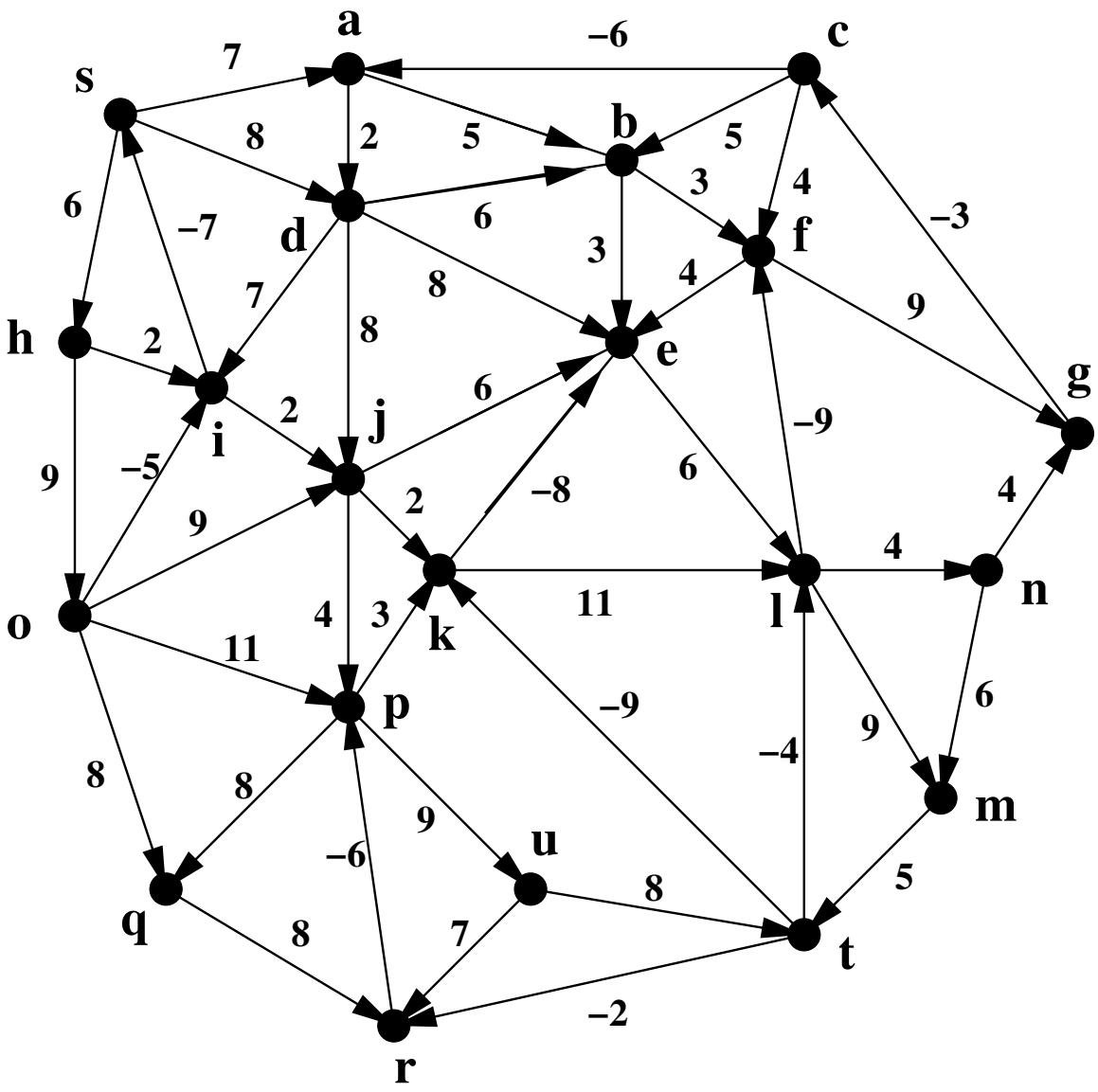
University of Nevada, Las Vegas Computer Science 477/677 Fall 2020

Assignment 6 Problem 4 Due Thursday October 22, 2020

Name:_____

You are permitted to work in groups, get help from others, read books, and use the internet. Your answers must be written in a pdf file and emailed to the graudate assistant, Tandreana Chua `chuat4@unlv.nevada.edu` , by midnight October 22. Your file must not exceed 5 megabytes, and must print out to at most 4 pages.

4. The first step of Johnson's algorithm is to compute the heuristic function On the weighted directed graph (a) below, label each node of (a) with the correct heuristic. (You do not have to show the steps of the algorithm for this. The example is small enough that you can simply compute the values in your head.) The next step is to adjust the arc weights. Label the arcs of (b) with the adjusted weights.



(a)

Here is the solution to the first phase.

