



# 進階資料型態定義



丁培毅

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ulong x; // equivalent to unsigned long x;
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```
typedef int IntArray[20];  
IntArray y[30]; // equivalent to int y[30][20];
```

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typedef unsigned long ulong;  
ulong x; // equivalent to unsigned long x;
```

- More general rule: *typedef* type definition of new\_type\_name;

```
typedef int IntArray[20];  
IntArray y[30]; // equivalent to int y[30][20];
```

```
typedef double (*FP)( )[10];  
FP fp; // equivalent to double (*fp)( )[10];  
meaning: “a function pointer fp to a function that takes no argument  
and returns a pointer to a 10-element array of doubles”
```

Equivalent and more self-explaining definitions:

```
typedef double DoubleArray[10];  
typedef DoubleArray *PtrDoubleArray;  
typedef PtrDoubleArray (*FP)( );
```



# 以 *typedef* 重新定義型態名稱

- ❖ You can also define multiple new type names in one *typedef* statement, just like you define several variables in one definition.

```
typedef struct
{
    int x;
    int y;
} Point, *PtrPoint;
Point point;          // equivalent to struct { int x; int y; } point;
PtrPoint ptrPoint;   // equivalent to struct { int x; int y; } *ptrPoint;
```

# 複雜的資料型態範例

## ❖ Examples:

```
int *x;
```

```
int *x[10];
```

```
int (*x)[10];
```

```
int (**x)[10];
```

```
int *(*x)[10];
```

```
int x[10][20][30];
```

```
void (*funcPtr)();
```

```
void *func(); // definition of a function
```

```
void (*signal(int, void (*)(int)))(int); // definition of a function
```

```
void *(*fp1)(int)[10];
```

```
float *(*fp2)(int, int, float)(int);
```

```
double *(*fp3)()[10]();
```

```
int (*fp4)()[10]();
```

Using *typedef* can simplify these definitions

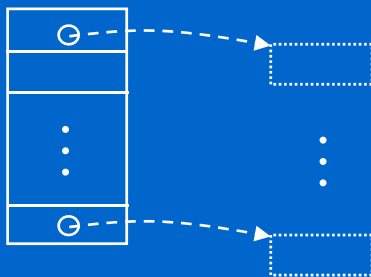
# 陣列與指標型態

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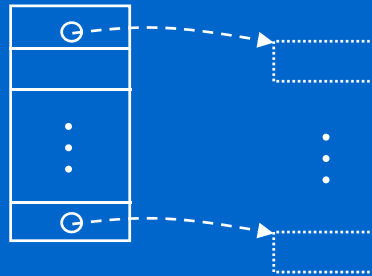
```
int *x[10]; // 10-element ARRAY of (PTR to integer)
```



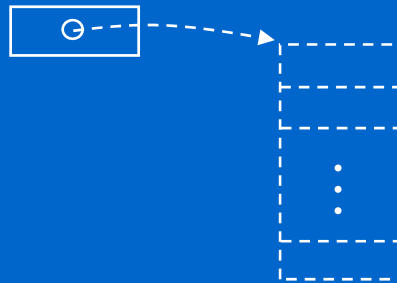
# 陣列與指標型態

❖ Two simplest examples first:

**int \*x[10];** // 10-element ARRAY of (PTR to integer)



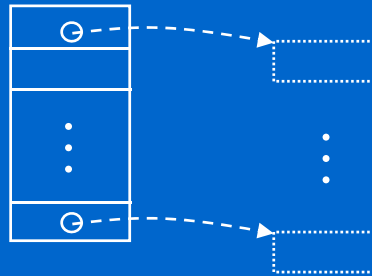
**int (\*x)[10]=a;** // PTR to (10-element ARRAY of integers), int a[5][10];



