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# Chapter 1

## Rubric

Question	Points
Question 1	10
Question 2	10
Question 3	10
Question 4	10
Question 5	10
<b>commonLetters</b>	
Test Cases	$1 \times 15$
Compilation	10
<b>commonLetters Total</b>	25
<b>printPermutations</b>	
Test Cases	$1 \times 15$
Compilation	10
<b>printPermutations Total</b>	25
Total	100

# Chapter 2

## Metadata

### 2.1 Submitted Files

				handin.time		
1	09/17/2019	11:49:24	fsandhu:	csce310h0mework01part01.cpp		- OK
2	09/17/2019	11:49:27	fsandhu:	csce310h0mework01part01.h	- OK	
3	09/17/2019	11:54:35	fsandhu:	csce310h0mework01part01.cpp		- OK
4	09/17/2019	11:56:08	fsandhu:	csce310h0mework01part01.cpp		- OK
5	09/17/2019	11:57:45	fsandhu:	csce310h0mework01part01.cpp		- OK
6	09/17/2019	12:01:31	fsandhu:	csce310h0mework01part01.cpp		- OK
7	09/17/2019	12:03:15	fsandhu:	csce310h0mework01part01.cpp		- OK
8	09/17/2019	14:25:16	fsandhu:	csce310h0mework01part02.cpp		- OK
9	09/17/2019	14:25:19	fsandhu:	csce310h0mework01part02.h	- OK	
10	09/17/2019	14:26:23	fsandhu:	csce310h0mework01part02.cpp		- OK
11	09/17/2019	14:32:42	fsandhu:	csce310h0mework01part02.cpp		- OK
12	09/17/2019	14:33:06	fsandhu:	csce310h0mework01part02.cpp		- OK
13	09/17/2019	15:31:37	fsandhu:	csce310h0mework01part02.cpp		- OK
14	09/17/2019	16:27:01	fsandhu:	csce310h0mework01part02.cpp		- OK
15	09/17/2019	16:36:56	fsandhu:	csce310h0mework01part02.cpp		- OK
16	09/17/2019	16:45:25	fsandhu:	csce310h0mework01part02.cpp		- OK
17	09/17/2019	16:47:13	fsandhu:	csce310h0mework01part02.cpp		- OK
18	09/17/2019	16:58:04	fsandhu:	csce310h0mework01part02.cpp		- OK
19	09/17/2019	17:01:58	fsandhu:	csce310h0mework01part02.cpp		- OK
20	09/17/2019	17:11:58	fsandhu:	csce310h0mework01part02.cpp		- OK
21	09/17/2019	18:39:20	fsandhu:	csce310h0mework01part02.cpp		- OK
22	09/17/2019	18:41:50	fsandhu:	csce310h0mework01part01.cpp		- OK
23	09/17/2019	18:45:19	fsandhu:	csce310h0mework01part01.cpp		- OK
24	09/18/2019	11:13:26	fsandhu:	csce310h0mework01part01.cpp		- OK
25	09/18/2019	11:13:41	fsandhu:	csce310h0mework01part01.cpp		- OK
26	09/18/2019	11:13:43	fsandhu:	csce310h0mework01part02.cpp		- OK
27	09/18/2019	19:21:59	fsandhu:	csce310hw1.pdf	- OK	

### 2.2 webgrader Runs

				webgrader.time
1	2019-09-17T11:49:58-0500	10.43.39.129	fsandhu	001
2	2019-09-17T11:54:40-0500	10.43.39.129	fsandhu	001
3	2019-09-17T11:56:10-0500	10.43.39.129	fsandhu	001
4	2019-09-17T11:57:47-0500	10.43.39.129	fsandhu	001
5	2019-09-17T12:01:34-0500	10.43.39.129	fsandhu	001
6	2019-09-17T12:03:18-0500	10.43.39.129	fsandhu	001
7	2019-09-17T14:15:02-0500	10.43.39.129	fsandhu	001
8	2019-09-17T14:25:22-0500	10.43.39.129	fsandhu	001
9	2019-09-17T14:26:27-0500	10.43.39.129	fsandhu	001

10	2019-09-17T14:33:12-0500	10.43.39.129	fsandhu	001
11	2019-09-17T16:27:25-0500	10.43.39.129	fsandhu	001
12	2019-09-17T16:37:01-0500	10.43.39.129	fsandhu	001
13	2019-09-17T16:45:28-0500	10.43.39.129	fsandhu	001
14	2019-09-17T16:58:06-0500	10.43.39.129	fsandhu	001
15	2019-09-17T17:02:06-0500	10.43.39.129	fsandhu	001
16	2019-09-17T17:12:26-0500	10.43.39.129	fsandhu	001
17	2019-09-17T18:39:49-0500	76.84.50.181	fsandhu	001
18	2019-09-17T18:41:52-0500	76.84.50.181	fsandhu	001
19	2019-09-18T11:13:34-0500	10.43.39.129	fsandhu	001
20	2019-09-18T11:13:46-0500	10.43.39.129	fsandhu	001
21	2019-09-18T11:21:30-0500	10.43.39.129	fsandhu	001
22	2019-09-18T19:22:18-0500	76.84.50.181	fsandhu	001
23	2019-09-26T13:34:23-0500	10.43.1.171	fsandhu	002
24	2019-09-26T13:35:36-0500	10.43.1.171	fsandhu	002
25	2019-09-26T13:43:13-0500	10.43.1.171	fsandhu	002
26	2019-09-26T13:45:44-0500	10.43.1.171	fsandhu	002
27	2019-09-26T13:47:18-0500	10.43.1.171	fsandhu	002
28	2019-09-26T13:47:24-0500	10.43.1.171	fsandhu	002
29	2019-09-26T14:40:16-0500	10.43.1.171	fsandhu	002
30	2019-09-26T14:44:07-0500	10.43.1.171	fsandhu	002
31	2019-09-26T14:53:07-0500	10.43.1.171	fsandhu	002
32	2019-09-26T14:54:37-0500	10.43.1.171	fsandhu	002
33	2019-09-26T14:56:24-0500	10.43.1.171	fsandhu	002
34	2019-09-26T14:57:58-0500	10.43.1.171	fsandhu	002
35	2019-09-26T15:08:12-0500	10.43.1.171	fsandhu	002
36	2019-09-26T15:15:34-0500	10.43.1.171	fsandhu	002
37	2019-09-26T20:25:20-0500	76.84.50.181	fsandhu	002
38	2019-09-26T20:27:33-0500	76.84.50.181	fsandhu	002
39	2019-09-26T20:33:39-0500	76.84.50.181	fsandhu	002
40	2019-09-26T20:33:56-0500	76.84.50.181	fsandhu	002
41	2019-09-26T21:04:25-0500	76.84.50.181	fsandhu	002
42	2019-09-26T21:06:27-0500	76.84.50.181	fsandhu	002
43	2019-09-26T21:06:59-0500	76.84.50.181	fsandhu	002
44	2019-09-27T10:44:39-0500	10.43.118.108	fsandhu	002
45	2019-09-28T01:12:11-0500	97.98.163.171	fsandhu	002
46	2019-09-28T01:13:02-0500	97.98.163.171	fsandhu	002
47	2019-09-28T01:14:19-0500	97.98.163.171	fsandhu	002
48	2019-09-28T01:30:05-0500	97.98.163.171	fsandhu	002
49	2019-09-28T01:32:23-0500	97.98.163.171	fsandhu	002
50	2019-09-28T01:33:50-0500	97.98.163.171	fsandhu	002
51	2019-09-28T01:45:49-0500	97.98.163.171	fsandhu	002
52	2019-09-28T01:47:29-0500	97.98.163.171	fsandhu	002
53	2019-09-28T01:51:27-0500	97.98.163.171	fsandhu	002
54	2019-09-28T01:52:42-0500	97.98.163.171	fsandhu	002
55	2019-09-28T01:56:42-0500	97.98.163.171	fsandhu	002
56	2019-09-28T01:58:07-0500	97.98.163.171	fsandhu	002
57	2019-09-28T01:58:21-0500	97.98.163.171	fsandhu	002
58	2019-09-28T02:04:07-0500	97.98.163.171	fsandhu	002
59	2019-09-30T13:50:40-0500	10.43.63.145	fsandhu	002
60	2019-10-01T14:16:19-0500	10.43.114.9	fsandhu	002
61	2019-10-01T14:16:53-0500	10.43.114.9	fsandhu	002
62	2019-10-01T14:33:44-0500	10.43.114.9	fsandhu	002
63	2019-10-08T14:50:16-0500	10.43.23.54	fsandhu	002
64	2019-10-08T14:51:02-0500	10.43.23.54	fsandhu	002
65	2019-10-08T14:51:54-0500	10.43.23.54	fsandhu	002
66	2019-10-08T14:59:55-0500	10.43.23.54	fsandhu	002
67	2019-10-08T15:00:17-0500	10.43.23.54	fsandhu	002
68	2019-10-08T15:00:30-0500	10.43.23.54	fsandhu	002
69	2019-10-08T15:00:45-0500	10.43.23.54	fsandhu	002

