Data Structures
Chapter 2

1. Recurrence Relations
2. Discrete Math
3. **Structure**
   - Structure & Array
   - **Structure & Class**
   - **PSet – Clock**

Struct and Class

- Believe it or not, only one difference between **`struct`** and **`class`** is that by default **`struct`** members are **`public`** and **`class`** members are **`private`** in C++.
- But as per programming consideration,
  - Use the **`struct`** keyword for data-only structures.
  - Use the **`class`** keyword for objects that have both data and functions..

Reference: https://stackoverflow.com/questions/1127396/struct-constructor-in-c/1127406

PSet Clock: Demo

- clock3
- clock4
- clock

```
PS C:\GitHub\nowicx\labs\lab9clock> ./clock3
14:38:57
14:38:58
14:38:59
14:39:00
14:39:01
14:39:02
PS C:\GitHub\nowicx\labs\lab9clock> ./clock4
11:59:17
```

```
PS C:\GitHub\nowicx\labs\lab9clock> ./clockx
11:58:57
11:58:58
11:58:59
11:59:00
11:59:01
11:59:02
12:00:25
```

PSet Clock: Step 1

- What is wrong in the code?

ver.1

```
#include <iostream>
#include <iomanip>
struct Clock{
  int hr, min, sec;
};

void tick(Clock *ptr);
void show(Clock *ptr);

int main (void) {
  Clock *clock = {14, 38, 56};

  for(int i = 0; i < 6; ++i) {
      tick(clock);
      show(clock);
  }
  return 0;
}
```

NOTE: Correct the code above **not to use** pointers in `main()`.

ver.1

```
// increment the time by one second.
void tick(Clock *ptr) {
  ptr->sec++;




  // your code here




}

// show the current time in military form.
void show(Clock *ptr)  {
  std::cout.fill('0');
  std::cout << std::setw(2) << ptr->hr << ":"
            << std::setw(2) << ptr->min << ":"
            << std::setw(2) << ptr->sec << std::endl;
}
```

PSet Clock: Step 1

- What is wrong in the code?

ver.1

```
#include <iostream>
#include <iomanip>
struct Clock{
  int hr, min, sec;
};

void tick(Clock *ptr);
void show(Clock *ptr);

int main (void) {
  Clock clock = {14, 38, 56};

  for(int i = 0; i < 6; ++i) {
      tick(&clock);
      show(&clock);
  }
  return 0;
}
```

ver.1

```
// increment the time by one second.
void tick(Clock *ptr) {
  ptr->sec++;




  // your code here




}

// show the current time in military form.
void show(Clock *ptr)  {
  std::cout.fill('0');
  std::cout << std::setw(2) << ptr->hr << ":"
            << std::setw(2) << ptr->min << ":"
            << std::setw(2) << ptr->sec << std::endl;
}
```

PSet Clock: Step 2

- Rewrite the code using a pointer ***ptr** and new instead of **Clock clock**;

ver.1

```
#include <iostream>
#include <iomanip>
struct Clock{
  int hr, min, sec;
};

void tick(Clock *ptr);
void show(Clock *ptr);

int main (void) {
  Clock clock = {14, 38, 56};

  for(int i = 0; i < 6; ++i) {
      tick(&clock);
      show(&clock);
  }
  return 0;
}
```

ver.2

```
#include <iostream>
#include <iomanip>
struct Clock{
  int hr, min, sec;
};

void tick(Clock *ptr);
void show(Clock *ptr);

int main (void) {


  for(int i = 0; i < 6; ++i) {
      tick(&ptr);
      show(&ptr);
  }
  return 0;
}
```

PSet Clock: Step 2

- Rewrite the code using a pointer ***ptr** and new instead of **Clock clock**;

ver.1

```
#include <iostream>
#include <iomanip>
struct Clock{
  int hr, min, sec;
};

void tick(Clock *ptr);
void show(Clock *ptr);

int main (void) {
  Clock clock = {14, 38, 56};

  for(int i = 0; i < 6; ++i) {
      tick(&clock);
      show(&clock);
  }
  return 0;
}
```

ver.2

```
#include <iostream>
#include <iomanip>
struct Clock{
  int hr, min, sec;
};

void tick(Clock *ptr);
void show(Clock *ptr);

int main (void) {
  Clock *ptr = new Clock {14, 38, 56};

  for(int i = 0; i < 6; ++i) {
      tick(ptr);
      show(ptr);
  }
  return 0;
}
```