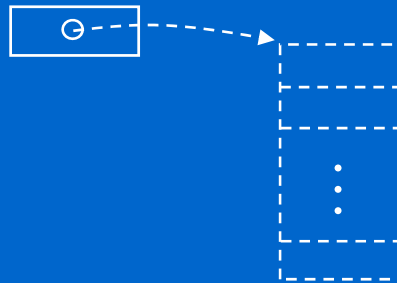
# 陣列與指標型態

❖ Two simplest examples first:

**int \*x[10];** // 10-element ARRAY of (PTR to integer)



**int (\*x)[10]=a;** // PTR to (10-element ARRAY of integers), int a[5][10];



**TYPE [n]** means “n-element ARRAY of TYPE”

**TYPE \*** means “PTR to TYPE”

[ ] has higher precedence than \*, ( ) can change the priority

# 陣列與指標型態 (cont'd)

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✧ Some more

```
int **x1; // PTR to (PTR to int)
```

```
int (**x2)[10]; // PTR to (PTR to (10-element ARRAY of int))
```

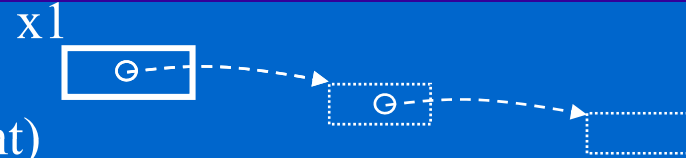
```
int *(*x3)[10]; // PTR to (PTR to (10-elem ARY of (PTR to int)))
```



# 陣列與指標型態 (cont'd)

✧ Some more

```
int **x1;           // PTR to (PTR to int)  
int (**x2)[10];    // PTR to (PTR to (10-element ARRAY of int))  
int *(*x3)[10];    // PTR to (PTR to (10-elem ARY of (PTR to int)))
```



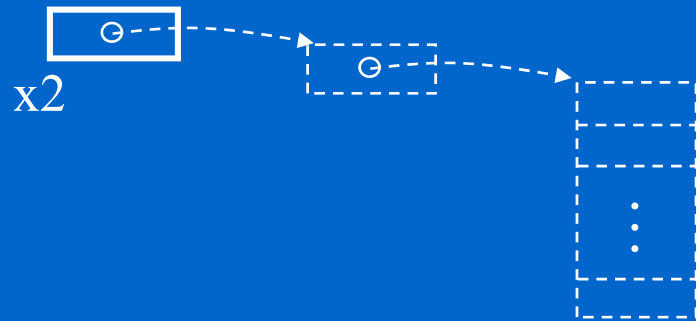
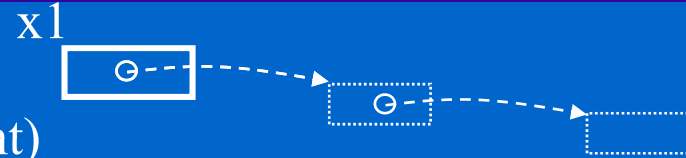
# 陣列與指標型態 (cont'd)