70	2019-10-08T15:01:09-0500	10.43.23.54	fsandhu 002
71	2019-10-08T15:02:46-0500	10.43.23.54	fsandhu 002
72	2019-10-08T15:03:00-0500	10.43.23.54	fsandhu 002
73	2019-10-08T15:03:22-0500	10.43.23.54	fsandhu 002
74	2019-10-08T15:04:08-0500	10.43.23.54	fsandhu 002
75	2019-10-08T15:04:21-0500	10.43.23.54	fsandhu 002
76	2019-10-09T14:28:00-0500	10.43.67.76	fsandhu 002
77	2019-10-09T14:28:54-0500	10.43.67.76	fsandhu 002
78	2019-10-09T18:33:45-0500	76.84.50.181	fsandhu 002
79	2019-10-09T18:34:28-0500	76.84.50.181	fsandhu 002
80	2019-10-09T18:34:55-0500	76.84.50.181	fsandhu 002
81	2019-10-09T20:33:02-0500	76.84.50.181	fsandhu 002
82	2019-10-09T21:25:44-0500	76.84.50.181	fsandhu 002
83	2019-10-11T10:37:53-0500	10.43.47.170	fsandhu 002
84	2019-10-26T20:26:12-0500	97.98.163.171	fsandhu 003
85	2019-10-26T20:33:05-0500	97.98.163.171	fsandhu 003
86	2019-10-26T20:35:03-0500	97.98.163.171	fsandhu 003
87	2019-10-26T20:36:27-0500	97.98.163.171	fsandhu 003
88	2019-10-26T20:38:11-0500	97.98.163.171	fsandhu 003
89	2019-10-26T20:38:46-0500	97.98.163.171	fsandhu 003
90	2019-10-26T20:39:09-0500	97.98.163.171	fsandhu 003
91	2019-10-26T20:39:47-0500	97.98.163.171	fsandhu 003
92	2019-10-26T20:39:56-0500	97.98.163.171	fsandhu 003
93	2019-10-26T20:41:14-0500	97.98.163.171	fsandhu 003
94	2019-10-26T20:42:29-0500	97.98.163.171	fsandhu 003
95	2019-10-26T20:43:37-0500	97.98.163.171	fsandhu 003
96	2019-10-26T20:46:34-0500	97.98.163.171	fsandhu 003
97	2019-10-26T20:47:55-0500	97.98.163.171	fsandhu 003
98	2019-10-26T20:51:31-0500	97.98.163.171	fsandhu 003
99	2019-10-26T21:30:15-0500	97.98.163.171	fsandhu 003
100	2019-10-26T21:30:28-0500	97.98.163.171	fsandhu 003
101	2019-10-26T21:32:10-0500	97.98.163.171	fsandhu 003
102	2019-10-26T21:33:13-0500	97.98.163.171	fsandhu 003
103	2019-10-26T21:33:44-0500	97.98.163.171	fsandhu 003
104	2019-10-26T21:39:25-0500	97.98.163.171	fsandhu 003
105	2019-10-28T14:06:38-0500	10.43.86.250	fsandhu 003
106	2019-10-29T13:37:17-0500	10.43.43.198	fsandhu 003
107	2019-10-29T14:05:47-0500	10.43.43.198	fsandhu 003
108	2019-10-29T14:08:52-0500	10.43.43.198	fsandhu 003
109	2019-10-29T14:09:19-0500	10.43.43.198	fsandhu 003
110	2019-10-29T14:10:06-0500	10.43.43.198	fsandhu 003
111	2019-10-29T14:13:57-0500	10.43.43.198	fsandhu 003
112	2019-10-29T14:30:58-0500	10.43.43.198	fsandhu 003
113	2019-10-29T15:02:20-0500	10.43.43.198	fsandhu 003
114	2019-10-29T15:02:59-0500	10.43.43.198	fsandhu 003
115	2019-10-29T15:04:02-0500	10.43.43.198	fsandhu 003
116	2019-10-29T15:15:15-0500	10.43.43.198	fsandhu 003
117	2019-10-29T15:16:10-0500	10.43.43.198	fsandhu 003
118	2019-10-29T15:18:33-0500	10.43.43.198	fsandhu 003
119	2019-10-29T15:21:25-0500	10.43.43.198	fsandhu 003
120	2019-10-29T15:22:49-0500	10.43.43.198	fsandhu 003
121	2019-10-29T15:31:28-0500	10.43.43.198	fsandhu 003
122	2019-10-30T13:29:50-0500	10.43.107.14	fsandhu 003
123	2019-10-30T13:44:54-0500	10.43.107.14	fsandhu 003
124	2019-10-30T13:45:54-0500	10.43.107.14	fsandhu 003
125	2019-10-30T13:48:13-0500	10.43.107.14	fsandhu 003
126	2019-10-30T13:48:51-0500	10.43.107.14	fsandhu 003
127	2019-10-30T13:52:51-0500	10.43.107.14	fsandhu 003
128	2019-10-30T13:53:53-0500	10.43.107.14	fsandhu 003
129	2019-10-30T13:57:10-0500	10.43.107.14	fsandhu 003



130	2019-10-30T13:58:09-0500	10.43.107.14	fsandhu	003
131	2019-10-30T14:01:02-0500	10.43.107.14	fsandhu	003
132	2019-10-30T14:02:31-0500	10.43.107.14	fsandhu	003
133	2019-10-30T14:02:41-0500	10.43.107.14	fsandhu	003
134	2019-10-30T14:26:41-0500	10.43.107.14	fsandhu	003
135	2019-10-30T14:28:17-0500	10.43.107.14	fsandhu	003
136	2019-10-30T14:39:01-0500	10.43.107.14	fsandhu	003
137	2019-10-30T14:40:10-0500	10.43.107.14	fsandhu	003
138	2019-10-30T14:40:31-0500	10.43.107.14	fsandhu	003
139	2019-10-30T14:41:12-0500	10.43.107.14	fsandhu	003
140	2019-10-30T14:43:26-0500	10.43.107.14	fsandhu	003
141	2019-10-30T14:47:32-0500	10.43.107.14	fsandhu	003
142	2019-10-30T14:55:46-0500	10.43.107.14	fsandhu	003
143	2019-10-30T15:02:05-0500	10.43.107.14	fsandhu	003
144	2019-10-30T15:04:13-0500	10.43.107.14	fsandhu	003
145	2019-10-30T15:13:06-0500	10.43.107.14	fsandhu	003
146	2019-10-30T15:22:55-0500	10.43.107.14	fsandhu	003
147	2019-10-30T15:23:59-0500	10.43.107.14	fsandhu	003
148	2019-10-30T15:24:35-0500	10.43.107.14	fsandhu	003
149	2019-10-30T15:24:52-0500	10.43.107.14	fsandhu	003
150	2019-10-30T15:26:45-0500	10.43.107.14	fsandhu	003
151	2019-10-30T15:30:46-0500	10.43.107.14	fsandhu	003
152	2019-10-30T18:57:24-0500	76.84.50.181	fsandhu	003
153	2019-10-30T21:28:00-0500	76.84.50.181	fsandhu	003
154	2019-11-13T18:13:09-0600	76.84.50.181	fsandhu	004
155	2019-11-13T18:40:48-0600	76.84.50.181	fsandhu	004
156	2019-11-13T18:50:19-0600	76.84.50.181	fsandhu	004
157	2019-11-13T18:51:51-0600	76.84.50.181	fsandhu	004
158	2019-11-18T18:13:52-0600	10.43.83.198	fsandhu	004
159	2019-11-18T18:18:05-0600	10.43.83.198	fsandhu	004
160	2019-11-18T18:21:25-0600	10.43.83.198	fsandhu	004
161	2019-11-18T18:22:07-0600	10.43.83.198	fsandhu	004
162	2019-11-18T18:35:40-0600	10.43.83.198	fsandhu	004
163	2019-11-18T18:35:46-0600	10.43.83.198	fsandhu	004
164	2019-11-18T18:38:02-0600	10.43.83.198	fsandhu	004
165	2019-11-18T18:38:07-0600	10.43.83.198	fsandhu	004
166	2019-11-18T18:39:24-0600	10.43.83.198	fsandhu	004
167	2019-11-18T18:39:29-0600	10.43.83.198	fsandhu	004
168	2019-11-18T18:42:10-0600	10.43.83.198	fsandhu	004
169	2019-11-18T18:42:16-0600	10.43.83.198	fsandhu	004
170	2019-11-18T19:07:37-0600	10.43.83.198	fsandhu	004
171	2019-11-18T19:07:43-0600	10.43.83.198	fsandhu	004
172	2019-11-18T19:14:00-0600	10.43.83.198	fsandhu	004
173	2019-11-18T19:24:28-0600	10.43.83.198	fsandhu	004
174	2019-11-18T19:24:52-0600	10.43.83.198	fsandhu	004
175	2019-11-18T19:25:16-0600	10.43.83.198	fsandhu	004
176	2019-11-18T19:26:46-0600	10.43.83.198	fsandhu	004
177	2019-11-18T19:26:55-0600	10.43.83.198	fsandhu	004
178	2019-11-19T13:23:54-0600	10.43.73.242	fsandhu	004
179	2019-11-19T13:46:21-0600	10.43.73.242	fsandhu	004
180	2019-11-19T13:46:29-0600	10.43.73.242	fsandhu	004
181	2019-11-19T13:48:01-0600	10.43.73.242	fsandhu	004
182	2019-11-19T13:48:07-0600	10.43.73.242	fsandhu	004
183	2019-11-19T14:05:18-0600	10.43.73.242	fsandhu	004
184	2019-11-19T14:05:56-0600	10.43.73.242	fsandhu	004
185	2019-11-19T14:06:30-0600	10.43.73.242	fsandhu	004
186	2019-11-19T14:06:36-0600	10.43.73.242	fsandhu	004
187	2019-11-19T15:36:30-0600	10.43.73.242	fsandhu	004
188	2019-11-19T15:43:52-0600	10.43.73.242	fsandhu	004
189	2019-11-19T15:43:58-0600	10.43.73.242	fsandhu	004

```

190 2019-11-21T22:02:49-0600 76.84.50.181 fsandhu 004
191 2019-12-05T12:25:31-0600 10.43.86.40 fsandhu 005
192 2019-12-05T12:34:39-0600 10.43.86.40 fsandhu 005
193 2019-12-05T12:34:55-0600 10.43.86.40 fsandhu 005
194 2019-12-05T12:37:45-0600 10.43.86.40 fsandhu 005
195 2019-12-05T14:31:24-0600 10.43.86.40 fsandhu 005
196 2019-12-05T14:35:55-0600 10.43.86.40 fsandhu 005
197 2019-12-05T14:36:16-0600 10.43.86.40 fsandhu 005
198 2019-12-09T16:27:15-0600 10.43.32.151 fsandhu 005
199 2019-12-09T16:30:12-0600 10.43.32.151 fsandhu 005
200 2019-12-09T19:03:06-0600 10.43.32.151 fsandhu 005
201 2019-12-10T19:02:29-0600 76.84.50.181 fsandhu 005
202 2019-12-15T19:52:02-0600 76.84.219.87 fsandhu 001

```

## 2.3 diffs

submission.diffs

## Chapter 3

### Written Exercises

# CSCE 310 Homework 01

Fateh Karen Singh Sandhu

17286643

Q1) Gaussian elimination

$$T(n) = \frac{1}{3} n^3$$

this algorithm will be  $O(n^3)$ .

