

HOMEWORK 9

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1) Code Implementation and Time Complexity

```
void dijkstras (Graph & g,Vertex s,int dist[], int prev[]) //O((|E|+|V|)log|V|)
{
    int N = g.num_vertex;
    PriorityQueue Q(N);
    for (int i=0; i < N; i++)
    {
        prev[i] = -1;
        if (i==s.id)
        {
            dist[i] = 0;
        }
        else
        {
            dist[i] = INT_MAX;
        }
        Q.enqueue(g.vertices[i],dist[i]);
    }
    dist[s.id] = 0;
    while (!Q.isEmpty())
    {
        Vertex u = Q.dequeue();
        for (Edge edge:g.outgoingEdges(u))
        {
            int v = edge.dst;
            if (dist[v] > dist[u.id] + edge.weight)
            {
                dist[v] = dist[u.id]+ edge.weight;
                prev[v] = u.id;
                Q.id(v,dist[v]);
                Q.heapsort();
            }
        }
    }
}
```

```
void id(int n, int m) //O(N)=N
{
    for (int i=0;i<size;i++)
    {
        if (l[i].id == n)
        {
            l[i].dist = m;
        }
    }
}
```

```
vector<Edge> outgoingEdges(Vertex& v) // O(N)=1
{
    return vertices[v.id].edges;
}
```

```
void enqueue(Vertex & v, int dist = INT_MAX) // O(NlogN)
{
    l[size] = v;
    l[size].dist = dist;
    l[size].id = l[size].edges[0].src;
    size++;
    heapsort();
}

Vertex dequeue() //O(NlogN)
{
    Vertex ret = l[0];
    l[0]=l[size-1];
    size--;
    heapsort();
    return ret;
}
```

2) Standard Graph Test (Vertex 0) w/ Valgrind

```
yangt8@andromeda-8 21:57:48 ~/hw/hw9
$ make
echo      -----compiling dijkstras.cpp-----
-----compiling dijkstras.cpp-----
g++ -ggdb -std=c++0x -std=c++11 -Wpedantic -Wall -Wextra -Werror -Wzero-as-null-pointer-constant dijkstras.
cpp -o dijkstras
g++ -std=c++11 genGraph.cpp -o genGraph
yangt8@andromeda-8 21:57:50 ~/hw/hw9
$ valgrind ./dijkstras 0 large.graph
==14482== Memcheck, a memory error detector
==14482== Copyright (C) 2002-2017, and GNU GPL'd, by Julian Seward et al.
==14482== Using Valgrind-3.13.0 and LibVEX; rerun with -h for copyright info
==14482== Command: ./dijkstras 0 large.graph
==14482==
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3 [0-3] (6)
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94 [0-3-7-11-14-16-19-23-26-29-33-37-39-43-47-51-55-56-59-63-67-69-73-75-78-80-84-87-89-92-94] (107)
95 [0-3-7-11-14-16-19-23-26-29-33-37-39-43-47-51-55-56-59-63-67-69-73-75-78-80-84-87-91-95] (109)
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97 [0-3-7-11-14-16-19-23-26-29-33-37-39-43-47-51-55-56-59-63-67-69-73-75-78-80-84-87-90-93-97] (110)
98 [0-3-7-11-14-16-19-23-26-29-33-37-39-43-47-51-55-56-59-63-67-69-73-75-78-80-84-87-91-95-98] (110)
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==14482==

==14482== HEAP SUMMARY:
==14482==     in use at exit: 0 bytes in 0 blocks
==14482==   total heap usage: 29,317 allocs, 29,317 frees, 1,506,948 bytes allocated
==14482==
==14482== All heap blocks were freed -- no leaks are possible
==14482==
==14482== For counts of detected and suppressed errors, rerun with: -v
==14482== ERROR SUMMARY: 0 errors from 0 contexts (suppressed: 0 from 0)
```

3) Standard Graph Test (Vertex 27) w/ Valgrind

```
yangt8@andromeda-8 22:03:21 ~/hw/hw9
$ make
echo -----compiling dijkstras.cpp-----
-----compiling dijkstras.cpp-----
g++ -ggdb -std=c++0x -std=c++11 -Wpedantic -Wall -Wextra -Werror -Wzero-as-null-pointer-constant dijkstras.
cpp -o dijkstras
^[[A^[[Ag++ -std=c++11 genGraph.cpp -o genGraph
yangt8@andromeda-8 22:03:25 ~/hw/hw9
$ valgrind ./dijkstras 27 large.graph
==17503== Memcheck, a memory error detector
==17503== Copyright (C) 2002-2017, and GNU GPL'd, by Julian Seward et al.