✧ Some more

**int \*\*x1;** // PTR to (PTR to int)

**int (\*\*x2)[10];** // PTR to (PTR to (10-element ARRAY of int))

**int \*(\*x3)[10];** // PTR to (PTR to (10-elem ARY of (PTR to int)))



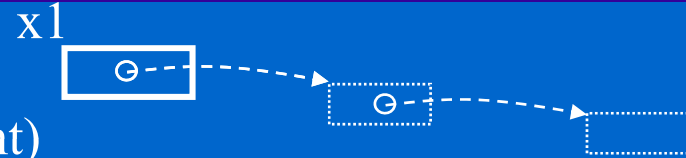
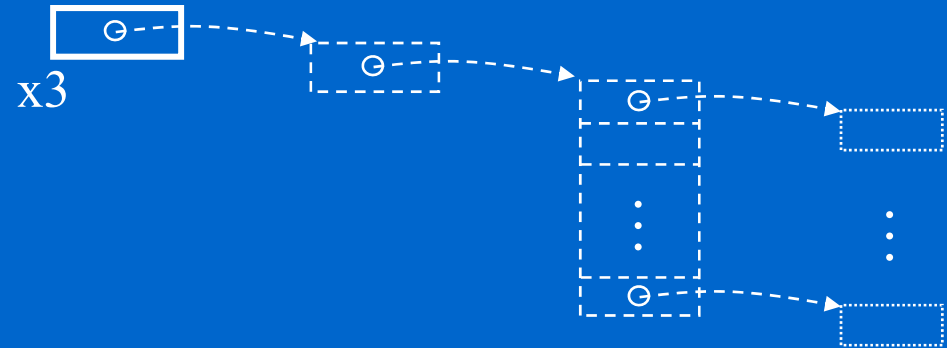
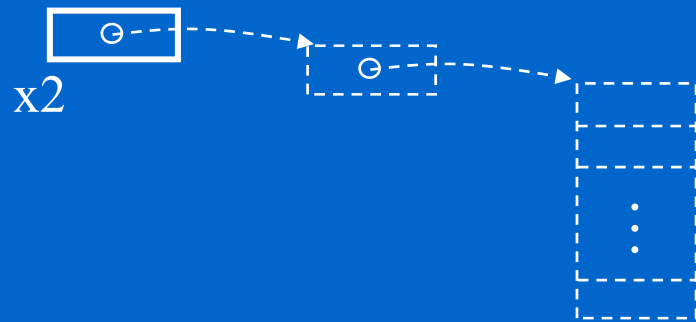
# 陣列與指標型態 (cont'd)

✧ Some more

**int \*\*x1;** // PTR to (PTR to int)

**int (\*\*x2)[10];** // PTR to (PTR to (10-element ARRAY of int))

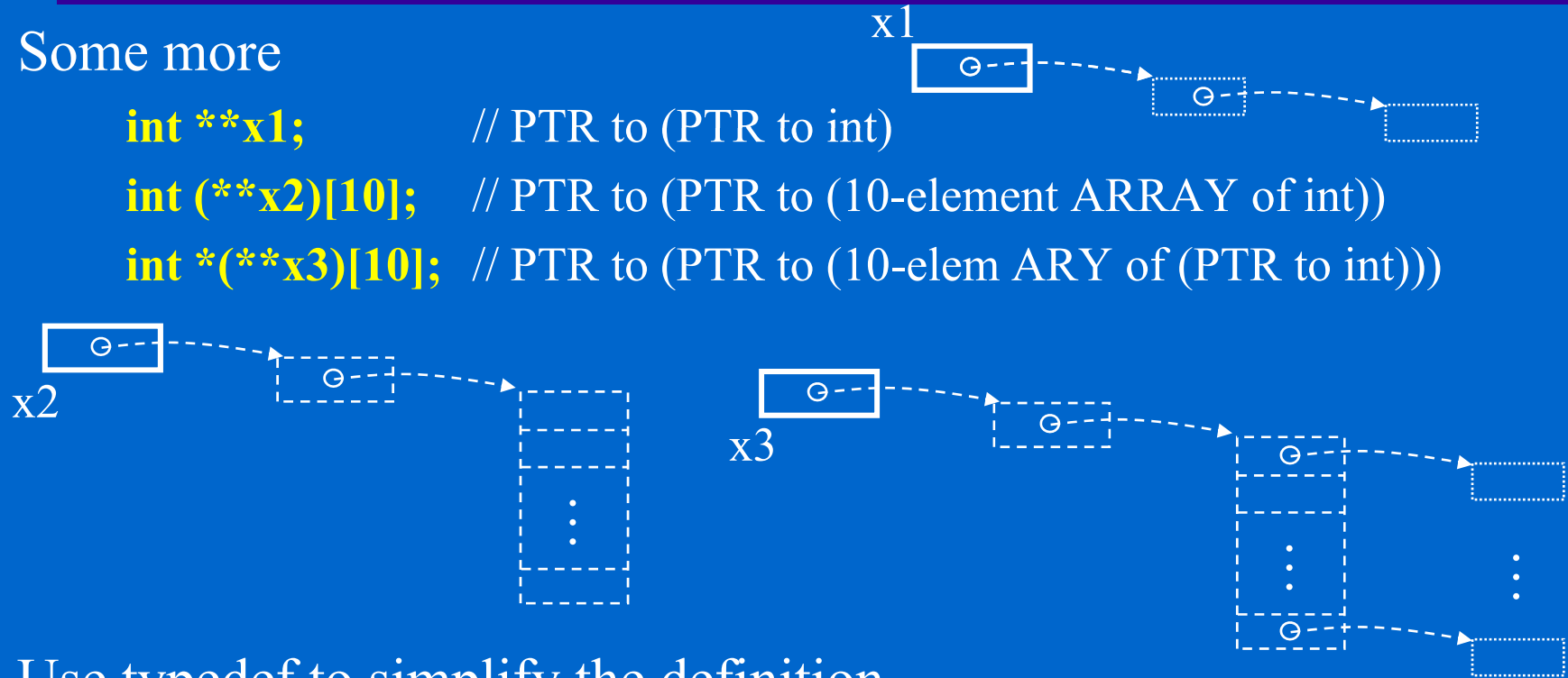
**int (\*\*x3)[10];** // PTR to (PTR to (10-elem ARY of (PTR to int)))