2).  $30 = 3(10)$ . If  $n = 10$   $30 = 3n$ .

$$T(n) = \frac{1}{3} n^3$$

$$T(3n) = \frac{1}{3} (3n)^3$$

$$= \frac{1}{3} \cdot 27(n^3)$$

$$= 27 \left[ \frac{1}{3} n^3 \right]$$

the algorithm will approximately take 27 times longer to run 30 equations than it would take 10 equations to run.

b) If  $C$  is the time taken for one calculation on the old computer, time taken on new computer  $= \frac{1}{8} C = \frac{1}{2^3} C$ .

If we equate time taken to run  $n$  equations on both old and new computers, we get:

$$T_{\text{old}}(n) = \frac{1}{3} n^3 \cdot C$$

$$T_{\text{new}}(N) = \frac{1}{3} (N^3) \cdot \frac{1}{2^3} C$$

$$= \frac{1}{3} (N^3) 2^{-3} C$$

$$\frac{T(N)}{T(n)} = \frac{\cancel{\left(\frac{1}{3}\right)} N^3 2^{-3} \cancel{C}}{\cancel{\left(\frac{1}{3}\right)} n^3 \cancel{C}} \Rightarrow \frac{N^3}{n^3} = \frac{1}{2^{-3}}$$

$$\Rightarrow \left(\frac{N}{n}\right)^3 = 2^{+3}$$

$$\Rightarrow \frac{N}{n} = \sqrt[3]{2^3}$$

$$\frac{N}{n} = 2$$

The new computer will be faster by a factor of 2.

Q2)

a)  $n(n+1) \Rightarrow O(n^2)$

$2000 n^2 \Rightarrow O(n^2)$

same order of growth.

b)  $100 n^2$

$0.01 n^3$

$O(n^2)(100 n^2) < (0.01 n^3)$

order of growth.

$O(n)^3$

c)  $\log_2(n) \Rightarrow O(\log n)$

$\ln(n) \Rightarrow O(\log n)$  same order of growth.

d)  $\log_2^2 n$

$\log_2 n^2$

$O(\log_2^2 n) > O(\log_2 n^2)$

order of growth

e)  $2^{n-1} \Rightarrow O(2^n)$

$2^n \Rightarrow O(2^n)$

same order of growth.

f)  $(n-1)!$

$n!$

$O(n-1)! > O(n!)$

order of growth

Q3)

$$2) \quad x(n) = x(n-1) + 8 \quad x(1) = 9$$

$$= (x(n-2) + 8) + 8$$

$$= (x(n-3) + 8) + 8 + 8$$

...

$$= x(n-i) + 8i$$

...

$$n-i = 1$$

$$= x(n-(n-1)) + 8(n-1) \quad i = n-1$$

$$= x(n-n+1) + 8n - 8$$

$$= x(1) + 8n - 8$$

$$= 8n - 8 + 9$$

$$= 8n + 1$$

$$b) \quad x(n) = 3x(n-1) + 1$$

$$x(0) = 4$$

$$x(1) = 3x(0) + 1$$

$$\begin{aligned} x(2) &= 3x(1) + 1 \\ &= 3^2x(0) + 3^1 + 1 \end{aligned}$$

$$\begin{aligned} x(3) &= 3x(2) + 1 \\ &= 3^3x(0) + 3^2 + 3^1 + 1 \end{aligned}$$

⋮

$$\begin{aligned} x(n) &= 3^n x(0) + 3^{n-1} + 3^{n-2} + \dots + 3^1 + 1 \\ &= 4 \cdot 3^n + (1 + 3 + 3^2 + 3^3 + \dots + 3^{n-1}) \\ &= 4 \cdot 3^n + \frac{3^n - 1}{2} \end{aligned}$$



$$c) \quad x(n) = x(n-1) + n^2 \quad x(0) = 3$$

$$x(1) = x(0) + 1^2$$

$$\begin{aligned} x(2) &= x(1) + 2^2 \\ &= x(0) + 1^2 + 2^2 \end{aligned}$$

$$\begin{aligned} x(3) &= x(2) + 3^2 \\ &= x(0) + 1^2 + 2^2 + 3^2 \end{aligned}$$

⋮

$$x(n) = x(0) + 1^2 + 2^2 + 3^2 + \dots + n^2$$

$$= 3 + \left[ \frac{n(n+1)(2n+1)}{6} \right]$$

$$\approx 3 + \frac{1}{3} n^3$$

$$d) \quad x(n) = x\left(\frac{n}{2}\right) + 9n \quad \text{for } n > 1 \quad x(1) = 6$$

$$n = 2^k$$

$$x(2^k) = x(2^{k-1}) + 9(2^k)$$

$$= x(2^{k-2}) + 9(2^{k-1}) + 9(2^k)$$

$$= x(2^{k-3}) + 9(2^{k-2}) + 9(2^{k-1}) + 9(2^k)$$

⋮

$$= x(2^{k-k}) + 9(2^{k-(k-1)} + \dots + 2^k)$$

$$= x(1) + 9(2^1 + 2^2 + 2^3 + \dots + 2^k)$$

$$= 6 + 9 \left( \frac{k(k+1)(2k+1)}{6} \right)$$

$$= 6 + 9 \left( \frac{(k^2+k)(2k+1)}{6} \right)$$

$$= 6 + \frac{9}{6} (2k^3 + k^2 + 2k^2 + k)$$

$$e) \quad x(n) = x(n/3) + 6 \quad \text{for } n > 1 \quad x(1) = 8 \\ \text{for } n = 3^k.$$

$$x(3^k) = x(3^{k-1}) + 6$$

$$= x(3^{k-2}) + 6 + 6$$

$$= x(3^{k-3}) + 6 + 6 + 6$$

⋮

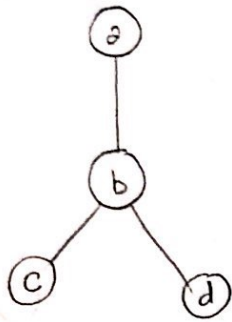
$$= x(3^{k-k}) + 6k$$

$$= x(3^0) + 6k$$

$$= x(1) + 6k$$

$$= \underline{8 + 6k}$$

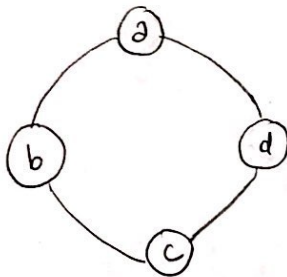
Q4) example of each topology with 4 nodes.



star

adjacency matrix

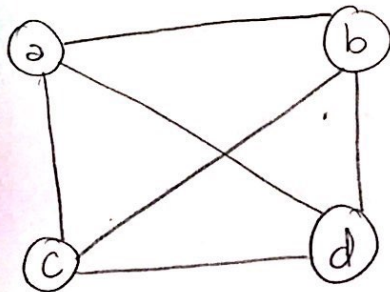
	a	b	c	d
a	0	1	0	0
b	1	0	1	1
c	0	1	0	0
d	0	1	0	0



ring

adjacency matrix

	a	b	c	d
a	0	1	0	1
b	1	0	1	0
c	0	1	0	1
d	1	0	1	0



adjacency matrix

	a	b	c	d
a	0	1	1	1
b	1	0	1	1
c	1	1	0	1
d	1	1	1	0

In a star topology, each vertex will be connected to only 1 vertex except for the center vertex which will be connected to  $n-1$  vertices.

In a ring topology, each vertex will be connected to only two other vertices.

In a mesh topology, each vertex will be connected to  $n-1$  vertices as each node is connected to every other node in the system.

So, in each of the topologies:

- star → every row and column will have sum 1 except for the row and column of the center node whose sum of row and column will be  $(n-1)$ .
- ring → every row and column must have sum 2.
- mesh → every row and column must have sum  $(n-1)$  as every node is connected to the remaining in the topology.



so ultimately, our algorithm would run through all the rows and columns taking their sums.

for star topology,

if the sum of each row and column comes out to be 1 except for the one exception, the column and row for the centre node which would sum to  $n-1$ .

for the ring

algorithm would run through each column and row and make sure the sum is 2 only.

for mesh,

algorithm would run through each column and row and make sure the sum is  $(n-1)$ .

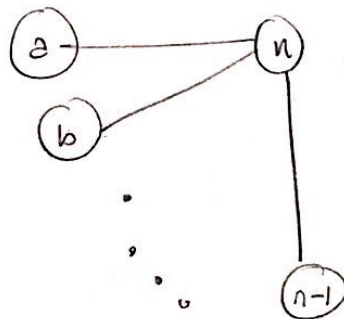
if it fails all three checks, it wouldn't match any topology.

time efficiency would be  $O(n^2)$ .

