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## 1 Basic

### 1.1 ascii

int	char	int	char	int	char
32		64	@	96	`
33	!	65	A	97	a
34	"	66	B	98	b
35	#	67	C	99	c
36	\$	68	D	100	d
37	%	69	E	101	e
38	&	70	F	102	f
39	'	71	G	103	g
40	(	72	H	104	h
41	)	73	I	105	i
42	*	74	J	106	j
43	+	75	K	107	k
44	,	76	L	108	l
45	-	77	M	109	m
46	.	78	N	110	n
47	/	79	O	111	o
48	0	80	P	112	p
49	1	81	Q	113	q
50	2	82	R	114	r
51	3	83	S	115	s
52	4	84	T	116	t
53	5	85	U	117	u
54	6	86	V	118	v
55	7	87	W	119	w
56	8	88	X	120	x
57	9	89	Y	121	y
58	:	90	Z	122	z
59	;	91	[	123	{
60	<	92	\	124	
61	=	93	]	125	}
62	>	94	^	126	~
63	?	95	_		

### 1.2 limits

[Type]	[size]	[range]
char	1	127 to -128
signed char	1	127 to -128
unsigned char	1	0 to 255
short	2	32767 to -32768
int	4	2147483647 to -2147483648
unsigned int	4	0 to 4294967295
long	4	2147483647 to -2147483648
unsigned long	4	0 to 18446744073709551615
long long	8	
	9223372036854775807 to -9223372036854775808	
double	8	1.79769e+308 to 2.22507e-308

13	long double	16	1.18973e+4932 to 3.3621e-4932
14	float	4	3.40282e+38 to 1.17549e-38
15	unsigned long long	8	0 to 18446744073709551615
16	string	32	

### 1.3 algorithm

1	min：取最小值。
2	min(a, b)
3	min(list)
4	max：取最大值。
5	max(a, b)
6	max(list)
7	min_element：找尋最小元素
8	min_element(first, last)
9	max_element：找尋最大元素
10	max_element(first, last)
11	sort：排序，預設由小排到大。
12	sort(first, last)
13	sort(first, last, comp)：可自行定義比較運算子 Comp。
14	find：尋找元素。
15	find(first, last, val)
16	lower_bound：尋找第一個小於 x
17	的元素位置，如果不存在，則回傳 last。
18	lower_bound(first, last, val)
19	upper_bound：尋找第一個大於 x
20	的元素位置，如果不存在，則回傳 last。
21	upper_bound(first, last, val)
22	next_permutation：
23	將序列順序轉換成下一個字典序，如果存在回傳 true
24	，反之回傳 false。
25	next_permutation(first, last)
26	prev_permutation：
27	將序列順序轉換成上一個字典序，如果存在回傳 true
28	，反之回傳 false。
29	prev_permutation(first, last)

### 1.4 graph

1	
2	#include<bits/stdc++.h>
3	using namespace std;
4	
5	class Node {
6	public:
7	int val;
8	vector<Node*> children;
9	
10	Node() {}
11	
12	Node(int _val) {
13	val = _val;
14	}
15	
16	Node(int _val, vector<Node*> _children) {
17	val = _val;
18	children = _children;
19	}
20	};
21	
22	struct ListNode {
23	int val;
24	ListNode *next;
25	ListNode() : val(0), next(nullptr) {}
26	ListNode(int x) : val(x), next(nullptr) {}
27	ListNode(int x, ListNode *next) : val(x),
28	next(next) {}
29	};
30	
31	struct TreeNode {
32	int val;
33	TreeNode *left;

```

33     TreeNode *right;
34     TreeNode() : val(0), left(nullptr),
35                 right(nullptr) {}
36     TreeNode(int x) : val(x), left(nullptr),
37                     right(nullptr) {}
38     TreeNode(int x, TreeNode *left, TreeNode *right)
39         : val(x), left(left), right(right) {}
40 };
41
42 class ListProblem {
43     vector<int> nums={};
44 public:
45     void solve() {
46         return;
47     }
48
49     ListNode* buildList(int idx) {
50         if(idx == nums.size()) return NULL;
51         ListNode *current=new
52             ListNode(nums[idx++],current->next);
53         return current;
54     }
55
56     void deleteList(ListNode* root) {
57         if(root == NULL) return;
58         deleteList(root->next);
59         delete root;
60         return;
61     }
62 };
63
64 class TreeProblem {
65     int null = INT_MIN;
66     vector<int> nums = {}, result;
67 public:
68     void solve() {
69         return;
70     }
71
72     TreeNode* buildBinaryTreeUsingDFS(int left, int
73         right) {
74         if((left > right) || (nums[(left+right)/2] ==
75             null)) return NULL;
76         int mid = (left+right)/2;
77         TreeNode* current = new TreeNode(
78             nums[mid],
79             buildBinaryTreeUsingDFS(left,mid-1),
80             buildBinaryTreeUsingDFS(mid+1,right));
81         return current;
82     }
83
84     TreeNode* buildBinaryTreeUsingBFS() {
85         int idx = 0;
86         TreeNode* root = new TreeNode(nums[idx++]);
87         queue<TreeNode*> q;
88         q.push(root);
89         while(idx < nums.size()) {
90             if(nums[idx] != null) {
91                 TreeNode* left = new
92                     TreeNode(nums[idx]);
93                 q.front()->left = left;
94                 q.push(left);
95             }
96             idx++;
97             if((idx < nums.size()) && (nums[idx] !=
98                 null)) {
99                 TreeNode* right = new
100                     TreeNode(nums[idx]);
101                 q.front()->right = right;
102                 q.push(right);
103             }
104             idx++;
105             q.pop();
106         }
107         return root;
108     }
109 }