==17503== Using Valgrind-3.13.0 and LibVEX; rerun with -h for copyright info
==17503== Command: ./dijkstras 27 large.graph
==17503==
0 [27-31-34-37-39-43-47-51-55-56-59-63-67-69-73-75-78-80-84-87-90-93-97-0] (90)
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13 [27-31-34-37-39-43-47-51-55-56-59-63-67-69-73-75-78-80-84-87-89-92-94-96-99-3-7-9-13] (111)
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18 [27-31-34-37-39-43-47-51-55-56-59-63-67-69-73-75-78-80-84-87-89-92-94-96-99-3-7-11-14-18] (112)
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24 [27-31-34-37-39-43-47-51-55-56-59-63-67-69-73-75-78-80-84-87-89-92-94-96-99-3-7-11-14-16-20-24] (126)
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72 [27-31-34-37-39-43-47-51-55-56-58-62-66-68-72] (59)
73 [27-31-34-37-39-43-47-51-55-56-59-63-67-69-73] (49)
74 [27-31-34-37-39-43-47-51-55-56-59-63-67-70-74] (60)
75 [27-31-34-37-39-43-47-51-55-56-59-63-67-69-73-75] (51)
76 [27-31-34-37-39-43-47-51-55-56-59-63-67-69-73-75-76] (58)
77 [27-31-34-37-39-43-47-51-55-56-59-63-67-69-73-77] (60)
78 [27-31-34-37-39-43-47-51-55-56-59-63-67-69-73-75-78] (53)
79 [27-31-34-37-39-43-47-51-55-56-59-63-67-69-73-75-79] (57)
80 [27-31-34-37-39-43-47-51-55-56-59-63-67-69-73-75-78-80] (58)
81 [27-31-34-37-39-43-47-51-55-56-59-63-67-69-73-75-79-81] (67)
82 [27-31-34-37-39-43-47-51-55-56-59-63-67-69-73-75-78-80-82] (63)
83 [27-31-34-37-39-43-47-51-55-56-59-63-67-69-73-75-78-80-83] (67)
84 [27-31-34-37-39-43-47-51-55-56-59-63-67-69-73-75-78-80-84] (63)
85 [27-31-34-37-39-43-47-51-55-56-59-63-67-69-73-75-78-80-84-85] (64)
86 [27-31-34-37-39-43-47-51-55-56-59-63-67-69-73-75-78-80-84-85-86] (73)
87 [27-31-34-37-39-43-47-51-55-56-59-63-67-69-73-75-78-80-84-87] (67)
88 [27-31-34-37-39-43-47-51-55-56-59-63-67-69-73-75-78-80-84-87-88] (74)
89 [27-31-34-37-39-43-47-51-55-56-59-63-67-69-73-75-78-80-84-87-89] (72)
90 [27-31-34-37-39-43-47-51-55-56-59-63-67-69-73-75-78-80-84-87-90] (80)
91 [27-31-34-37-39-43-47-51-55-56-59-63-67-69-73-75-78-80-84-87-91] (79)
92 [27-31-34-37-39-43-47-51-55-56-59-63-67-69-73-75-78-80-84-87-89-92] (79)
93 [27-31-34-37-39-43-47-51-55-56-59-63-67-69-73-75-78-80-84-87-90-93] (83)
94 [27-31-34-37-39-43-47-51-55-56-59-63-67-69-73-75-78-80-84-87-89-92-94] (81)
95 [27-31-34-37-39-43-47-51-55-56-59-63-67-69-73-75-78-80-84-87-91-95] (83)
96 [27-31-34-37-39-43-47-51-55-56-59-63-67-69-73-75-78-80-84-87-89-92-94-96] (85)
97 [27-31-34-37-39-43-47-51-55-56-59-63-67-69-73-75-78-80-84-87-90-93-97] (84)
98 [27-31-34-37-39-43-47-51-55-56-59-63-67-69-73-75-78-80-84-87-91-95-98] (84)
99 [27-31-34-37-39-43-47-51-55-56-59-63-67-69-73-75-78-80-84-87-89-92-94-96-99] (87)

==14590==

==14590== HEAP SUMMARY:
==14590==     in use at exit: 0 bytes in 0 blocks
==14590==   total heap usage: 29,624 allocs, 29,624 frees, 1,521,685 bytes allocated
==14590==

==14590== All heap blocks were freed -- no leaks are possible
==14590==

==14590== For counts of detected and suppressed errors, rerun with: -v
==14590== ERROR SUMMARY: 0 errors from 0 contexts (suppressed: 0 from 0)

```

4) Random Graph Test (Vertex 0) w/ Valgrind

```
yangt8@andromeda-8 21:44:18 ~/hw/hw9
$ make
echo -----compiling dijkstras.cpp-----
-----compiling dijkstras.cpp-----
g++ -ggdb -std=c++0x -std=c++11 -Wpedantic -Wall -Wextra -Werror -Wzero-as-null-pointer-constant dijkstras.cpp -o dijkstras
g++ -std=c++11 genGraph.cpp -o genGraph
yangt8@andromeda-8 21:44:22 ~/hw/hw9
$ ./genGraph > rdm.graph
yangt8@andromeda-8 21:45:24 ~/hw/hw9
$ valgrind ./dijkstras 0 rdm.graph
==13031== Memcheck, a memory error detector
==13031== Copyright (C) 2002-2017, and GNU GPL'd, by Julian Seward et al.