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Q5) The algorithm will fail in some cases.

for example;  $G$  could be connected to the last node but the algorithm only runs recursively until  $n-2$  failing to check the last node's adjacency. and giving the wrong output. i.e does not check  $(n-1)$  row and column.



Q6)

a)

let  $d_H(a, b)$  be the Hamming distance between two points  $a, b$

i)  $d_H(a, b)$

it does satisfy axiom 1

if string  $a \neq$  string  $b$  then  $d_H(a, b) \geq 0$

and if strings are same  $d_H = 0$

ii) it does satisfy axiom 2 as well.

$$d_H(a, b) = d_H(b, a).$$

as number of positions with different character will stay the same regardless of their order.

iii) it does - satisfy axiom 3.

$$a = 101010$$

$$b = 101011$$

$$c = 010110$$

$$d_H(a, b) = 1 + \Rightarrow 6 \geq 5$$

$$d_H(b, c) = 5$$

$$d_H(a, c) = 5$$

b). worst case complexity :  $O(n^2)$

brute force algorithm compared each character from string 1 with all characters in string 2.



## Chapter 4

# Programming Exercises

### 4.1 csce310h0mework01part01

#### 4.1.1 Test 01

diff

part01test01.diff

**Input**

part01test01.input

mmrtt  
bceefhijnopqrvwxy

**Submission Output**

part01test01.output

mmrtt and bceefhijnopqrvwxy have r in common.

**Solution Output**

part01test01.solution

mmrtt and bceefhijnopqrvwxy have r in common.

stderr

part01test01.err

#### 4.1.2 Test 02

diff

part01test02.diff

**Input**

part01test02.input

bdgijwx  
bffgimmnnnuw

**Submission Output**

part01test02.output

bdgijwx and bffgimmnnnuw have bgiw in common.

## Solution Output

part01test02.solution

bdgijwx and bffgimmnnuw have bgiw in common.

stderr

part01test02.err

### 4.1.3 Test 03

diff

part01test03.diff

## Input

part01test03.input

cceffhipqttvwx

bdddelmooqrsx

## Submission Output

part01test03.output

cceffhipqttvwx and bdddelmooqrsx have eqx in common.

## Solution Output

part01test03.solution

cceffhipqttvwx and bdddelmooqrsx have eqx in common.

stderr

part01test03.err

### 4.1.4 Test 04

diff

part01test04.diff

## Input

part01test04.input

brvw

afn

## Submission Output

part01test04.output

brvw and afn have in common.

## Solution Output

part01test04.solution

brvw and afn have in common.

stderr

part01test04.err

#### 4.1.5 Test 05

diff

part01test05.diff

**Input**

part01test05.input

ccdiorssuuuz  
cjmppqssuuwz

**Submission Output**

part01test05.output

ccdiorssuuuz and cjmppqssuuwz have cssuuz in common.

**Solution Output**

part01test05.solution

ccdiorssuuuz and cjmppqssuuwz have cssuuz in common.  
stderr

part01test05.err

#### 4.1.6 Test 06

diff

part01test06.diff

**Input**

part01test06.input

bccgjkoqrssstwx  
ddiqtz

**Submission Output**

part01test06.output

bccgjkoqrssstwx and ddiqtz have qt in common.

**Solution Output**

part01test06.solution

bccgjkoqrssstwx and ddiqtz have qt in common.  
stderr

part01test06.err

#### 4.1.7 Test 07

diff

part01test07.diff

**Input**

part01test07.input

egiiiklmmooooqrtuvyy  
bceefgnouu

**Submission Output**

part01test07.output

egiiiklmmooooqrtuvyy and bceefgnouu have egou in common.

**Solution Output**

part01test07.solution

egiiiklmmooooqrtuvyy and bceefgnouu have egou in common.  
stderr

part01test07.err

#### 4.1.8 Test 08

diff

part01test08.diff

**Input**

part01test08.input

ccdinyy  
eijkkopqqsttuux

**Submission Output**

part01test08.output

ccdinyy and eijkkopqqsttuux have i in common.

**Solution Output**

part01test08.solution

ccdinyy and eijkkopqqsttuux have i in common.  
stderr

part01test08.err

#### 4.1.9 Test 09

diff

part01test09.diff

**Input**

part01test09.input

befkoppuyz  
aaccdmopqrrttuvwx

**Submission Output**

part01test09.output

befkoppuyz and aaccdmopqrrttuvwx have fopu in common.

## Solution Output

part01test09.solution

befkoppuyz and aaccdmopqrrttuvwx have fopu in common.  
stderr

part01test09.err

## 4.1.10 Test 10

diff

part01test10.diff

## Input

part01test10.input

cddffggklnoopprtwyyz  
cddfjptuvxxx

## Submission Output

part01test10.output

cddffggklnoopprtwyyz and cddfjptuvxxx have cddfptz in common.

## Solution Output

part01test10.solution

cddffggklnoopprtwyyz and cddfjptuvxxx have cddfptz in common.  
stderr

part01test10.err

## 4.1.11 Test 11

diff

part01test11.diff

## Input

part01test11.input

aelnrtw  
ip

## Submission Output

part01test11.output

aelnrtw and ip have in common.

## Solution Output

part01test11.solution

aelnrtw and ip have in common.  
stderr

part01test11.err

#### 4.1.12 Test 12

diff

part01test12.diff

##### Input

part01test12.input

aabefhhjkmnoqttwxy  
ajkppsuvvwz

##### Submission Output

part01test12.output

aabefhhjkmnoqttwxy and ajkppsuvvwz have ajkw in common.

##### Solution Output

part01test12.solution

aabefhhjkmnoqttwxy and ajkppsuvvwz have ajkw in common.

stderr

part01test12.err

#### 4.1.13 Test 13

diff

part01test13.diff

##### Input

part01test13.input

affffjklopttuvwxy  
cdeefghikklopvwxyz

##### Submission Output

part01test13.output

affffjklopttuvwxy and cdeefghikklopvwxyz have fklopvwy in common.

##### Solution Output

part01test13.solution

affffjklopttuvwxy and cdeefghikklopvwxyz have fklopvwy in common.

stderr

part01test13.err

#### 4.1.14 Test 14

diff

part01test14.diff

##### Input

part01test14.input

```
ddhjjkmnoprxz
djlsyz
```

#### Submission Output

part01test14.output

```
ddhjjkmnoprxz and djlsyz have djz in common.
```

#### Solution Output

part01test14.solution

```
ddhjjkmnoprxz and djlsyz have djz in common.
```

stderr

part01test14.err

### 4.1.15 Test 15

diff

part01test15.diff

#### Input

part01test15.input

```
bekmnopsvvvwx
gqtvv
```

#### Submission Output

part01test15.output

```
bekmnopsvvvwx and gqtvv have v in common.
```

#### Solution Output

part01test15.solution

```
bekmnopsvvvwx and gqtvv have v in common.
```

stderr

part01test15.err

### 4.1.16 Source Code

csce310h0mework01part01.h

```
1 #ifndef CSCE310HOMEWORK01PART01_H
2 #define CSCE310HOMEWORK01PART01_H
3
4 #include <string>
5
6 using namespace std;
7
8 string commonLetters( string , string );
9
10 #endif
```

```

1 #include "csce310h0mework01part01.h"
2 #include <string>
3
4 using namespace std;
5
6 string commonLetters( string word01 , string word02 ){
7     string common = "";
8     int temp = 0;
9
10    for (int i = 0 ; i < word01.length() ; i++) {
11        for (int j = temp ; j < word02.length() ; j ++ ) {
12            if (word01[i] == word02[j]) {
13                common += word01[i]; //add common letter to string
14                temp = j + 1; //to skip to the next letter
15                break;
16            }
17        }
18    }
19
20    return common;
21 }

```

## 4.2 csce310h0mework01part02

### 4.2.1 Test 01

diff

part02test01.diff

**Input**

part02test01.input

1  
yc

**Submission Output**

part02test01.output

1 yc

**Solution Output**

part02test01.solution

1 yc  
stderr

part02test01.err

### 4.2.2 Test 02

diff

part02test02.diff

**Input**



part02test02.input

5  
yqm

**Submission Output**

part02test02.output

1 yqm  
2 ymq  
3 qym  
4 qmy  
5 myq

**Solution Output**

part02test02.solution

1 yqm  
2 ymq  
3 qym  
4 qmy  
5 myq  
stderr

part02test02.err

### 4.2.3 Test 03

diff

part02test03.diff

**Input**

part02test03.input

1  
r

**Submission Output**

part02test03.output

1 r

**Solution Output**

part02test03.solution

1 r  
stderr

part02test03.err

### 4.2.4 Test 04

diff

part02test04.diff

**Input**

part02test04.input

2  
ug

**Submission Output**

part02test04.output

1 ug  
2 gu

**Solution Output**

part02test04.solution

1 ug  
2 gu  
stderr

part02test04.err

#### 4.2.5 Test 05

diff

part02test05.diff

**Input**

part02test05.input

19  
yrmh

**Submission Output**

part02test05.output

1 yrmh  
2 yrhm  
3 ymrh  
4 ymhr  
5 yhrm  
6 yhmr  
7 rymh  
8 ryhm  
9 rmyh  
10 rmhy  
11 rhym  
12 rhmy  
13 myrh  
14 myhr  
15 mryh  
16 mrhy  
17 mhyr  
18 mhry  
19 hyrm