# 陣列與指標型態 (cont'd)

✧ Some more

```
int **x1;           // PTR to (PTR to int)
int (**x2)[10];    // PTR to (PTR to (10-element ARRAY of int))
int (**x3)[10];    // PTR to (PTR to (10-elem ARY of (PTR to int)))
```



✧ Use typedef to simplify the definition

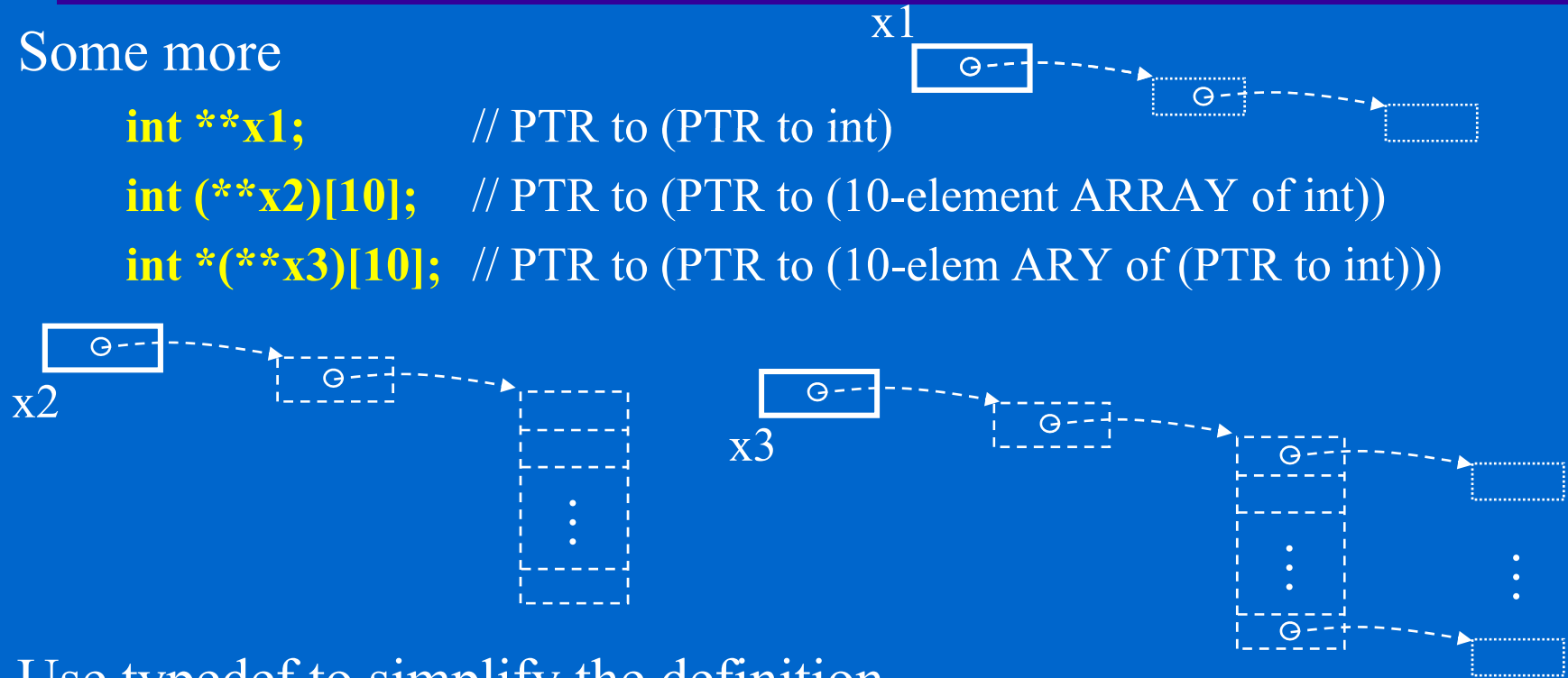
```
typedef int *IPTR;
IPTR *x1;

typedef int IARY[10];
typedef IARY *PTRIARY;
PTRIARY *x2;
```