```

```

101
102 Node* buildNaryTree() {
103     int idx = 2;
104     Node *root = new Node(nums.front());
105     queue<Node*> q;
106     q.push(root);
107     while(idx < nums.size()) {
108         while((idx < nums.size()) && (nums[idx]
109             != null)) {
110             Node *current = new Node(nums[idx++]);
111             q.front()->children.push_back(current);
112             q.push(current);
113         }
114         idx++;
115         q.pop();
116     }
117     return root;
118 }
119
120 void deleteBinaryTree(TreeNode* root) {
121     if(root->left != NULL)
122         deleteBinaryTree(root->left);
123     if(root->right != NULL)
124         deleteBinaryTree(root->right);
125     delete root;
126     return;
127 }
128
129 void deleteNaryTree(Node* root) {
130     if(root == NULL) return;
131     for(int i=0; i<root->children.size(); i++) {
132         deleteNaryTree(root->children[i]);
133         delete root->children[i];
134     }
135     delete root;
136     return;
137 }
138
139 void inorderTraversal(TreeNode* root) {
140     if(root == NULL) return;
141     inorderTraversal(root->left);
142     cout<<root->val<< ' ';
143     inorderTraversal(root->right);
144     return;
145 }
146
147 int main() {
148     return 0;
149 }

```

## 2 STL

### 2.1 priority\_queue

```

1 priority_queue <int> pq; //宣告
2
3 pq.push(x);
4
5 x = pq.top();
6 pq.pop(); //讀取後刪除
7
8 pq.empty() //回傳 true
9 pq.size() //回傳 0
10
11 priority_queue<T> pq; //預設由大到小
12 priority_queue<T, vector<T>, greater<T>> pq;
13 //改成由小到大
14 priority_queue<T, vector<T>, cmp> pq; //cmp

```

## 2.2 map

```

1 map：存放 key-value pairs 的映射資料結構，會按 key
  由小到大排序。
2 元素存取
3 operator[]：存取指定的[i]元素的資料
4
5 迭代器
6 begin()：回傳指向map頭部元素的迭代器
7 end()：回傳指向map末尾的迭代器
8 rbegin()：回傳一個指向map尾部的反向迭代器
9 rend()：回傳一個指向map頭部的反向迭代器
10
11 遍歷整個map時，利用iterator操作：
12 取key：it->first 或 (*it).first
13 取value：it->second 或 (*it).second
14
15 容量
16 empty()：檢查容器是否為空，空則回傳true
17 size()：回傳元素數量
18 max_size()：回傳可以容納的最大元素個數
19
20 修改器
21 clear()：刪除所有元素
22 insert()：插入元素
23 erase()：刪除一個元素
24 swap()：交換兩個map
25
26 查找
27 count()：回傳指定元素出現的次數
28 find()：查找一個元素
29
30
31 #include <bits/stdc++.h>
32 using namespace std;
33
34 int main(){
35
36     //declaration container and iterator
37     map<string, string> mp;
38     map<string, string>::iterator iter;
39     map<string, string>::reverse_iterator iter_r;
40
41     //insert element
42     mp.insert(pair<string, string>("r000",
43     "student_zero"));
44
45     mp["r123"] = "student_first";
46     mp["r456"] = "student_second";
47
48     //traversal
49     for(iter = mp.begin(); iter != mp.end(); iter++)
50         cout<<iter->first<<" "<<iter->second<<endl;
51     for(iter_r = mp.rbegin(); iter_r != mp.rend();
52         iter_r++)
53         cout<<iter_r->first<<"
54         "<<iter_r->second<<endl;
55
56     //find and erase the element
57     iter = mp.find("r123");
58     mp.erase(iter);
59
60     iter = mp.find("r123");
61
62     if(iter != mp.end())
63         cout<<"Find, the value is
64         "<<iter->second<<endl;
65     else
66         cout<<"Do not Find"<<endl;
67
68     return 0;
69 }

```

## 2.3 unordered\_map

```

1 unordered_map：存放 key-value pairs
  的「無序」映射資料結構。
2 用法與map相同

```

## 3 sort

### 3.1 big number sort

```

1 while True:
2     try:
3         n = int(input())          # 有幾筆數字需要排序
4         arr = []                  # 建立空串列
5         for i in range(n):
6             arr.append(int(input())) # 依序將數字存入串列
7         arr.sort()                 # 串列排序
8         for i in arr:
9             print(i)               #
10            依序印出串列中每個項目
11     except:
12         break

```

### 3.2 bubble sort

```

1 #include <bits/stdc++.h>
2 using namespace std;
3
4 int main() {
5     int n;
6     cin>>n;
7     int a[n], tmp;
8     for(int i=0; i<n; i++) cin>>a[i];
9     for(int i=n-1; i>0; i--) {
10         for(int j=0; j<=i-1; j++) {
11             if( a[j]>a[j+1]) {
12                 tmp=a[j];
13                 a[j]=a[j+1];
14                 a[j+1]=tmp;
15             }
16         }
17     }
18     for(int i=0; i<n; i++) cout<<a[i]<<" ";
19 }

```

## 4 math

### 4.1 prime factorization

```

1 #include <bits/stdc++.h>
2 using namespace std;
3
4 int main() {
5     int n;
6     while(true) {
7         cin>>n;
8         for(int x=2; x<=n; x++) {
9             while(n%x==0) {
10                 cout<<x<<"*";
11                 n/=x;
12             }
13         }
14         cout<<"\b \n";
15     }
16     system("pause");
17     return 0;
18 }

```

## 5 Section2

### 5.1 thm

- 中文測試

- $\sum_{i=1}^n i^2 = \frac{n(n+1)(2n+1)}{6}$