**Solution Output**

part02test05.solution

1 yrmh  
2 yrhm

```
3 ymrh
4 ymhr
5 yhrm
6 yhmr
7 rymh
8 ryhm
9 rmyh
10 rmhy
11 rhym
12 rhmy
13 myrh
14 myhr
15 mryh
16 mrhy
17 mhyr
18 mhry
19 hyrm
stderr
```

part02test05.err

#### 4.2.6 Test 06

diff

part02test06.diff

**Input**

part02test06.input

```
93
xwttee
```

**Submission Output**

part02test06.output

```
1 xwttee
2 xwtete
3 xwteet
4 xwette
5 xwetet
6 xweett
7 xtwtee
8 xtwete
9 xtweet
10 xttwee
11 xttewe
12 xtteew
13 xtewte
14 xtewet
15 xtetwe
16 xtetew
17 xteewt
18 xteetw
19 xewtte
20 xewtet
21 xewett
22 xetwte
23 xetwet
24 xettwe
```

25 xettew  
26 xetewt  
27 xetetw  
28 xeewtt  
29 xeetwt  
30 xeettw  
31 wxttee  
32 wxtete  
33 wxteet  
34 wxette  
35 wxetet  
36 wxeett  
37 wtxtee  
38 wtxete  
39 wtxeet  
40 wttxee  
41 wttexe  
42 wtteex  
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47 wteext  
48 wteetx  
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55 wettex  
56 wetext  
57 wetetx  
58 weextt  
59 weetxt  
60 weettx  
61 txwtee  
62 txwete  
63 txweet  
64 txtwee  
65 txtewe  
66 txteww  
67 txewte  
68 txewet  
69 txetwe  
70 txetew  
71 txeewt  
72 txeetw  
73 twxtee  
74 twxete  
75 twxeet  
76 twtxee  
77 twtexe  
78 twteex  
79 twexte  
80 twexet  
81 twetxe  
82 twetex  
83 tweext  
84 tweetx

85 ttxwee  
86 ttxewe  
87 ttxeew  
88 ttwxee  
89 ttwexe  
90 ttweex  
91 ttexwe  
92 ttexew  
93 ttewxe

## Solution Output

part02test06.solution

1 xwttee  
2 xwtete  
3 wxteet  
4 xwette  
5 xwetet  
6 xweett  
7 xtwtee  
8 xtwete  
9 xtweet  
10 xttwee  
11 xttewe  
12 xtteeew  
13 xtewte  
14 xtewet  
15 xtetwe  
16 xtetew  
17 xteewt  
18 xteetw  
19 xewtte  
20 xewtet  
21 xewett  
22 xetwte  
23 xetwet  
24 xettwe  
25 xettew  
26 xetewt  
27 xetetw  
28 xeewtt  
29 xeeetwt  
30 xeeettw  
31 wxttee  
32 wxtete  
33 wxteet  
34 wxette  
35 wxetet  
36 wxeett  
37 wtxtee  
38 wtxete  
39 wtxeet  
40 wttxee  
41 wttexe  
42 wtteex  
43 wtexte  
44 wtexet  
45 wtetxe  
46 wtetex  
47 wteext

48 wteetx  
49 wextte  
50 wextet  
51 wexett  
52 wetxte  
53 wetxet  
54 wettxe  
55 wettex  
56 wetext  
57 wetetx  
58 weextt  
59 weetxt  
60 weettx  
61 txwtee  
62 txwete  
63 txweet  
64 txtwee  
65 txtewe  
66 txteww  
67 txewte  
68 txewet  
69 txetwe  
70 txetew  
71 txeewt  
72 txeetw  
73 twxtee  
74 twxete  
75 twxeet  
76 twtxee  
77 twtexe  
78 twteex  
79 twexte  
80 twexet  
81 twetxe  
82 twetex  
83 tweext  
84 tweetx  
85 ttxwee  
86 ttxewe  
87 ttxeew  
88 ttwxee  
89 ttwexe  
90 ttweex  
91 ttexwe  
92 ttexew  
93 ttewxe  
  
stderr

part02test06.err

#### 4.2.7 Test 07

diff

part02test07.diff

Input

part02test07.input

xsp

### Submission Output

part02test07.output

1 xsp  
2 xps  
3 sxp  
4 spx  
5 pxs

### Solution Output

part02test07.solution

1 xsp  
2 xps  
3 sxp  
4 spx  
5 pxs

stderr

part02test07.err

## 4.2.8 Test 08

diff

part02test08.diff

### Input

part02test08.input

1  
vrpe

### Submission Output

part02test08.output

1 vrpe

### Solution Output

part02test08.solution

1 vrpe  
stderr

part02test08.err

## 4.2.9 Test 09

diff

part02test09.diff

### Input

part02test09.input

18  
yvlh

## Submission Output

part02test09.output

```
1 yvlh
2 yvhl
3 ylvh
4 ylhv
5 yhvl
6 yhlv
7 vylh
8 vyhl
9 vlyh
10 vlhy
11 vhyl
12 vhly
13 lyvh
14 lyhv
15 lvyh
16 lvhy
17 lhyv
18 lhvy
```

## Solution Output

part02test09.solution

```
1 yvlh
2 yvhl
3 ylvh
4 ylhv
5 yhvl
6 yhlv
7 vylh
8 vyhl
9 vlyh
10 vlhy
11 vhyl
12 vhly
13 lyvh
14 lyhv
15 lvyh
16 lvhy
17 lhyv
18 lhvy
```

stderr

part02test09.err

## 4.2.10 Test 10

diff

part02test10.diff

## Input

part02test10.input

```
54
xuqlc
```



## Submission Output

part02test10.output

```
1 xuqlc
2 xuqcl
3 xulqc
4 xulcq
5 xucql
6 xuclq
7 xqulc
8 xqucl
9 xqluc
10 xqlcu
11 xqcul
12 xqclu
13 xluqc
14 xlucq
15 xlquc
16 xlqcu
17 xlcuq
18 xlcqu
19 xcuql
20 xculq
21 xcqul
22 xcqlu
23 xcluq
24 xclqu
25 uxqlc
26 uxqcl
27 uxlqc
28 uxlcq
29 uxcql
30 uxclq
31 uqxlc
32 uqxcl
33 uqlxc
34 uqlcx
35 uqcxl
36 uqclx
37 ulxqc
38 ulxcq
39 ulqxc
40 ulqcx
41 ulcxq
42 ulcqx
43 ucxql
44 ucxlq
45 ucqxl
46 ucqlx
47 uclxq
48 uclqx
49 qxulc
50 qxucl
51 qxluc
52 qxlcu
53 qxcul
54 qxclu
```

## Solution Output

```
1 xuqlc
2 xuqcl
3 xulqc
4 xulcq
5 xucql
6 xucql
7 xqulc
8 xqucl
9 xqluc
10 xqlcu
11 xqcul
12 xqclu
13 xluqc
14 xlucq
15 xlquc
16 xlqcu
17 xlcuq
18 xlcqu
19 xcuql
20 xculq
21 xcqul
22 xcqlu
23 xcluq
24 xclqu
25 uxqlc
26 uxqcl
27 uxlqc
28 uxlcq
29 uxcql
30 uxclq
31 uqxlc
32 uqxcl
33 uqlxc
34 uqlcx
35 uqcxl
36 uqclx
37 ulxqc
38 ulxcq
39 ulqxc
40 ulqcx
41 ulcxq
42 ulcqx
43 ucxql
44 ucxlq
45 ucqxl
46 ucqlx
47 uclxq
48 uclqx
49 qxulc
50 qxucl
51 qxluc
52 qxlcu
53 qxcul
54 qxclu
```

stderr

#### 4.2.11 Test 11

diff

part02test11.diff

**Input**

part02test11.input

66

ysfdb

**Submission Output**

part02test11.output

```
1  ysfdb
2  ysfbf
3  ysdfb
4  ysdbf
5  ysbfd
6  ysbdf
7  yfsdb
8  yfsbd
9  yfdsb
10 yfdbb
11 yfbds
12 yfbds
13 ydsfb
14 ydsbf
15 ydfsfb
16 ydfbs
17 ydbsf
18 ydbfs
19 ybsfd
20 ybsdf
21 ybfds
22 ybfds
23 ybdsf
24 ybdfs
25 syfdb
26 syfbf
27 sydfb
28 sydbf
29 sybfd
30 sybdf
31 sfydb
32 sfybd
33 sfdyb
34 sfdby
35 sfbyd
36 sfbdy
37 sdyfb
38 sdybf
39 sdfyb
40 sdfby
41 sdbyf
42 sdbfy
43 sbyfd
44 sbydf
45 sbfyd
```

46 sbfdy  
47 sbdyf  
48 sbdfy  
49 fysdb  
50 fysbd  
51 fydsb  
52 fydbb  
53 fybsd  
54 fybds  
55 fsydb  
56 fsybd  
57 fsdyb  
58 fsdby  
59 fsbyd  
60 fsbdy  
61 fdysb  
62 fdybs  
63 fdsyb  
64 fdsby  
65 fdbys  
66 fdbsy

### Solution Output

part02test11.solution

1 ysfdb  
2 ysfbdb  
3 ysdffb  
4 ysdbfb  
5 ysbfd  
6 ysbdf  
7 yfsdb  
8 yfsbd  
9 yfdsb  
10 yfdbb  
11 yfbdb  
12 yfbds  
13 ydsfb  
14 ydsbf  
15 ydfsfb  
16 ydfbs  
17 ydbfb  
18 ydbfs  
19 ybsfd  
20 ybsdf  
21 ybfdb  
22 ybfds  
23 ybdsf  
24 ybdfs  
25 syfdb  
26 syfbdb  
27 sydfb  
28 sydbfb  
29 sybfb  
30 sybdf  
31 sfydb  
32 sfybd  
33 sfdyb  
34 sfdbby  
35 sfbyd

```
36 sfbdy
37 sdyfb
38 sdybf
39 sdfyb
40 sdfby
41 sdbyf
42 sdbfy
43 sbyfd
44 sbydf
45 sbfyd
46 sbfdy
47 sbdyf
48 sbdfy
49 fysdb
50 fysbd
51 fydsb
52 fydbf
53 fybsd
54 fybds
55 fsydb
56 fsybd
57 fsdyb
58 fsdby
59 fsbyd
60 fsbdy
61 fdysb
62 fdybs
63 fdsyb
64 fdsby
65 fdbys
66 fdbsy
stderr
```

part02test11.err

#### 4.2.12 Test 12

diff

part02test12.diff

**Input**

part02test12.input

```
2
yyx
```

**Submission Output**

part02test12.output

```
1 yyx
2 yxy
```

**Solution Output**

part02test12.solution

```
1 yyx
2 yxy
stderr
```

part02test12.err

### 4.2.13 Test 13

diff

part02test13.diff

**Input**

part02test13.input

15

zxmh

**Submission Output**

part02test13.output

```
1  zxmh
2  zxhm
3  zmxh
4  zmhx
5  zhxm
6  zhmx
7  xzmh
8  xzhm
9  xmzh
10 xmhz
11 xhzm
12 xhmz
13 mzxh
14 mzhx
15 mxzh
```