==13031== Using Valgrind-3.13.0 and LibVEX; rerun with -h for copyright info
==13031== Command: ./dijkstras 0 rdm.graph
==13031==
0 [0] (0)
1 [0-1] (3)
2 [0-1-2] (14)
3 [0-3] (4)
4 [0-4] (4)
5 [0-4-5] (12)
6 [0-3-6] (6)
7 [0-4-7] (10)
8 [0-4-8] (14)
9 [0-4-7-9] (12)
10 [0-3-6-10] (14)
11 [0-4-7-11] (15)
12 [0-4-7-11-12] (18)
13 [0-3-6-10-13] (18)
14 [0-3-6-10-14] (16)
15 [0-3-6-10-13-15] (24)
16 [0-3-6-10-13-16] (20)
17 [0-3-6-10-14-17] (20)
18 [0-3-6-10-13-16-18] (24)
19 [0-3-6-10-13-16-19] (26)
20 [0-3-6-10-14-17-20] (24)
21 [0-3-6-10-13-16-19-21] (28)
22 [0-3-6-10-13-16-19-22] (27)
23 [0-3-6-10-13-16-19-23] (30)
24 [0-3-6-10-14-17-20-24] (27)
25 [0-3-6-10-13-16-19-22-25] (39)
26 [0-3-6-10-14-17-20-24-26] (33)
27 [0-3-6-10-14-17-20-24-27] (32)
28 [0-3-6-10-14-17-20-24-28] (35)
29 [0-3-6-10-14-17-20-24-27-29] (33)
30 [0-3-6-10-14-17-20-24-28-30] (40)
31 [0-3-6-10-14-17-20-24-27-31] (35)
32 [0-3-6-10-14-17-20-24-27-29-32] (36)
33 [0-3-6-10-14-17-20-24-27-31-33] (38)
34 [0-3-6-10-14-17-20-24-27-31-34] (46)
35 [0-3-6-10-14-17-20-24-27-31-35] (46)
36 [0-3-6-10-14-17-20-24-27-29-32-36] (39)
37 [0-3-6-10-14-17-20-24-27-31-33-37] (43)
38 [0-3-6-10-14-17-20-24-27-29-32-36-38] (57)
39 [0-3-6-10-14-17-20-24-27-31-33-37-39] (45)
40 [0-3-6-10-14-17-20-24-27-29-32-36-40] (46)
41 [0-3-6-10-14-17-20-24-27-31-33-37-41] (49)
42 [0-3-6-10-14-17-20-24-27-31-33-37-39-42] (46)
43 [0-3-6-10-14-17-20-24-27-31-33-37-39-42-43] (47)
44 [0-3-6-10-14-17-20-24-27-31-33-37-39-42-44] (53)
45 [0-3-6-10-14-17-20-24-27-31-33-37-39-42-43-45] (52)
46 [0-3-6-10-14-17-20-24-27-31-33-37-39-42-46] (56)
47 [0-3-6-10-14-17-20-24-27-31-33-37-39-42-43-45-47] (55)
48 [0-3-6-10-14-17-20-24-27-31-33-37-39-42-44-48] (67)
49 [0-3-6-10-14-17-20-24-27-31-33-37-39-42-43-45-47-49] (64)
50 [0-3-6-10-14-17-20-24-27-31-33-37-39-42-46-50] (58)
51 [0-3-6-10-14-17-20-24-27-31-33-37-39-42-46-50-51] (63)
52 [0-3-6-10-14-17-20-24-27-31-33-37-39-42-46-50-52] (63)
53 [0-3-6-10-14-17-20-24-27-31-33-37-39-42-46-50-52-53] (65)
54 [0-3-6-10-14-17-20-24-27-31-33-37-39-42-46-50-51-54] (68)
55 [0-3-6-10-14-17-20-24-27-31-33-37-39-42-46-50-51-55] (69)
56 [0-3-6-10-14-17-20-24-27-31-33-37-39-42-46-50-52-56] (71)
57 [0-3-6-10-14-17-20-24-27-31-33-37-39-42-46-50-52-56-57] (72)
58 [0-3-6-10-14-17-20-24-27-31-33-37-39-42-46-50-51-55-58] (76)
59 [0-3-6-10-14-17-20-24-27-31-33-37-39-42-46-50-52-56-57-59] (73)
60 [0-3-6-10-14-17-20-24-27-31-33-37-39-42-46-50-52-56-60] (77)
```

etc.

```
