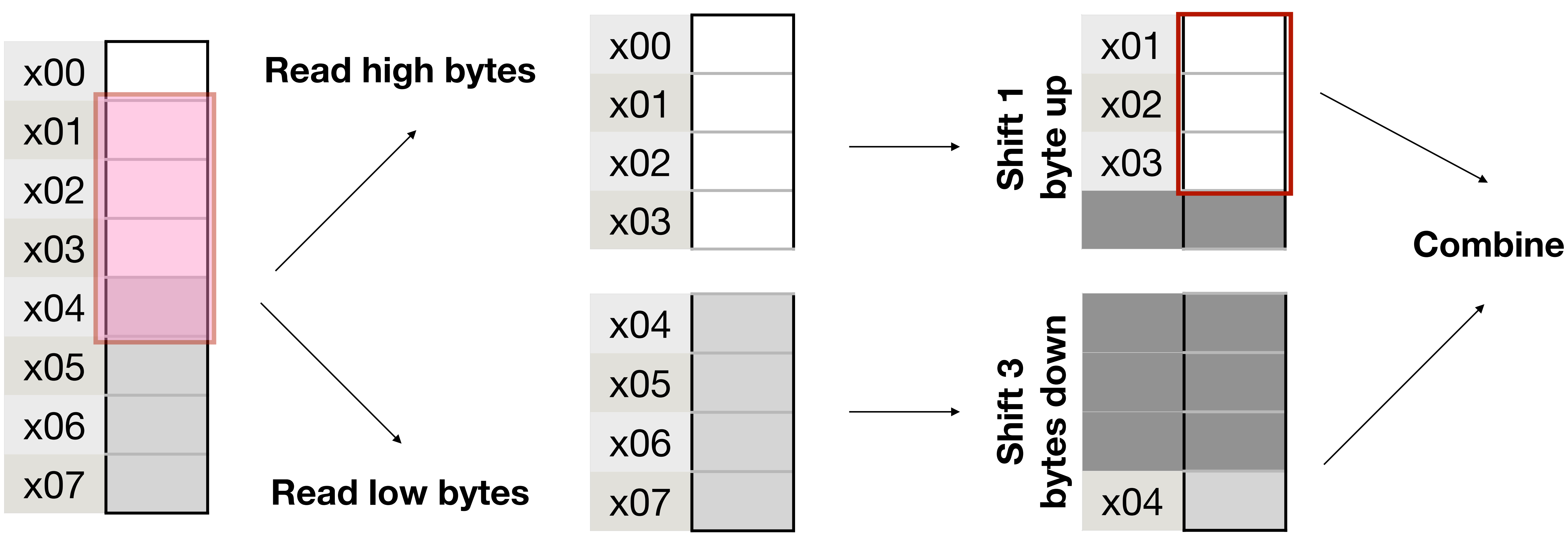

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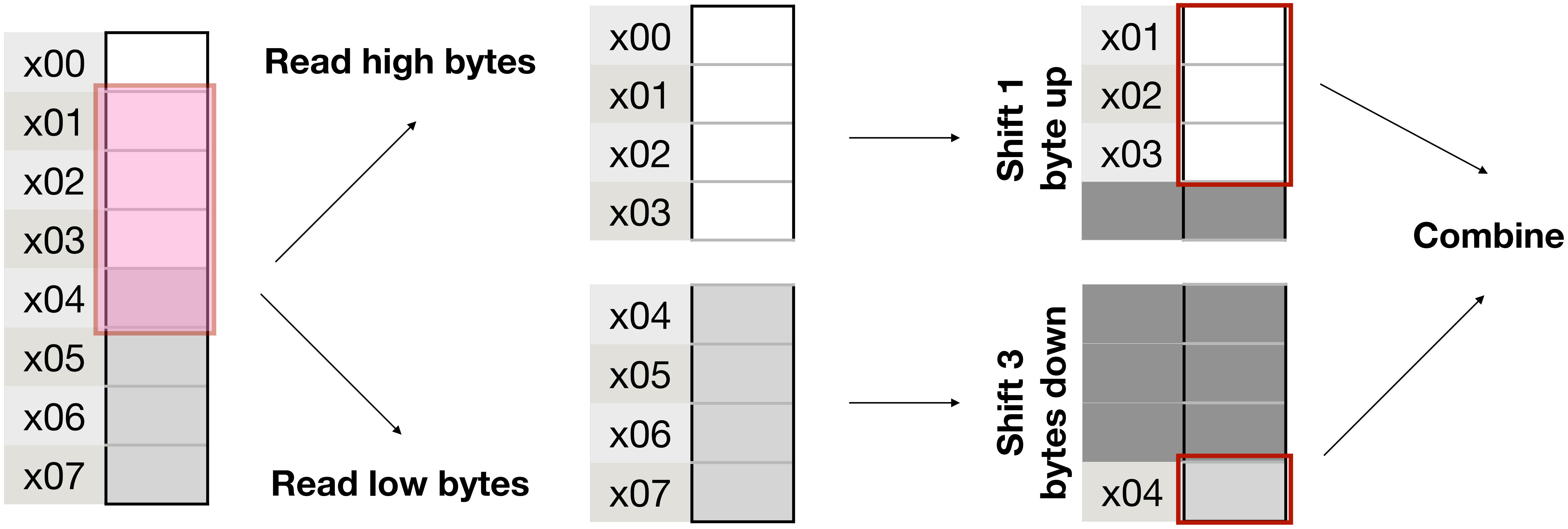