**Solution Output**

part02test13.solution

```
1  zxmh
2  zxhm
3  zmxh
4  zmhx
5  zhxm
6  zhmx
7  xzmh
8  xzhm
9  xmzh
10 xmhz
11 xhzm
12 xhmz
13 mzxh
14 mzhx
15 mxzh
```

stderr

part02test13.err

### 4.2.14 Test 14

diff

part02test14.diff

## Input

part02test14.input

622  
vslihd

## Submission Output

part02test14.output

```
1  vslihd
2  vslidh
3  vslhid
4  vslhdi
5  vsldih
6  vsldhi
7  vsilhd
8  vsildh
9  vsihld
10 vsihdl
11 vsidlh
12 vsidhl
13 vshlid
14 vshldi
15 vshild
16 vshidl
17 vshdli
18 vshdil
19 vsdlih
20 vsdlhi
21 vsdilh
22 vsdihl
23 vsdhli
24 vsdhil
25 vlsihd
26 vlsidh
27 vlshid
28 vlshdi
29 vlsdih
30 vlsdhi
31 vlishd
32 vlisdh
33 vlihsd
34 vlihds
35 vlidsh
36 vlidhs
37 vlhsid
38 vlhsdi
39 vlhisd
40 vlhids
41 vlhdsi
42 vlhdis
43 vldsih
44 vldshi
45 vldish
46 vldihs
47 vldhsi
48 vldhis
49 vislhd
50 visldh
51 vishld
```

52 vishdl  
53 visdlh  
54 visdhl  
55 vilshd  
56 vilsdh  
57 vilhsd  
58 vilhds  
59 vildsh  
60 vildhs  
61 vihsld  
62 vihsdl  
63 vihlsl  
64 vihlsls  
65 vihdsl  
66 vihdls  
67 vidslh  
68 vidshl  
69 vidlsh  
70 vidlhs  
71 vidhsl  
72 vidhls  
73 vhsldi  
74 vhsldi  
75 vhsild  
76 vhsidl  
77 vhsdli  
78 vhsdil  
79 vhlslid  
80 vhlslid  
81 vhlslid  
82 vhlslid  
83 vhlslid  
84 vhlslid  
85 vhlslid  
86 vhlslid  
87 vhlslid  
88 vhlslid  
89 vhlslid  
90 vhlslid  
91 vhlslid  
92 vhlslid  
93 vhlslid  
94 vhlslid  
95 vhlslid  
96 vhlslid  
97 vhlslid  
98 vhlslid  
99 vhlslid  
100 vhlslid  
101 vhlslid  
102 vhlslid  
103 vhlslid  
104 vhlslid  
105 vhlslid  
106 vhlslid  
107 vhlslid  
108 vhlslid  
109 vhlslid  
110 vhlslid  
111 vhlslid



112 vdilhs  
113 vdihs1  
114 vdihls  
115 vdhsli  
116 vdhsil  
117 vdhlsl  
118 vdhlis  
119 vdhis1  
120 vdhils  
121 svlihd  
122 svlidh  
123 svlhid  
124 svlhdi  
125 svldih  
126 svldhi  
127 svilhd  
128 svildh  
129 svihld  
130 svihdl  
131 svidlh  
132 svidhl  
133 svhlid  
134 svhldi  
135 svhild  
136 svhidl  
137 svhdli  
138 svhdil  
139 svdlih  
140 svdlhi  
141 svdilh  
142 svdihl  
143 svdhli  
144 svdhil  
145 slvihd  
146 slvidh  
147 slvhid  
148 slvhdi  
149 slvdih  
150 slvdhi  
151 slivhd  
152 slivdh  
153 slihvd  
154 slihdv  
155 slidvh  
156 slidhv  
157 slhvid  
158 slhvdi  
159 slhivd  
160 slhidv  
161 slhdvi  
162 slhdiv  
163 sldvih  
164 sldvhi  
165 sldivh  
166 sldihv  
167 sldhvi  
168 sldhiv  
169 sivlhd  
170 sivldh  
171 sivhld

172 sivhdl  
173 sivdlh  
174 sivdhl  
175 silvhd  
176 silvdh  
177 silhvd  
178 silhdv  
179 sildvh  
180 sildhv  
181 sihvld  
182 sihvdl  
183 sihlvd  
184 sihl dv  
185 sihdvl  
186 sihdlv  
187 sidvlh  
188 sidvhl  
189 sidlvh  
190 sidlhv  
191 sidhvl  
192 sidhlv  
193 shvlid  
194 shvldi  
195 shvild  
196 shvidl  
197 shvdli  
198 shvdil  
199 shlvid  
200 shl vdi  
201 shlivd  
202 shlidv  
203 shldvi  
204 shldiv  
205 shivld  
206 shivdl  
207 shilvd  
208 shildv  
209 shidvl  
210 shidlv  
211 shdvli  
212 shdvil  
213 shdlvi  
214 shdliv  
215 shdivl  
216 shdilv  
217 sdvlih  
218 sdvlhi  
219 sdvilh  
220 sdvihl  
221 sdvhli  
222 sdvhil  
223 sdlvih  
224 sdlvhi  
225 sdlivh  
226 sdlihv  
227 sdlhvi  
228 sdlhiv  
229 sdivlh  
230 sdivhl  
231 sdilvh

232 sdilhv  
233 sdihvl  
234 sdihlv  
235 sdhvoli  
236 sdhvil  
237 sdhlvi  
238 sdhliv  
239 sdhivl  
240 sdhilv  
241 lvsihd  
242 lvsidh  
243 lvshid  
244 lvshdi  
245 lvsdih  
246 lvsdhi  
247 lvishd  
248 lvisdh  
249 lvihsd  
250 lvihds  
251 lvidsh  
252 lvidhs  
253 lvhsid  
254 lvhsdi  
255 lvhisd  
256 lvhids  
257 lvhdsi  
258 lvhdis  
259 lvdsih  
260 lvdshi  
261 lvdish  
262 lvdihs  
263 lvdhsi  
264 lvdhis  
265 lsvihd  
266 lsvidh  
267 lsvhid  
268 lsvhdi  
269 lsvdih  
270 lsvdhi  
271 lsivhd  
272 lsivdh  
273 lsihvd  
274 lsihdv  
275 lsidvh  
276 lsidhv  
277 lshvid  
278 lshvdi  
279 lshivd  
280 lshidv  
281 lshdvi  
282 lshdiv  
283 lsdvih  
284 lsdvhi  
285 lsdivh  
286 lsdihv  
287 lsdhvi  
288 lsdhiv  
289 livshd  
290 livsdh  
291 livhsd

292 livhds  
293 livdsh  
294 livdhs  
295 lisvhd  
296 lisvdh  
297 lishvd  
298 lishdv  
299 lisdvh  
300 lisdhv  
301 lihvsd  
302 lihvds  
303 lihsvd  
304 lihsvd  
305 lihdvs  
306 lihdsd  
307 lidvsh  
308 lidvhs  
309 lidsvh  
310 lidshv  
311 lidhvs  
312 lidhsv  
313 lhvsid  
314 lhvsdi  
315 lhvisd  
316 lhvids  
317 lhvdsi  
318 lhvdis  
319 lhsvid  
320 lhsvdi  
321 lhsivd  
322 lhsidv  
323 lhsdvi  
324 lhsdiv  
325 lhivsd  
326 lhivds  
327 lhsivd  
328 lhsidv  
329 lhdivs  
330 lhdivs  
331 lhdvsi  
332 lhdvis  
333 lhdsvi  
334 lhdsvi  
335 lhdvsi  
336 lhdvis  
337 ldvsih  
338 ldvshi  
339 ldvish  
340 ldvihs  
341 ldvhsi  
342 ldvhis  
343 ldsvih  
344 ldsvhi  
345 ldsivh  
346 ldsihv  
347 ldshvi  
348 ldshiv  
349 ldivsh  
350 ldivhs  
351 ldisvh

352 ldishv  
353 ldihvs  
354 ldihsv  
355 ldhvs i  
356 ldhvis  
357 ldhsvi  
358 ldhsiv  
359 ldhivs  
360 ldhisv  
361 ivslhd  
362 ivsl dh  
363 ivshld  
364 ivshdl  
365 ivsdlh  
366 ivsdhl  
367 ivlshd  
368 ivlsdh  
369 ivl hsd  
370 ivlhds  
371 ivldsh  
372 ivldhs  
373 ivhsld  
374 ivhsdl  
375 ivhl sd  
376 ivhl ds  
377 ivhdsl  
378 ivhdls  
379 ivdslh  
380 ivdshl  
381 ivdlsh  
382 ivdlhs  
383 ivdhsl  
384 ivdhls  
385 isvlhd  
386 isvldh  
387 isvhld  
388 isvhdl  
389 isvdlh  
390 isvdhl  
391 islvhd  
392 islvdh  
393 islhvd  
394 islh dv  
395 isldvh  
396 isldhv  
397 ishvld  
398 ishvd l  
399 ishlvd  
400 ishldv  
401 ishdv l  
402 ishdlv  
403 isdvlh  
404 isdvhl  
405 isdlvh  
406 isdlhv  
407 isdhv l  
408 isdhlv  
409 ilvshd  
410 ilvsdh  
411 ilvh sd