1020 [[0-3-6-10-14-17-20-24-27-31-33-37-39-42-46-50-52-56-57-61-65-68-69-73-75-78-80-84-88-89-92-95-98-102-104-107-111-113-117-121-124-127-130-133-134-136-140-144-146-149-153-157-161-162-165-169-173-177-180-184-186-188-190-192-195-199-203-205-206-210-212-216-218-220-224-228-232-236-237-241-242-244-247-251-255-257-261-264-265-269-273-276-280-284-286-290-291-292-295-299-302-304-308-311-312-315-319-323-325-327-331-334-338-341-344-348-351-355-357-361-365-369-371-373-374-377-381-385-389-393-396-398-401-403-406-408-412-415-418-420-424-428-430-434-435-439-443-446-449-453-456-460-462-466-469-473-476-479-482-486-488-492-496-499-502-505-506-508-510-513-514-518-520-523-527-529-533-536-539-543-546-548-551-555-556-560-563-567-568-569-572-575-576-579-583-585-589-592-596-600-604-606-609-611-615-616-618-621-624-628-631-633-637-639-640-642-646-650-653-655-657-660-661-665-669-673-677-681-685-687-690-693-697-700-701-705-707-711-715-717-719-722-725-727-731-732-735-737-741-745-747-751-754-760-762-766-768-771-775-779-783-784-788-792-794-797-800-802-803-806-808-810-814-818-822-826-828-831-835-839-841-844-846-850-854-857-859-862-865-868-872-875-876-878-882-885-888-892-895-899-901-905-909-912-914-917-921-924-928-932-936-939-943-946-949-953-957-961-964-968-972-974-978-981-984-987-988-992-996-999-1003-1006-1009-1013-1017-1020] (1323)  
1021 [[0-3-6-10-14-17-20-24-27-31-33-37-39-42-46-50-52-56-57-61-65-68-69-73-75-78-80-84-88-89-92-95-98-102-104-107-111-113-117-121-124-127-130-133-134-136-140-144-146-149-153-157-161-162-165-169-173-177-180-184-186-188-190-192-195-199-203-205-206-210-212-216-218-220-224-228-232-236-237-241-242-244-247-251-255-257-261-264-265-269-273-276-280-284-286-290-291-292-295-299-302-304-308-311-312-315-319-323-325-327-331-334-338-341-344-348-351-355-357-361-365-369-371-373-374-377-381-385-389-393-396-398-401-403-406-408-412-415-418-420-424-428-430-434-435-439-443-446-449-453-456-460-462-466-469-473-476-479-482-486-488-492-496-499-502-505-506-508-510-513-514-518-520-523-527-529-533-536-539-543-546-548-551-555-556-560-563-567-568-569-572-575-576-579-583-585-589-592-596-600-604-606-609-611-615-616-618-621-624-628-631-633-637-639-640-642-646-650-653-655-657-660-661-665-669-673-677-681-685-687-690-693-697-700-701-705-707-711-715-717-719-722-725-727-731-732-735-737-741-745-747-751-754-760-762-766-768-771-775-779-783-784-788-792-794-797-800-802-803-806-808-810-814-818-822-826-828-831-835-839-841-844-846-850-854-857-859-862-865-868-872-875-876-878-882-885-888-892-895-899-901-905-909-912-914-917-921-924-928-932-936-939-943-946-949-953-957-961-964-968-972-974-978-981-984-987-988-992-996-999-1003-1006-1009-1013-1017-1021] (1324)  