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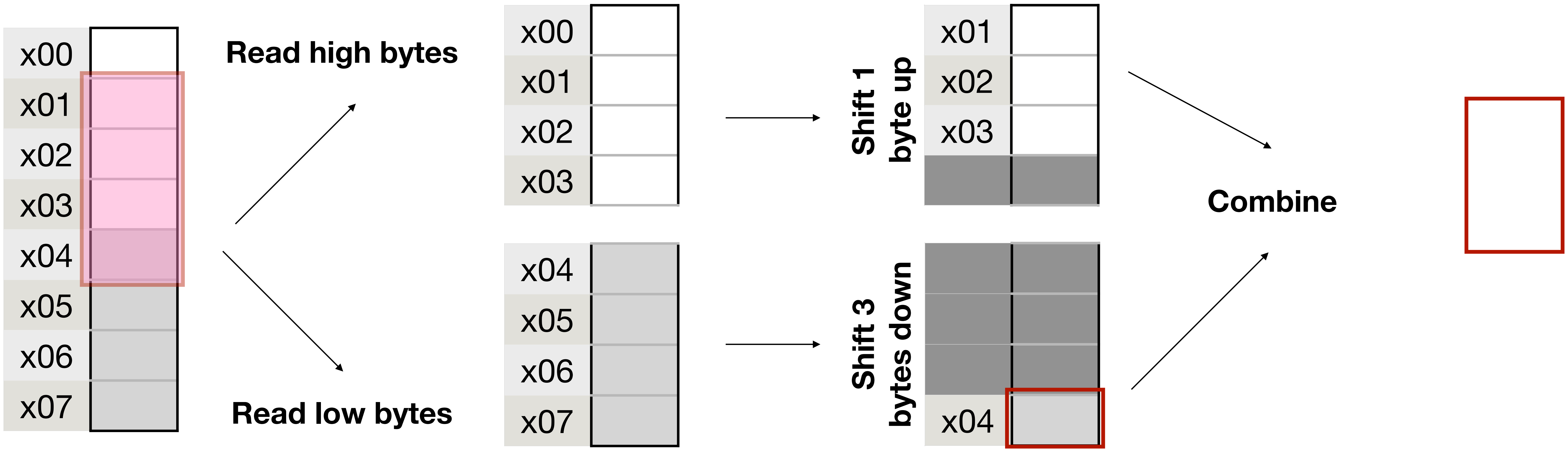