PSet Clock: Step 3

- Rewrite ver.2 using **`pClock`** alias of a pointer to a **`struct`**.

ver.2

```
#include <iostream>
#include <iomanip>
struct Clock{
  int hr, min, sec;
};

void tick(Clock *ptr);
void show(Clock *ptr);

int main (void) {
  Clock *ptr = new Clock {14, 38, 56};

  for(int i = 0; i < 6; ++i) {
      tick(ptr);
      show(ptr);
  }
  return 0;
}
```

PSet Clock: Step 3

- Rewrite ver.2 using **pClock** alias of a pointer to a **struct**.

ver.3

```
#include <iostream>
#include <iomanip>
struct Clock{
  int hr, min, sec;
};
using pClock = Clock*;
void tick(pClock ptr);
void show(pClock ptr);

int main (void) {
  pClock ptr = new Clock {14, 38, 56};

  for(int i = 0; i < 6; ++i) {
      tick(ptr);
      show(ptr);
  }
  delete ptr;
}
```

ver.3

```
void tick(pClock ptr) {  // by one second.
  ptr->sec++;




  // your code here




}
void show(pClock ptr)  {
  std::cout.fill('0');
  std::cout << std::setw(2) << ptr->hr << ":"
            << std::setw(2) << ptr->min << ":"
            << std::setw(2) << ptr->sec << std::endl;
}
```

PSet Clock: Step 4

- Remove magic numbers. Do you have any idea?

ver.3

```
#include <iostream>
#include <iomanip>
struct Clock{
  int hr, min, sec;
};
using pClock = Clock*;
void tick(pClock ptr);
void show(pClock ptr);

int main (void) {
  pClock ptr = new Clock {14, 38, 56};

  for(int i = 0; i < 6; ++i) {
      tick(ptr);
      show(ptr);
  }
  delete ptr;
}
```

PSet Clock: Step 4

- Remove magic numbers. Do you have any idea?

ver.4

```
#include <iostream>
#include <iomanip>
struct Clock{
  int hr, min, sec;
};
using pClock = Clock*;
void tick(pClock ptr);
void show(pClock ptr);
void runs(pClock ptr);

int main (void) {
  pClock ptr = new Clock {14, 38, 56};

  runs(ptr);

  delete ptr;
}
```

ver.4

```
void runs(pClock clk)  {
  while(true) {
    sleep(1);

    // your code here

  }
}
```

Hint: Use **'\r'** instead of **'\n'** to prevent it from printing a new line.

Replace **show()** with **runs()** such that it ticks and redisplays the time **at the same line** continuously.

To make **'\r'** to work on a mac, invoke std::flush right after '\r'.

PSet Clock: Step 5

- Create **clock.h, clock.cpp,** and **clockDriver.cpp** such that they can separate the implementation from interface. Make your files work with **clockDriver.cpp** as provided.

clockDriver.cpp

```
/*
* C++ for C Coders & Data Structures
* Lecture note by idebtor@gmail.com
* This code explains:
*   - struct and its initialization, using alias
*   - pointer to struct, new/delete, optional argument
*   - SIIS(Separation of Interface and Implementation)
*   - NMN(No Magic Number)
*
*/
#include "clock.h"
int main (void) {
  pClock clk = new Clock {11, 58, 56};
  for(int i = 0; i < 6; ++i) {
      tick(clk);
      show(clk);
  }
  runs(clk, '\r');
  delete clk;
}
```

To make '\r' to work on a mac, invoke std::flush right after '\r'.

PSet Clock: Step 5

- Create **clock.h**, **clock.cpp**, and **clockDriver.cpp** such that they can separate the implementation from interface. Make your files work with **clockDriver.cpp** as provided.
  - Do **not** use `"using namespace std;"` in these files at all.
- Keep the function prototypes in **clock.h** as shown below:

```
void tick(pClock clk);
void show(pClock clk, char end = '\n');
void runs(pClock clk, char end = '\n');
```

