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5 (b) $$f(n) = \begin{cases} n^4 & 0 < n < 2000 \\ n^{\log 8} & n \geq 2000 \end{cases}$$

$$g(n) = \begin{cases} n^5 \log n & 0 < n < 1000 \\ n^2 & n \geq 1000 \end{cases}$$

I for $0 < n < 1000$

$f(n) = n^4$

$g(n) = n^5 \log n$

$\therefore n^4 < n^5 \log n$

$\therefore f(n) = O(g(n))$

II for $1000 \leq n < 2000$

$f(n) = n^4$

$g(n) = n^2$

$\therefore n^4 > n^2$

$\therefore g(n) = O(f(n))$

III for $2000 \leq n$

$f(n) = n^{\log 8} \approx n^3$

$g(n) = n^2$

$\therefore g(n) < f(n)$

$g(n) = O(f(n))$

So, we see, for $0 < n < 1000$,

$f(n) = O(g(n))$

but ultimately after $n \geq n_0 = 1000$ and $c = 1$

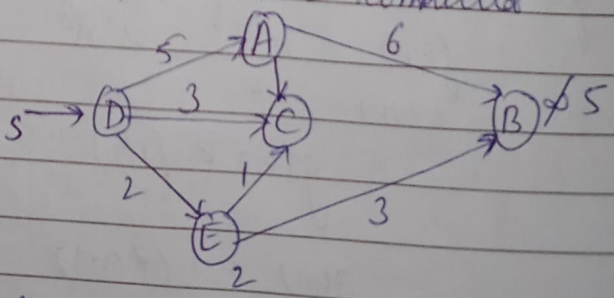
$g(n) = O(f(n))$

$\therefore f(n) = O(g(n))$ is false.

(c) insertion sort is a best choice over small inputs that is almost sorted. It doesn't take any extra space (internal sorting) and can have time complexity $O(n^2)$ in worst case since, sorted array is the best case of insertion sort which takes $O(n)$ time with $O(1)$ space.

But another best case for insertion sort is a array with all same elements
eg- [1, 1, 1, 1 . . . .]
in this case, the algo will never go in second while loop and the time complexity will be $o(n)$
as arr[i] i.e. ele $\not>$ ele in any case so it does not go in inner loop

(a) let us start with vertex D.
from D, vertex A, C, E are connected



$\therefore d(A) = 5$
$d(C) = 3$
$d(E) = 2$
$d(B) = \infty$
$d(E)$ is smallest
$\therefore$ next node selected is E.

from E, vertex C and B are connected.
$d(E) + c(E, C) < 3$
$2 + 1 < 3$ false

$\therefore d(C) = 3$

$d(E) + C(E,B) < \infty$

$2 + 3 < \infty$

$5 < \infty$

$\therefore d(B) = 5$

$d(C)$ is smallest $\therefore$ next vertex is C.
from C no outgoing edge is there.
$\therefore$ it will remain as it is.

$d(A) = 5$ $\therefore$ next vector is A
from A, B, and C are connected C is already selected.
for B, $d(A) + C(A,B) < 5$

$5 + 6 < 5$

$11 < 5$ (false)

$\therefore$ nothing change

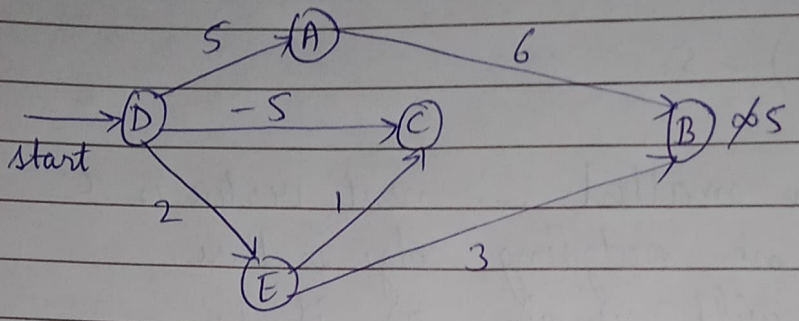
Next vertex is B,
from B, no outgoing edge is there
$\therefore$ it will remain as it is.

start D, selected vertex	A	B	C	E
E	5	∞	3	(2)
C	5	5	(3)	(2)
A	(5)	5	(3)	(2)
B	(5)	(5)	(3)	(2)
	(5)	(5)	(3)	(2)

∴ shortest distance of vertex A, B, C and E from vertex D is 5, 5, 3 and 2.

if DC = -5

start = D



Selected Vertex	A	B	C	E
C	5	∞	(-5)	2
E	5	∞	(-5)	(2)
A	(5)	5	(-5)	(2)
B	(5)	(5)	(-5)	(2)

Yes, it worked for DC = -5 also.
As, there is no outgoing edge from C ∴ the negative value is not affecting any other value of vertex.

But, this may not be true always.
Drawback of Dijkstra's Algo is that it may or may not work for negative edges.