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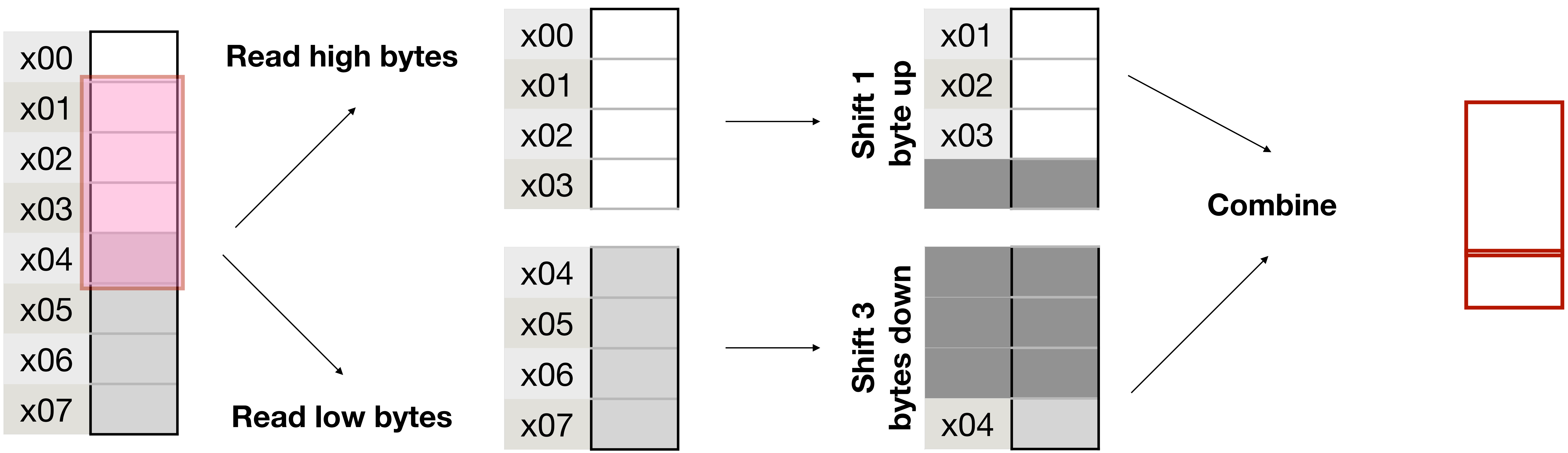

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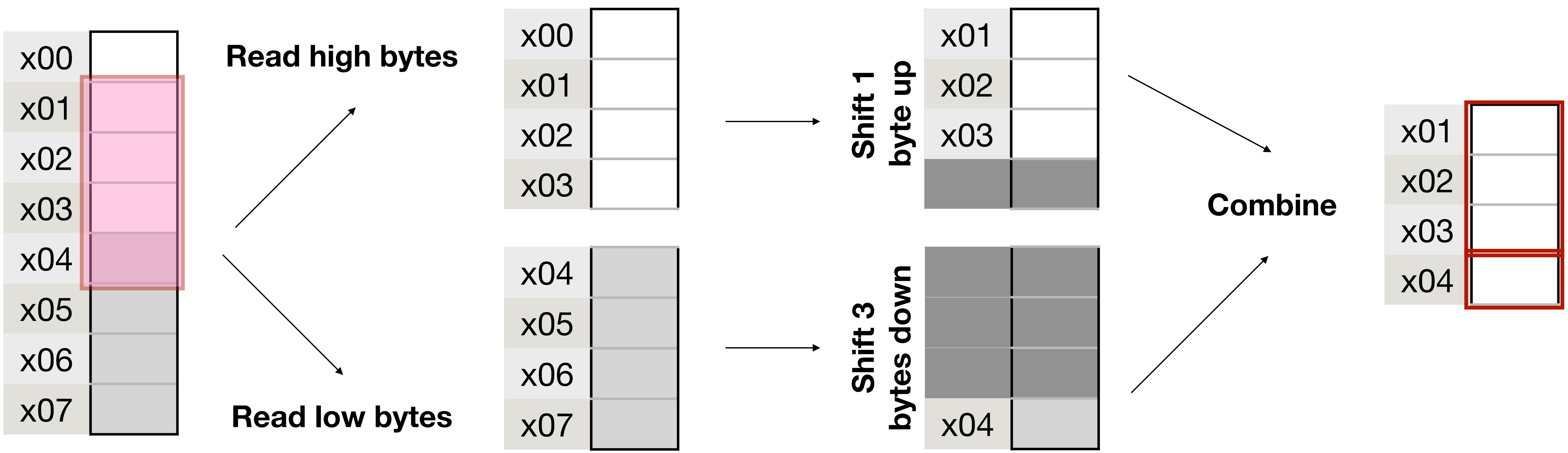