# 陣列與指標型態 (cont'd)

✧ Some more

```
int **x1;           // PTR to (PTR to int)
int (**x2)[10];    // PTR to (PTR to (10-element ARRAY of int))
int (**x3)[10];    // PTR to (PTR to (10-elem ARY of (PTR to int)))
```



✧ Use typedef to simplify the definition

```
typedef int *IPTR;
IPTR *x1;
typedef int IARY[10];
typedef IARY *PTRIARY;
PTRIARY *x2;
```

```
typedef IPTR IPTRARY[10];
typedef IPTRARY *PTR_IPTRARY;
PTR_IPTRARY *x3;
```

Note: sizeof(x1)=4, sizeof(x2)=4,  
sizeof(x3)=4

# 函式指標型態

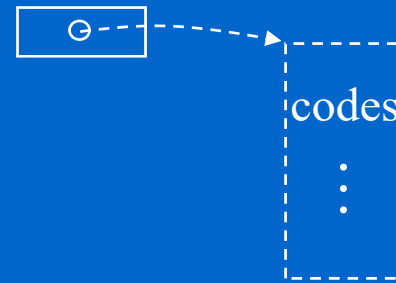
## ❖ Function pointers

**void (\*funcPtr)();** // PTR to a function that takes no argument and returns void

# 函式指標型態

## ❖ Function pointers

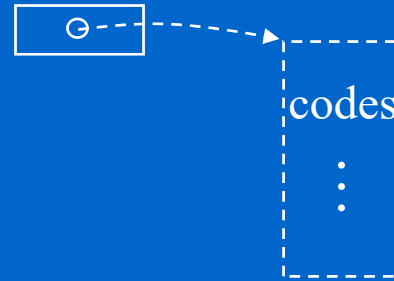
**void (\*funcPtr)();** // PTR to a function that takes no argument and returns void



# 函式指標型態

## ❖ Function pointers

**void (\*funcPtr)();** // PTR to a function that takes no argument and returns void



## ❖ Real example:

**void (\*\*fp)(int, void (\*)(int))(int) = func;**

// fp is a PTR to a function that takes two arguments, an int, (a function pointer that takes one int argument and returns void), and returns (a function pointer that takes one int argument and returns void)

