5 common misconceptions concerning heuristic search

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misconception #1

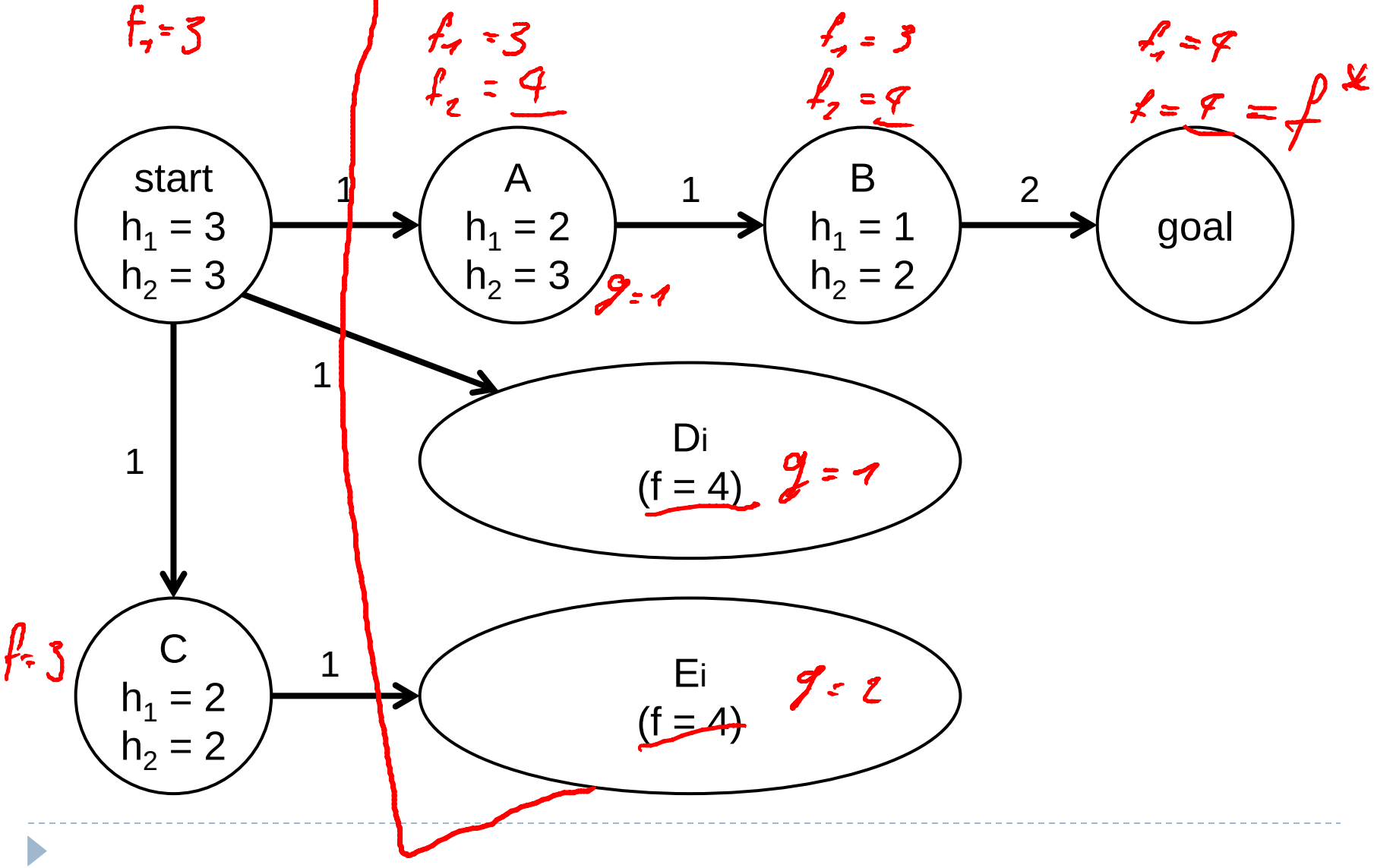
better heuristics result in fewer node expansions by A* and IDA*