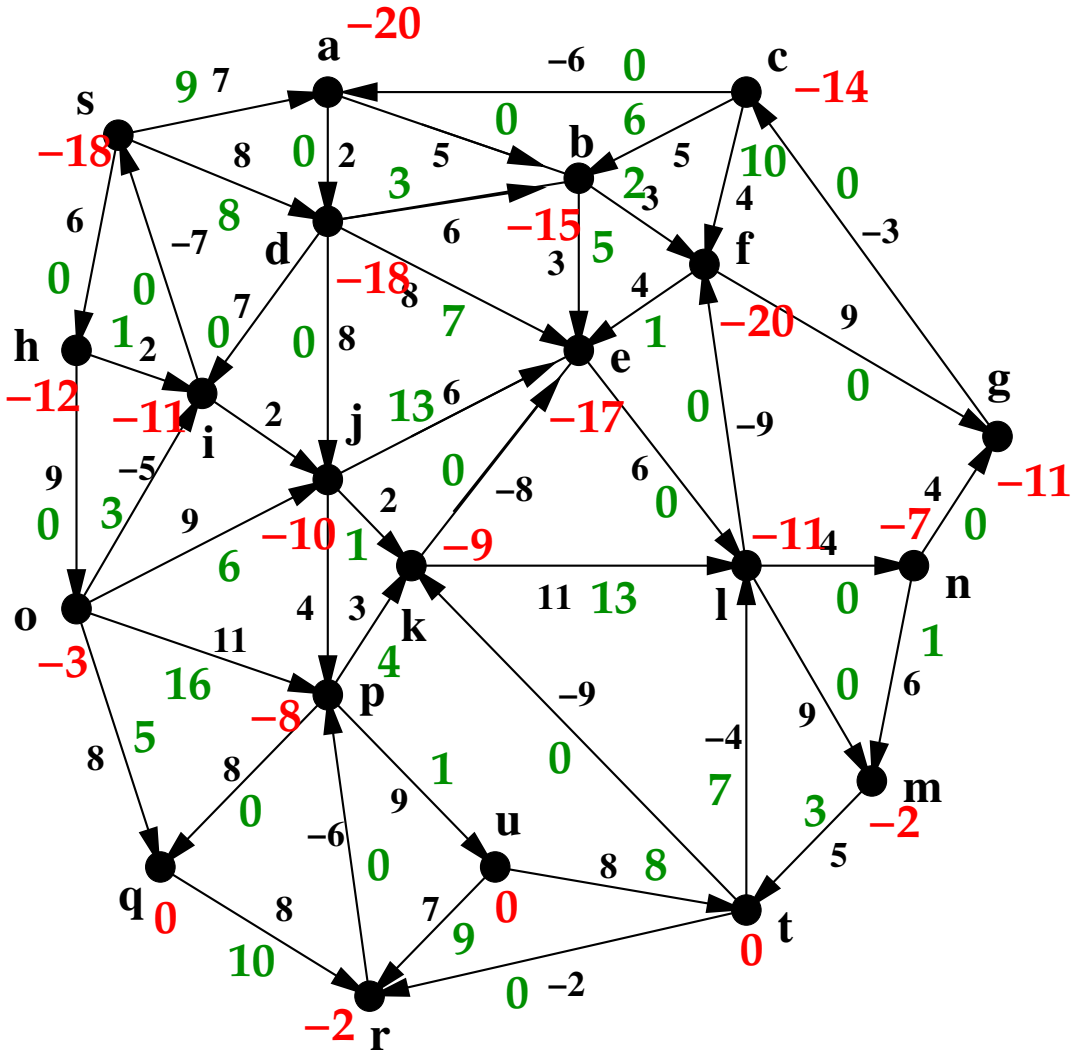
a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u
-20	-15	-14	-18	-17	-20	-11	-12	-11	-10	-9	-11	-2	-7	-3	-8	0	-2	-18	0	0

Here is the graph in array of out-neighbor lists form:

```
a: d  2 b  5
b: e  3 f  3
c: b  5 f  4 a -6
d: b  6 e  8 i  7 j  8
e: l  6
f: e  4 g  9
g: c -3
h: i  2 o  9
i: j  2 s -7
j: e  6 k  2 p  4
k: e -8 l 11
l: f -9 n  4 m  9
m: t  5
n: 4  6 m  6
o: i -5 j  9 p 11 q  8
p: k  3 q  8 u  9
q: r  8
r: p -6
```

Here is the graph in matrix form:

```
    a  b  c  d  e  f  g  h  i  j  k  l  m  n  o  p  q  r  s  t  u
a      5      2
b               3   3
c  -6   5            4
d      6         8            7   8
e                                  6
f               4      9
g        -3
h                            2                 9
i                               2                          -7
j               6                  2              4
k              -8                    11                    6
l                 -9                     9   4
m                                                        5
n                                        6
o                           -5   9                11   8
p                                  3                 8            9
q                                                      8
r                                                -6
s   7         8            6
t                                  -9  -4                -2
u                                                      7
```



Here is the labeled graph. The results to the first phase are shown as a red label on each vertex. The results to the second phase are shown as a green label on each edge.

Here are the solutions to the all pairs problem. For each vertex the first line shows distance and the second line shows the backpointer.