Equivalently,

**typedef void (\*sig\_t)(int);**

**typedef sig\_t (\*FP)(int, sig\_t);**

**FP fp;**



# 陣列與函式指標型態

- ✧ Ex: PTR to a function that takes an int argument and returns a PTR to  
(10-element ARRAY of (PTR to void))

```
void *(*fp1)(int)[10];
```

# 陣列與函式指標型態

- ❖ Ex: PTR to a function that takes an int argument and returns a PTR to  
(10-element ARRAY of (PTR to void))

```
void *(*fp1)(int)[10];
```

- ❖ Ex: PTR to a function that takes three arguments: int, int, float and returns  
(PTR to a function that takes an int argument and returns float)

```
float (*fp2)(int, int, float)(int);
```

# 陣列與函式指標型態

- ❖ Ex: PTR to a function that takes an int argument and returns a PTR to  
(10-element ARRAY of (PTR to void))

```
void *(*fp1)(int)[10];
```

- ❖ Ex: PTR to a function that takes three arguments: int, int, float and returns  
(PTR to a function that takes an int argument and returns float)

```
float *(*fp2)(int, int, float)(int);
```

- ❖ Ex: PTR to a function that takes no argument, returns  
(PTR to (10-element ARRAY of  
(PTR to a function that takes no argument and returns double)))

```
double *(*fp3)() [10]();
```

# 陣列與函式指標型態

- ❖ Ex: PTR to a function that takes an int argument and returns a PTR to  
(10-element ARRAY of (PTR to void))

**void \*(\*fp1)(int))[10];**

- ❖ Ex: PTR to a function that takes three arguments: int, int, float and returns  
(PTR to a function that takes an int argument and returns float)

**float \*(\*fp2)(int, int, float))(int);**

- ❖ Ex: PTR to a function that takes no argument, returns  
(PTR to (10-element ARRAY of  
(PTR to a function that takes no argument and returns double)))

**double \*(\*(\*fp3)())[10])();**

- ❖ Ex: function that takes no argument, returns  
(PTR to (10-element ARRAY of  
(PTR to function that takes no argument and returns int)))

**int>(\*f4())[10]();**

# More Example

Ex. 3-element array of function pointers that takes no argument and returns function pointers that takes no argument and returns nothing

```
void (*(*f1[3])())();
```

# More Example

Ex. 3-element array of function pointers that takes no argument and returns function pointers that takes no argument and returns nothing

```
void (*(*f1[3])0)0;
```

equivalently

```
typedef void (*FP)0;
```

```
typedef FP (*FP2)0;
```

# More Example

Ex. 3-element array of function pointers that takes no argument and returns function pointers that takes no argument and returns nothing

```
void (*(*f1[3])0)0;
```

equivalently

```
typedef void (*FP)();
```

```
typedef FP (*FP2)();
```

```
FP (*f2[3])0;
```

# More Example

Ex. 3-element array of function pointers that takes no argument and returns function pointers that takes no argument and returns nothing

```
void (*(*f1[3])())();
```

equivalently

```
typedef void (*FP)();
```

```
typedef FP (*FP2)();
```

```
FP (*f2[3])();
```

or simply

```
FP2 f3[3];
```



# Example

# Example

```
int main() {
```

# Example

```
int main() {  
    typedef int (*pAry)[5];  
    pAry *b;
```

# Example

```
int main() {  
    typedef int (*pAry)[5];  
    pAry *b;  
    b = (pAry*) malloc(sizeof(pAry));
```

# Example

```
int main() {  
    typedef int (*pAry)[5];  
    pAry *b;  
    b = (pAry*) malloc(sizeof(pAry));  
    //b = (int (**)[5]) malloc(4); // equivalent
```

# Example

```
int main() {  
    typedef int (*pAry)[5];  
    pAry *b;  
    b = (pAry*) malloc(sizeof(pAry));  
    //b = (int (**)[5]) malloc(4); // equivalent
```

```
//b = ((int *)[5]) malloc(4); // syntax error
```

```
//b = (int (*)[5]) malloc(4); // syntax error
```