412 ilvhds  
413 ilvdsh  
414 ilvdhs  
415 ilsvhd  
416 ilsvdh  
417 ilshvd  
418 ilshdv  
419 ilsdvh  
420 ilsdhv  
421 ilhvsvd  
422 ilhvds  
423 ilhsvd  
424 ilhsdv  
425 ilhdvs  
426 ilhdsv  
427 ildvsh  
428 ildvhs  
429 ildsvh  
430 ildshv  
431 ildhvs  
432 ildhsv  
433 ihvsl  
434 ihvsdl  
435 ihvlsd  
436 ihvlds  
437 ihvds  
438 ihvdls  
439 ihsvld  
440 ihsvdl  
441 ihsldv  
442 ihsldv  
443 ihsdvl  
444 ihsdlv  
445 ihlvsvd  
446 ihlvds  
447 ihlsvd  
448 ihlsdv  
449 ihldvs  
450 ihldsv  
451 ihdvsl  
452 ihdvls  
453 ihdsvl  
454 ihdslv  
455 ihdlvs  
456 ihdlsv  
457 idvslh  
458 idvshl  
459 idvlsh  
460 idvlhs  
461 idvhs  
462 idvhls  
463 idsvlh  
464 idsvhl  
465 idslvh  
466 idslhv  
467 idshvl  
468 idshlv  
469 idlvsh  
470 idlvhs  
471 idlsvh

472 idlshv  
473 idlhvs  
474 idlhsv  
475 idhvsl  
476 idhvls  
477 idhsvl  
478 idhslv  
479 idhlvs  
480 idhlsv  
481 hvslid  
482 hvslid  
483 hvsild  
484 hvsidl  
485 hvsdli  
486 hvsdil  
487 hvlsid  
488 hvlsdi  
489 hvlisd  
490 hvllids  
491 hvldsi  
492 hvldis  
493 hvisld  
494 hvisdl  
495 hvilsd  
496 hvilds  
497 hvidsl  
498 hvidls  
499 hvdsli  
500 hvdsil  
501 hvdlsi  
502 hvdlis  
503 hvdisl  
504 hvdils  
505 hsvlid  
506 hsvldi  
507 hsvild  
508 hsvidl  
509 hsvdli  
510 hsvdil  
511 hslvid  
512 hslvdi  
513 hslivd  
514 hslidv  
515 hsldvi  
516 hsldiv  
517 hsivld  
518 hsivdl  
519 hsilvd  
520 hsildv  
521 hsidvl  
522 hsidlv  
523 hsdvli  
524 hsdvil  
525 hsdlvi  
526 hsdliv  
527 hsdivl  
528 hsdilv  
529 hlvsid  
530 hlvsvdi  
531 hlvisd

532 hlvids  
533 hlvdsi  
534 hlvdiss  
535 hlsvid  
536 hlsvdi  
537 hlsivd  
538 hlsidv  
539 hlsdvi  
540 hlsdiv  
541 hlivsd  
542 hlivds  
543 hlisvd  
544 hlisdv  
545 hlidvs  
546 hlidsv  
547 hldvsi  
548 hldvis  
549 hldsvi  
550 hldsiv  
551 hldivs  
552 hldisv  
553 hivsld  
554 hivsdl  
555 hivlsd  
556 hivlds  
557 hivdsl  
558 hivdls  
559 hisvld  
560 hisvdl  
561 hislvd  
562 hisldv  
563 hisdvl  
564 hisdlv  
565 hilvsd  
566 hilvds  
567 hilsvd  
568 hilsdv  
569 hildvs  
570 hildsv  
571 hidvsl  
572 hidvls  
573 hidsvl  
574 hidslv  
575 hidlvs  
576 hidlsv  
577 hdvsl  
578 hdvsl  
579 hdvlsi  
580 hdvlls  
581 hdvisl  
582 hdvils  
583 hdsvli  
584 hdsvil  
585 hdsilvi  
586 hdsilv  
587 hdsivl  
588 hdsilv  
589 hdlvsi  
590 hdlvis  
591 hdlsvi



```

592 hdlisiv
593 hdlivs
594 hdlisv
595 hdivsl
596 hdivls
597 hdisvl
598 hdislv
599 hdilvs
600 hdilsv
601 dvslilh
602 dvslhi
603 dvsilh
604 dvsihl
605 dvshli
606 dvshil
607 dvlsih
608 dvlshi
609 dvlish
610 dvlihs
611 dvlhsi
612 dvlhis
613 dvislh
614 dvishl
615 dvilsh
616 dvilhs
617 dvihs1
618 dvihls
619 dvhsli
620 dvhsil
621 dvhlsi
622 dvhlis