	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u
a	0	5	7	2	4	1	10	8	9	10	12	10	19	14	17	14	22	22	2	24	23
	*	a	g	a	k	l	f	s	d	d	j	e	l	l	h	j	p	t	i	m	p
b	0	0	6	2	3	0	9	8	9	10	12	9	18	13	17	14	22	21	2	23	23
	c	*	g	a	b	l	f	s	d	d	j	e	l	l	h	j	p	t	i	m	p
c	-6	-1	0	-4	-2	-5	4	2	3	4	6	4	13	8	11	8	16	16	-4	18	17
	c	a	*	a	k	l	f	s	d	d	j	e	l	l	h	j	p	t	i	m	p
d	-1	4	5	0	2	-1	8	6	7	8	10	8	17	12	15	12	20	20	0	22	21
	c	a	g	*	k	l	f	s	d	d	j	e	l	l	h	j	p	t	i	m	p
e	-3	2	3	-1	0	-3	6	5	6	7	9	6	15	10	14	11	19	18	-1	20	20
	c	a	g	a	*	l	f	s	d	d	j	e	l	l	h	j	p	t	i	m	p
f	0	5	6	2	4	0	9	8	9	10	12	10	19	14	17	14	22	22	2	24	23
	c	a	g	a	f	*	f	s	d	d	j	e	l	l	h	j	p	t	i	m	p
g	-9	-4	-3	-7	-5	-8	0	-1	0	1	3	1	10	5	8	5	13	13	-7	15	14
	c	a	g	a	k	l	*	s	d	d	j	e	l	l	h	j	p	t	i	m	p
h	-5	0	1	-3	-2	-5	4	0	2	4	6	4	13	8	9	8	16	16	-5	18	17
	c	a	g	a	k	l	f	*	h	i	j	e	l	l	h	j	p	t	i	m	p
i	-7	-2	-1	-5	-4	-7	2	-1	0	2	4	2	11	6	8	6	14	14	-7	16	15
	c	a	g	a	k	l	f	s	*	i	j	e	l	l	h	j	p	t	i	m	p
j	-9	-4	-3	-7	-6	-9	0	-1	0	0	2	0	9	4	8	4	12	12	-7	14	13
	c	a	g	a	k	l	f	s	d	*	j	e	l	l	h	j	p	t	i	m	p
k	-11	-6	-5	-9	-8	-11	-2	-3	-2	-1	0	-2	7	2	6	3	11	10	-9	12	12
	c	a	g	a	k	l	f	s	d	d	*	e	l	l	h	j	p	t	i	m	p
l	-9	-4	-3	-7	-5	-9	0	-1	0	1	3	0	9	4	8	5	13	12	-7	14	14
	c	a	g	a	f	l	f	s	d	d	j	*	l	l	h	j	p	t	i	m	p
m	-15	-10	-9	-13	-12	-15	-6	-7	-6	-5	-4	-6	0	-2	2	-3	5	3	-13	5	6
	c	a	g	a	k	l	f	s	d	d	t	e	*	l	h	r	p	t	i	m	p

n	-9	-4	-3	-7	-6	-9	0	-1	0	1	2	0	6	0	8	3	11	9	-7	11	12
	c	a	g	a	k	l	f	s	d	d	t	e	n	*	h	r	p	t	i	m	p
o	-12	-7	-6	-10	-9	-12	-3	-6	-5	-3	-1	-3	6	1	0	1	8	9	-12	11	10
	c	a	g	a	k	l	f	s	o	i	j	e	l	l	*	j	o	t	i	m	p
p	-8	-3	-2	-6	-5	-8	1	0	1	2	3	1	10	5	9	0	8	13	-6	15	9
	c	a	g	a	k	l	f	s	d	d	p	e	l	l	h	*	p	t	i	m	p
q	-6	-1	0	-4	-3	-6	3	2	3	4	5	3	12	7	11	2	0	8	-4	17	11
	c	a	g	a	k	l	f	s	d	d	p	e	l	l	h	r	*	q	i	m	p
r	-14	-9	-8	-12	-11	-14	-5	-6	-5	-4	-3	-5	4	-1	3	-6	2	0	-12	9	3
	c	a	g	a	k	l	f	s	d	d	p	e	l	l	h	r	p	*	i	m	p
s	1	6	7	3	4	1	10	6	8	10	12	10	19	14	15	14	22	22	0	24	23
	c	a	g	a	k	l	f	s	h	i	j	e	l	l	h	j	p	t	*	m	p
t	-20	-15	-14	-18	-17	-20	-11	-12	-11	-10	-9	-11	-2	-7	-3	-8	0	-2	-18	0	1
	c	a	g	a	k	l	f	s	d	d	t	e	l	l	h	r	p	t	i	*	p
u	-7	-2	-1	-5	-4	-7	2	1	2	3	4	2	11	6	10	1	9	7	-5	16	0
	c	a	g	a	k	l	f	s	d	d	p	e	l	l	h	r	p	u	i	m	*