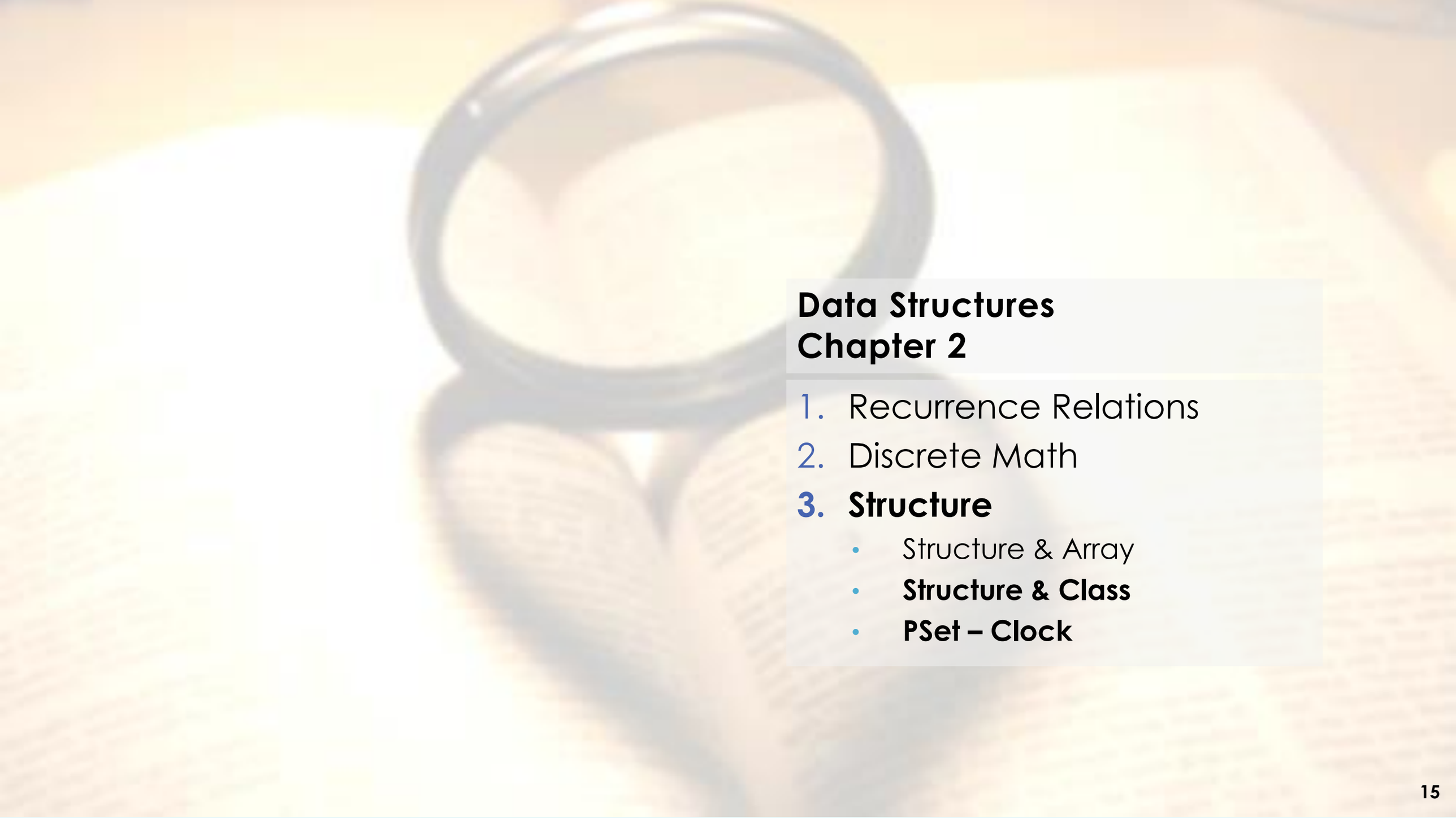
- Use an optional argument. It help you keep DRY principle.
- Sample run:
  `"-I./"` is **unnecessary** since it looks for header files in the current folder by default.

```
PS C:\GitHub\nowicx\labs\lab9clock> g++ clockx.cpp clockDriver.cpp -I./ -o clock
PS C:\GitHub\nowicx\labs\lab9clock> ./clock
11:58:57
11:58:58
11:58:59
11:59:00
11:59:01
11:59:02
12:00:12
```

This tick keeps on running.

PSet - Clock:

- Files provided:
  - **clockDriver.cpp - do not change, do not submit.**
  - sample executables
- Files to submit:
  - **`step 3: clock3.cpp`**
  - **`step 4: clock4.cpp`**
  - **`step 5: clock.h & clock.cpp`**
- Due:
  - 11:55 pm
- Grade:
  - step 3 ~ 5: 2 points
  - Watch out DRY principle



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   - **Structure & Class**
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