a better heuristic

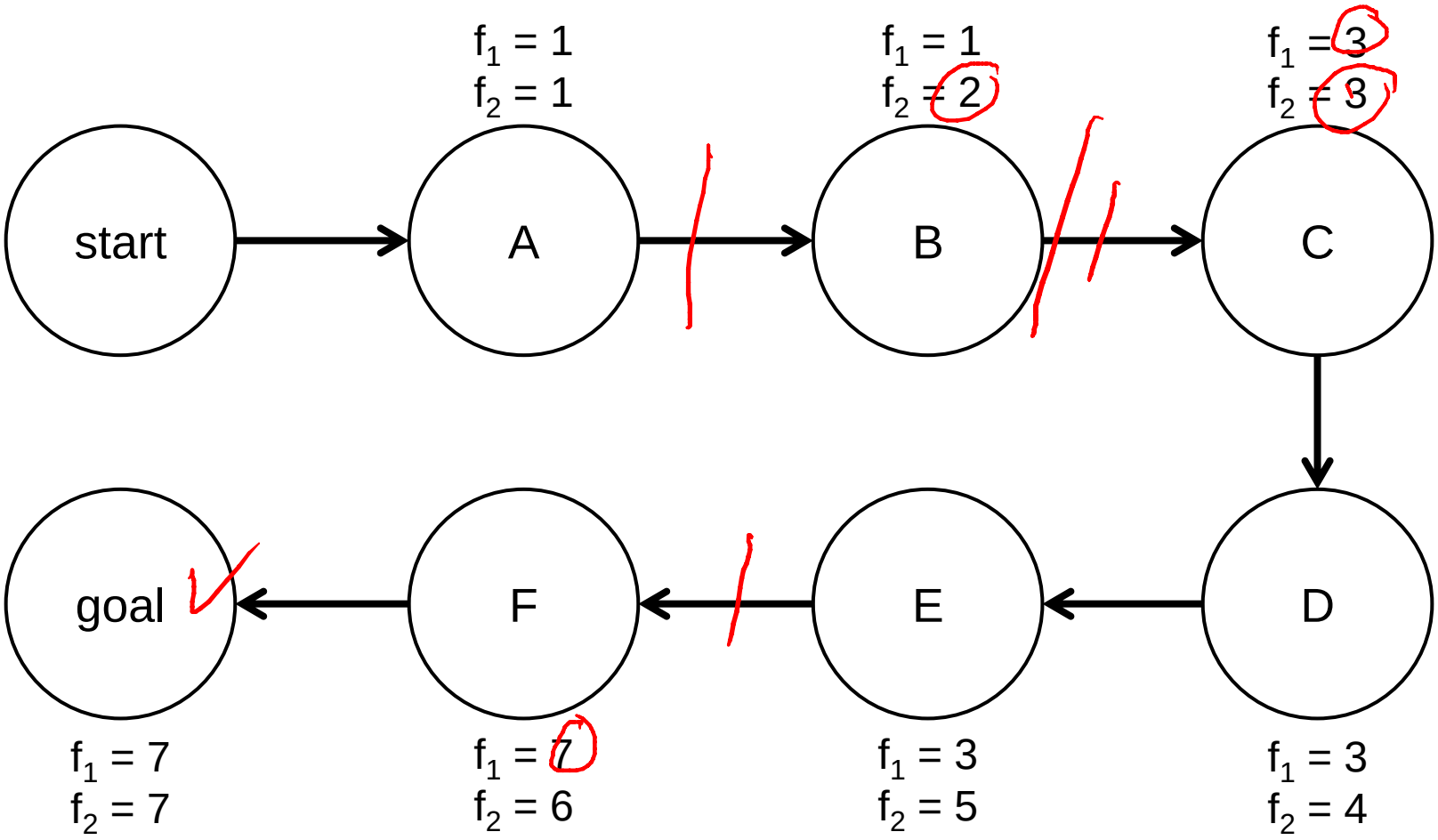
a heuristic h_2 is better than h_1 when…

- …h_2 is admissible
- …for all states s, $h_2(s) \geq h_1(s)$
- …for at least one state s, $h_2(s) > h_1(s)$

an example


start
h1 = 3
h2 = 3
A
h1 = 2
h2 = 3
B
h1 = 1
h2 = 2
goal
C
h1 = 2
h2 = 2
Di
(f = 4)
Ei
(f = 4)
1
1
2
1
1
1
f1=3
f1 =3
f2 = 4
f1 = 3
f2 =4
f1 = 4
f = 4 = f*
g=1
g=1
f=3
g=2

an example


start
A
B
C
D
E
F
goal
$f_1 = 1$
$f_2 = 1$
$f_1 = 1$
$f_2 = 2$
$f_1 = 3$
$f_2 = 3$
$f_1 = 3$
$f_2 = 4$
$f_1 = 3$
$f_2 = 5$
$f_1 = 7$
$f_2 = 6$
$f_1 = 7$
$f_2 = 7$