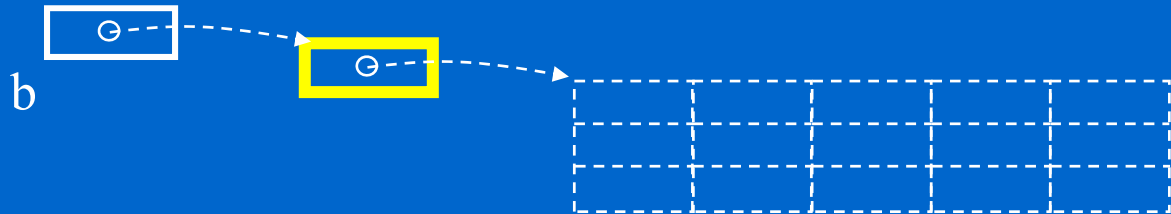
```
//b = (int [5]*) malloc(4); // syntax error
```

```
//b = ((int[5] *) malloc(4); // syntax error
```

```
//b = (int (*[5])) malloc(4); // syntax error
```

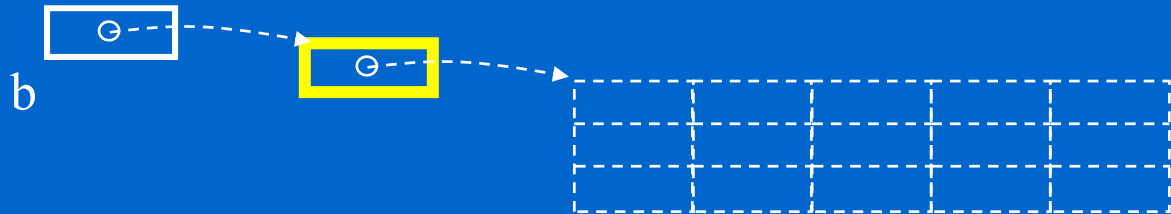
# Example

```
int main() {  
    typedef int (*pAry)[5];  
    pAry *b;  
    b = (pAry*) malloc(sizeof(pAry));  
    //b = (int (**)[5]) malloc(4); // equivalent  
    //b = ((int *)[5]) malloc(4); // syntax error  
    //b = (int (*)[5]) malloc(4); // syntax error  
    //b = (int [5]*) malloc(4); // syntax error  
    //b = ((int[5] *) malloc(4); // syntax error  
    //b = (int (*[5])) malloc(4); // syntax error  
    *b = (pAry) malloc(sizeof(int[3][5]));  
    free(*b);
```



# Example

```
int main() {  
    typedef int (*pAry)[5];  
    pAry *b;  
    b = (pAry*) malloc(sizeof(pAry));  
    //b = (int (**)[5]) malloc(4); // equivalent  
    //b = ((int *)[5]) malloc(4); // syntax error  
    //b = (int (*)[5]) malloc(4); // syntax error  
    //b = (int [5]*) malloc(4); // syntax error  
    //b = ((int[5] *) malloc(4); // syntax error  
    //b = (int (*[5])) malloc(4); // syntax error  
    *b = (pAry) malloc(sizeof(int[3][5]));  
    free(*b);  
    free(b);  
    return 0;  
}
```





# Example

```
int main() {  
    typedef int (*pAry)[5];  
    pAry *b;  
    b = (pAry*) malloc(sizeof(pAry));  
    //b = (int (**)[5]) malloc(4); // equivalent
```

```
//b = ((int *)[5]) malloc(4); // syntax error  
//b = (int (*)[5]) malloc(4); // syntax error  
//b = (int [5]*) malloc(4); // syntax error  
//b = ((int[5] *) malloc(4); // syntax error  
//b = (int (*[5])) malloc(4); // syntax error
```

**(int \*)** is type coercion!!

```
*b = (pAry) malloc(sizeof(int[3][5]));
```

```
free(*b);
```

```
free(b);
```

```
return 0;
```

```
}
```