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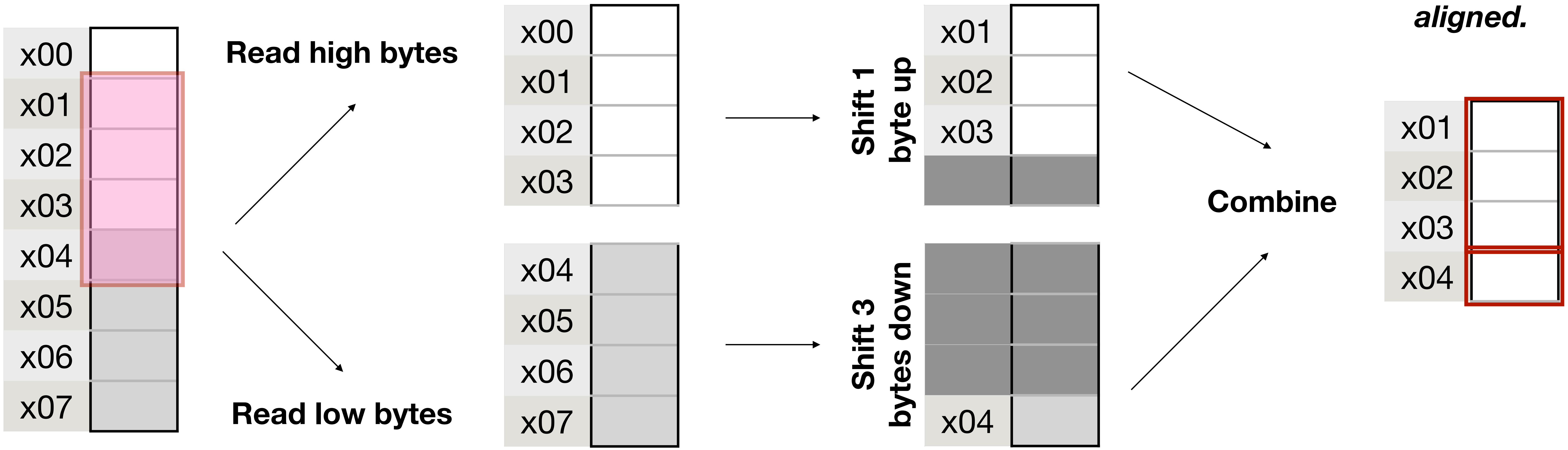

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- C provides a mechanism to avoid this verbosity.

```
typedef struct flightType{
     char flightCode[20];
     unsigned int altitude;
     float longitude;
     float latitude;
     unsigned float airSpeed;
} Flight;

Flight f1 = {"AA 4324",
             33000,
             87.6,
             41.8,
             700};
```

Pointers to structs

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Flight planes[100];
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printf("I am %f feet high",
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Special syntax! ←

Passing `structs` as arguments

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```
void print_student(struct student s){
  printf("Student %s is associated with UIN: %lu\n", s.name, s.UIN);
  printf("%s is in Year %d with GPA %f\n", s.name, s.year, s.GPA);
}
```

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void print_student(struct student s){
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  printf("%s is in Year %d with GPA %f\n", s.name, s.year, s.GPA);
}
```

```
void print_flight(Flight f){
  printf("Flight #%s is at altitude %u\n", f.flightCode, f.altitude);
  printf("%s has speed %f\n", f.flightCode, f.airSpeed);
}
```

Passing `structs` as arguments

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void print_flight_loc(Flight *f){
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  printf("%s has lattitude: %f\n", f->flightCode, f->latitude);
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```

- Which is cheaper in terms of memory/run-time stack?
  - What if we had an array of structs?

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Suppose we have:

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struct geoloc{
  float lattitude;
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  Suppose we have:

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struct geoloc{
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  float longitude;
};
```

- Then we can do:

```
typedef struct flight{
  char code[8];
  unsigned int arrival_time;
  unsigned int depart_time;
  struct geoloc origin;
  struct geoloc destination;
} Flight;
```

Example: Airport management

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- `size` is the size in bytes of each element to be **written** (use sizeof)
- `n_memb` is the number of items to **write**, each with size of size bytes
- `stream` is the pointer to FILE object in ***binary write mode.***

Example: Airport management

- Writing a struct to a file:

```
fread(void *ptr, size, n_memb, FILE *stream)
```

- `ptr` is pointer to instance of the struct to **hold data**
- `size` is the size in bytes of each element to be **read** (use sizeof)
- `n_memb` is the number of items to **read**, each with size of size bytes
- `stream` is the pointer to FILE object in ***binary read mode.***

Exercise

- In a C file, use a loop and have the user input three records of the **Flight** struct.
    - Write this data to disk using **fwrite**.
- In another C file, read the data back to an array of **Flight** using **fread**.

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  float lattitude;
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} Flight;
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