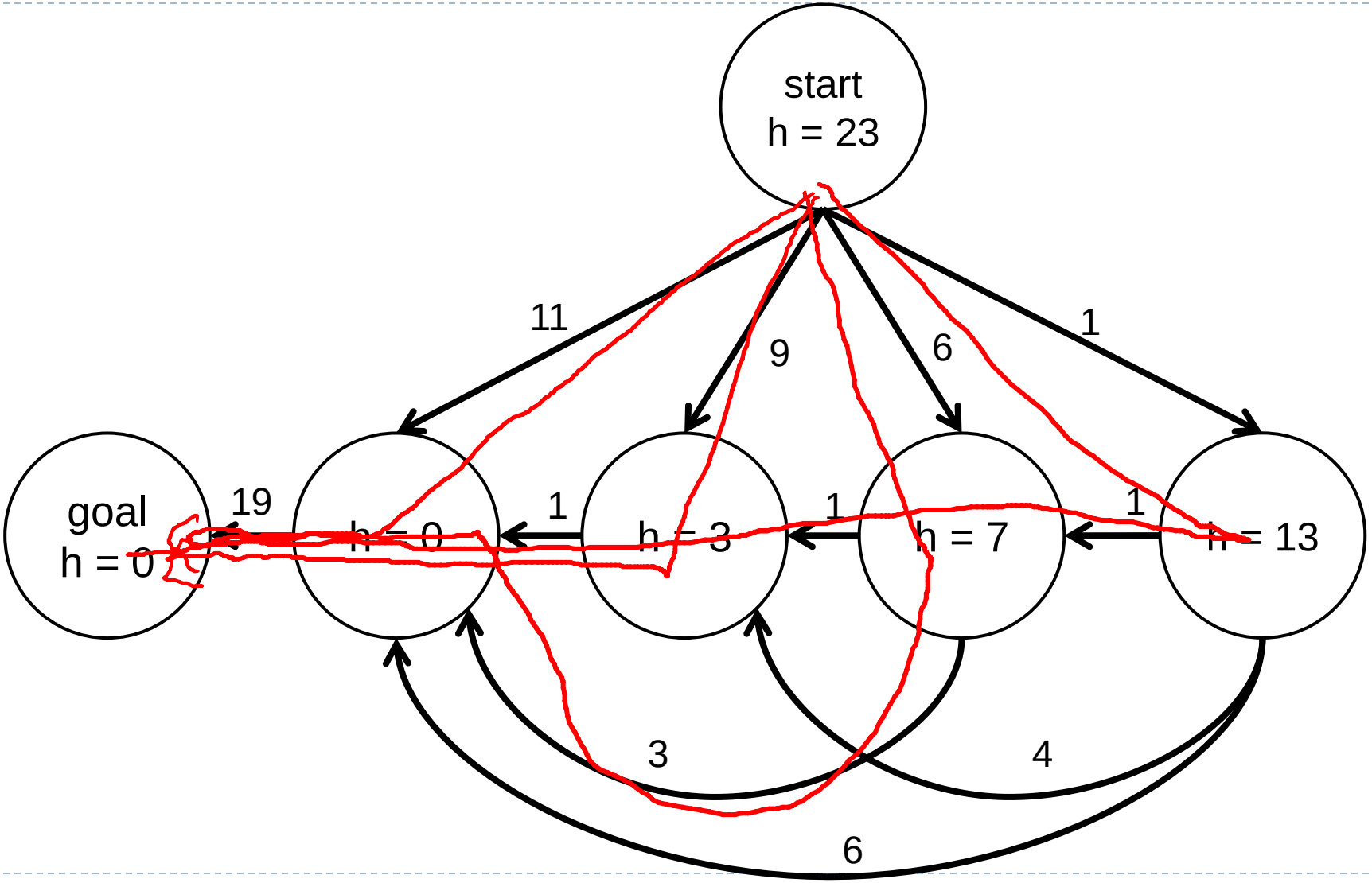
misconception #2

A* does fewer node expansions than any other equally informed algorithm that finds optimal solutions

discussion

- obviously false for inconsistent heuristics
  - $O(2^N)$ worst-case for A*, other algorithms with $O(N^2)$ worst-case
  - improved algorithm for that case called B
    - keeps track of maximum f value F
    - if next f < F, state with minimum g value is used
- correct for consistent heuristics
  - A* does not expand more nodes than rivals
  - other algorithms can be faster even with more node expansions