```

### Solution Output

part02test14.solution

```

1  vslihd
2  vslidh
3  vslhid
4  vslhdi
5  vsldih
6  vsldhi
7  vsilhd
8  vsildh
9  vsihld
10 vsihdl
11 vsidlh
12 vsidhl
13 vshlid
14 vshldi
15 vshild
16 vshidl
17 vshdli
18 vshdil
19 vsdlih
20 vsdlhi
21 vsdilh
22 vsdihl
23 vsdhli
24 vsdhil
25 vlsihd

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26 vlsidh  
27 vlshid  
28 vlshdi  
29 vlsdih  
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31 vlishd  
32 vlisdh  
33 vlihsd  
34 vlihds  
35 vlidsh  
36 vlidhs  
37 vlhsid  
38 vlhsdi  
39 vlhisd  
40 vlhids  
41 vlhdsi  
42 vlhdis  
43 vldsih  
44 vldshi  
45 vldish  
46 vldihs  
47 vldhsi  
48 vldhis  
49 vislhd  
50 visldh  
51 vishld  
52 vishdl  
53 visdlh  
54 visdhl  
55 vilshd  
56 vilsdh  
57 vilhsd  
58 vilhds  
59 vildsh  
60 vildhs  
61 vihsld  
62 vihsdl  
63 vihlsd  
64 vihlds  
65 vihds1  
66 vihdls  
67 vidslh  
68 vidshl  
69 vidlsh  
70 vidlhs  
71 vidhsl  
72 vidhls  
73 vhslid  
74 vhsldi  
75 vhsild  
76 vhsidl  
77 vhsdli  
78 vhsdil  
79 vhlsid  
80 vhlsdi  
81 vhlisd  
82 vhlids  
83 vhldsi  
84 vhldis  
85 vhisld

86 vhisdl  
87 vhilsd  
88 vhilds  
89 vhidsl  
90 vhidls  
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147 slvhid  
148 slvhdi  
149 slvdih  
150 slvdhi  
151 slivhd  
152 slivdh  
153 slihvd  
154 slihdv  
155 slidvh  
156 slidhv  
157 slhvid  
158 slhvdi  
159 slhivd  
160 slhidv  
161 slhdvi  
162 slhdiv  
163 sldvih  
164 sldvhi  
165 sldivh  
166 sldihv  
167 sldhvi  
168 sldhiv  
169 sivilhd  
170 sivildh  
171 sivhld  
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173 sivdlh  
174 sivdhl  
175 silvhd  
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177 silhvd  
178 silhdv  
179 sildvh  
180 sildhv  
181 sihvld  
182 sihvdl  
183 sihlvd  
184 sihl dv  
185 sihdvl  
186 sihdlv  
187 sidvlh  
188 sidvhl  
189 sidlvh  
190 sidlhv  
191 sidhvl  
192 sidhlv  
193 shvlid  
194 shvldi  
195 shvild  
196 shvidl  
197 shvdli  
198 shvdil  
199 shlvid  
200 shlvdi  
201 shlivd  
202 shlidv  
203 shldvi  
204 shldiv  
205 shivld

206 shivdl  
207 shilvd  
208 shildv  
209 shidvl  
210 shidlv  
211 shdvli  
212 shdvil  
213 shdlvi  
214 shdliv  
215 shdivl  
216 shdilv  
217 sdvlih  
218 sdvlhi  
219 sdvilh  
220 sdvihl  
221 sdvhli  
222 sdvhil  
223 sdlvih  
224 sdlvhi  
225 sdlivh  
226 sdlihv  
227 sdlhvi  
228 sdlhiv  
229 sdivlh  
230 sdivhl  
231 sdilvh  
232 sdilhv  
233 sdihvl  
234 sdihlv  
235 sdhvli  
236 sdhvil  
237 sdhlvi  
238 sdhliv  
239 sdhivl  
240 sdhilv  
241 lvsihd  
242 lvsidh  
243 lvshid  
244 lvshdi  
245 lvsdih  
246 lvsdhi  
247 lvishd  
248 lvisdh  
249 lvihsd  
250 lvihds  
251 lvidsh  
252 lvidhs  
253 lvhsid  
254 lvhsdi  
255 lvhisd  
256 lvhids  
257 lvhdsi  
258 lvhdis  
259 lvdsih  
260 lvdshi  
261 lvdish  
262 lvdihv  
263 lvdhsi  
264 lvdhis  
265 lsvihd

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267 lsvhid  
268 lsvhdi  
269 lsvdih  
270 lsvdhi  
271 lsivhd  
272 lsivdh  
273 lsihvd  
274 lsihdv  
275 lsidvh  
276 lsidhv  
277 lshvid  
278 lshvdi  
279 lshivd  
280 lshidv  
281 lshdvi  
282 lshdiv  
283 lsdvih  
284 lsdvhi  
285 lsdivh  
286 lsdihv  
287 lsdhvi  
288 lsdhiv  
289 livshd  
290 livsdh  
291 livhsd  
292 livhds  
293 livdsh  
294 livdhs  
295 lisvhd  
296 lisvdh  
297 lishvd  
298 lishdv  
299 lisdvh  
300 lisdhv  
301 lihvsd  
302 lihvds  
303 lihsvd  
304 lihsdv  
305 lihdvs  
306 lihdsv  
307 lidvsh  
308 lidvhs  
309 lidsvh  
310 lidshv  
311 lidhvs  
312 lidhsv  
313 lhvsid  
314 lhvsdi  
315 lhvisd  
316 lhvids  
317 lhvdsi  
318 lhvdis  
319 lhsvid  
320 lhsvdi  
321 lhsivd  
322 lhsidv  
323 lhsdvi  
324 lhsdiv  
325 lhivsd

326 lhivds  
327 lhisvd  
328 lhisdv  
329 lhidvs  
330 lhidsv  
331 lhdvsi  
332 lhdvis  
333 lhdsvi  
334 lhdshiv  
335 lhdivs  
336 lhdisv  
337 ldvsih  
338 ldvshi  
339 ldvish  
340 ldvihs  
341 ldvhsi  
342 ldvhis  
343 ldsvih  
344 ldsvhi  
345 ldsivh  
346 ldsihv  
347 ldshvi  
348 ldshiv  
349 ldivsh  
350 ldivhs  
351 ldisvh  
352 ldishv  
353 ldihvs  
354 ldihsv  
355 ldhvs  
356 ldhvis  
357 ldhsvi  
358 ldhsiv  
359 ldhivs  
360 ldhisv  
361 ivslhd  
362 ivslhd  
363 ivshld  
364 ivshdl  
365 ivsdlh  
366 ivsdhl  
367 ivlshd  
368 ivlsdh  
369 ivlhsd  
370 ivlhds  
371 ivldsh  
372 ivldhs  
373 ivhsld  
374 ivhsdl  
375 ivhlsd  
376 ivhlds  
377 ivhds  
378 ivhdls  
379 ivdslh  
380 ivdshl  
381 ivdlsh  
382 ivdlhs  
383 ivdhs  
384 ivdhls  
385 isvlhd

386 isvldh  
387 isvhld  
388 isvhdl  
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390 isvdhl  
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395 isldvh  
396 isldhv  
397 ishvld  
398 ishvd1  
399 ishlvd  
400 ishldv  
401 ishdv1  
402 ishdlv  
403 isdvlh  
404 isdvhl  
405 isdlvh  
406 isdlhv  
407 isdhv1  
408 isdhlv  
409 ilvshd  
410 ilvsdh  
411 ilvhsd  
412 ilvhds  
413 ilvdsh  
414 ilvdhs  
415 ilsvhd  
416 ilsvdh  
417 ilshvd  
418 ilshdv  
419 ilsdvh  
420 ilsdhv  
421 ilhvsd  
422 ilhvds  
423 ilhsvd  
424 ilhsdv  
425 ilhdvs  
426 ilhdsv  
427 ildvsh  
428 ildvhs  
429 ildsvh  
430 ildshv  
431 ildhvs  
432 ildhsv  
433 ihvsld  
434 ihvsdl  
435 ihvlsd  
436 ihvlds  
437 ihvds1  
438 ihvdls  
439 ihsvld  
440 ihsvdl  
441 ihsldv  
442 ihsldv  
443 ihsdvl  
444 ihsdlv  
445 ihlvsd



446 ihlvds  
447 ihlsvd  
448 ihlsdv  
449 ihldvs  
450 ihldsv  
451 ihdvsl  
452 ihdvls  
453 ihdsvl  
454 ihdslv  
455 ihdlvs  
456 ihdlsv  
457 idvslh  
458 idvshl  
459 idvlsh  
460 idvlhs  
461 idvhs1  
462 idvhls  
463 idsvlh  
464 idsvhl  
465 idslvh  
466 idslhv  
467 idshvl  
468 idshlv  
469 idlvsh  
470 idlvhs  
471 idlsvh  
472 idlshv  
473 idlhvs  
474 idlhsv  
475 idhvsl  
476 idhvls  
477 idhsvl  
478 idhslv  
479 idhlvs  
480 idhlsv  
481 hvslid  
482 hvslid  
483 hvsild  
484 hvsidl  
485 hvsdli  
486 hvsdil  
487 hvlsid  
488 hvlsdi  
489 hvlisd  
490 hvlids  
491 hvldsi  
492 hvldis  
493 hvisld  
494 hvisdl  
495 hvilsd  
496 hvilds  
497 hvidsl  
498 hvidls  
499 hvdsli  
500 hvdsil  
501 hvdlsi  
502 hvdli  
503 hvdisl  
504 hvdils  
505 hsvlid

506 hsvldi  
507 hsvild  
508 hsvidl  
509 hsvdli  
510 hsvdil  
511 hslvid  
512 hslvdi  
513 hslivd  
514 hslidv  
515 hsldvi  
516 hsldiv  
517 hsivld  
518 hsivdl  
519 hsilvd  
520 hsildv  
521 hsidvl  
522 hsidlv  
523 hsdvli  
524 hsdvil  
525 hsdvli  
526 hsdliv  
527 hsdvli  
528 hsdilv  
529 hlvsid  
530 hlvsdi  
531 hlvisd  
532 hlvids  
533 hlvdsl  
534 hlvdsl  
535 hlsvid  
536 hlsvdi  
537 hlsivd  
538 hlsidv  
539 hlsdvi  
540 hlsdiv  
541 hlvivd  
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567 hilsvd  
568 hilsdv  
569 hildvs  
570 hildsv  
571 hidvsl  
572 hidvls  
573 hidsvl  
574 hidslv  
575 hidlvs  
576 hidlsv  
577 hdvsli  
578 hdvsil  
579 hdvlsi  
580 hdvlis  
581 hdvisl  
582 hdvils  
583 hdsvli  
584 hdsvil  
585 hdsarvi  
586 hdsariv  
587 hdsarivl  
588 hdsarivl  
589 hdlvsi  
590 hdlvis  
591 hdlsvi  
592 hdlziv  
593 hdlivs  
594 hdlisv  
595 hdivsl  
596 hdivls  
597 hdisvl  
598 hdislv  
599 hdilvs  
600 hdilsv  
601 dvsliv  
602 dvslhi  
603 dvsilh  
604 dvsihl  
605 dvshli  
606 dvshil  
607 dvlsih  
608 dvlshi  
609 dvlivh  
610 dvlihs  
611 dvlhsi  
612 dvlhis  
613 dvislh  
614 dvishl  
615 dvilsh  
616 dvilhs  
617 dvihs  
618 dvihs  
619 dvhsli  
620 dvhsil  
621 dvhlis  
622 dvhlis

stderr

part02test14.err

#### 4.2.15 Test 15

diff

part02test15.diff

**Input**

part02test15.input

16

zuqg

**Submission Output**

part02test15.output

```
1 zuqg
2 zugq
3 zqug
4 zqgu
5 zguq
6 zgqu
7 uzqg
8 uzgq
9 uqzg
10 uqgz
11 ugzq
12 ugqz
13 qzug
14 qzgu
15 quzg
16 qugz
```

**Solution Output**

part02test15.solution

```
1 zuqg
2 zugq
3 zqug
4 zqgu
5 zguq
6 zgqu
7 uzqg
8 uzgq
9 uqzg
10 uqgz
11 ugzq
12 ugqz
13 qzug
14 qzgu
15 quzg
16 qugz
```

stderr

part02test15.err

#### 4.2.16 Source Code

```

1 #ifndef CSCE310HOMEWORK01PART02_H
2 #define CSCE310HOMEWORK01PART02_H
3
4 #include <string>
5 #include <vector>
6
7 using namespace std;
8
9 void printPermutations( string , int );
10
11 #endif

```

```

1 #include "csce310h0mework01part02.h"
2 #include <string>
3 #include <iostream>
4 #include <algorithm>
5
6 using namespace std;
7
8 void printPermutations(string word, int permutations) {
9
10     int index1 = 0; // create variable for index1 in algorithm
11     int index2 = 0; // create variable for index2 in algorithm
12     int loop = 0; //flag for loop
13     int temp = permutations;
14
15     // if word is of length 1, print the word out and end
16     if (word.length() == 1 && permutations == 1) {
17         cout << word[0] << endl;
18         return;
19     }
20
21     // see if any characters are in decreasing order
22     for (int m = 0; m < word.length() - 1; m++) {
23         if (word[m] >= word[m + 1]) {
24             loop = 1;
25             break;
26         } else {
27             loop = 0;
28         }
29     }
30
31     while (loop == 1 && permutations != 0) {
32         if (temp == permutations) {
33             cout << word << endl; //print out the word and not the first permutation
34             permutations--;
35         } else {
36             for (int k = 0; k < word.length() - 1; k++) {
37                 if (word[k] > word[k + 1]) {
38                     index1 = k; //index such that a[index1]>a[index1+1]
39                 }
40             }
41
42             for (int l = 0; l < word.length(); l++) {
43                 if (word[index1] > word[l])
44                     index2 = l; //index such than a[index1]>a[index2]
45             }
46

```

```

47     swap(word[index1], word[index2]);
48     //reverse order from a[index1+1] to a[word.length()]
49     reverse(word.begin() + index1 + 1, word.end());
50     permutations--; //decrease by 1 for each permutation printed
51     cout << word << endl; //print permutation
52
53     for (int m = 0; m < word.length() - 1; m++) {
54         if (word[m] >= word[m + 1]) {
55             loop = 1;
56             break;
57         } else {
58             loop = 0;
59         }
60     }
61 }
62 }
63 }

```