1022 [[0-3-6-10-14-17-20-24-27-31-33-37-39-42-46-50-52-56-57-61-65-68-69-73-75-78-80-84-88-89-92-95-98-102-104-107-111-113-117-121-124-127-130-133-134-136-140-144-146-149-153-157-161-162-165-169-173-177-180-184-186-188-190-192-195-199-203-205-206-210-212-216-218-220-224-228-232-236-237-241-242-244-247-251-255-257-261-264-265-269-273-276-280-284-286-290-291-292-295-299-302-304-308-311-312-315-319-323-325-327-331-334-338-341-344-348-351-355-357-361-365-369-371-373-374-377-381-385-389-393-396-398-401-403-406-408-412-415-418-420-424-428-430-434-435-439-443-446-449-453-456-460-462-466-469-473-476-479-482-486-488-492-496-499-502-505-506-508-510-513-514-518-520-523-527-529-533-536-539-543-546-548-551-555-556-560-563-567-568-569-572-575-576-579-583-585-589-592-596-600-604-606-609-611-615-616-618-621-624-628-631-633-637-639-640-642-646-650-653-655-657-660-661-665-669-673-677-681-685-687-690-693-697-700-701-705-707-711-715-717-719-722-725-727-731-732-735-737-741-745-747-751-754-760-762-766-768-771-775-779-783-784-788-792-794-797-800-802-803-806-808-810-814-818-822-826-828-831-835-839-841-844-846-850-854-857-859-862-865-868-872-875-876-878-882-885-888-892-895-899-901-905-909-912-914-917-921-924-928-932-936-939-943-946-949-953-957-961-964-968-972-974-978-981-984-987-988-992-996-999-1003-1006-1009-1013-1017-1022] (1331)  
1023 [[0-3-6-10-14-17-20-24-27-31-33-37-39-42-46-50-52-56-57-61-65-68-69-73-75-78-80-84-88-89-92-95-98-102-104-107-111-113-117-121-124-127-130-133-134-136-140-144-146-149-153-157-161-162-165-169-173-177-180-184-186-188-190-192-195-199-203-205-206-210-212-216-218-220-224-228-232-236-237-241-242-244-247-251-255-257-261-264-265-269-273-276-280-284-286-290-291-292-295-299-302-304-308-311-312-315-319-323-325-327-331-334-338-341-344-348-351-355-357-361-365-369-371-373-374-377-381-385-389-393-396-398-401-403-406-408-412-415-418-420-424-428-430-434-435-439-443-446-449-453-456-460-462-466-469-473-476-479-482-486-488-492-496-499-502-505-506-508-510-513-514-518-520-523-527-529-533-536-539-543-546-548-551-555-556-560-563-567-568-569-572-575-576-579-583-585-589-592-596-600-604-606-609-611-615-616-618-621-624-628-631-633-637-639-640-642-646-650-653-655-657-660-661-665-669-673-677-681-685-687-690-693-697-700-701-705-707-711-715-717-719-722-725-727-731-732-735-737-741-745-747-751-754-760-762-766-768-771-775-779-783-784-788-792-794-797-800-802-803-806-808-810-814-818-822-826-828-831-835-839-841-844-846-850-854-857-859-862-865-868-872-875-876-878-882-885-888-892-895-899-901-905-909-912-914-917-921-924-928-932-936-939-943-946-949-953-957-961-964-968-972-974-978-981-984-987-988-992-996-999-1003-1006-1009-1013-1017-1020-1023] (1324)  
==13031==  
==13031== HEAP SUMMARY:  
==13031==     in use at exit: 0 bytes in 0 blocks  
==13031==   total heap usage: 2,847,692 allocs, 2,847,692 frees, 138,054,240 bytes allocated  
==13031==  
==13031== All heap blocks were freed -- no leaks are possible  
==13031==  
==13031== For counts of detected and suppressed errors, rerun with: -v  
==13031== ERROR SUMMARY: 0 errors from 0 contexts (suppressed: 0 from 0)
```