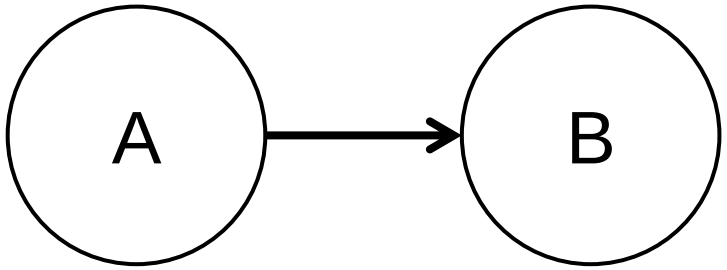
an example



misconception #3

any admissible heuristic can be turned into a consistent one by a simple technique called *pathmax*

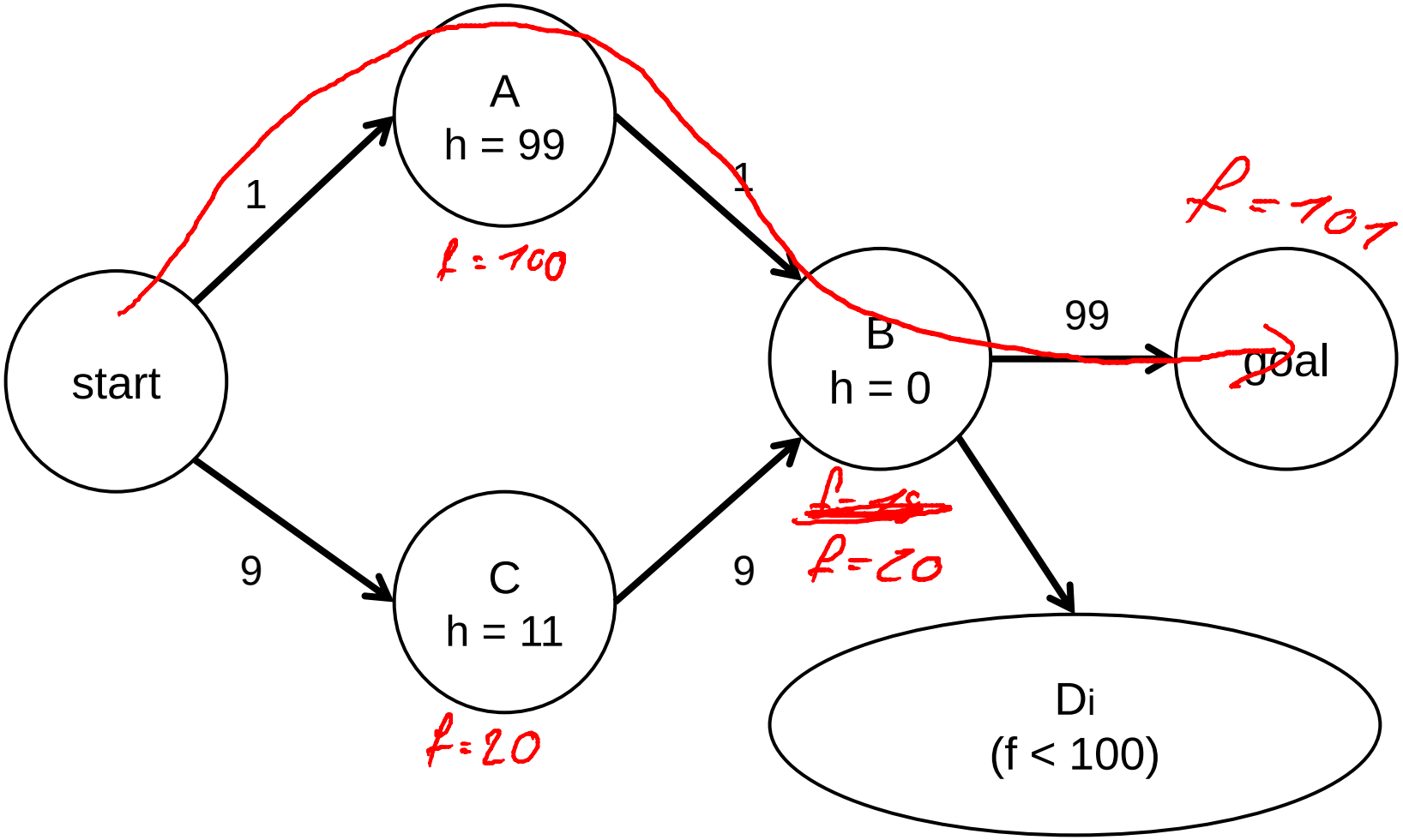
pathmax



$$f'(B) = \max(f(B), f(A))$$

along path

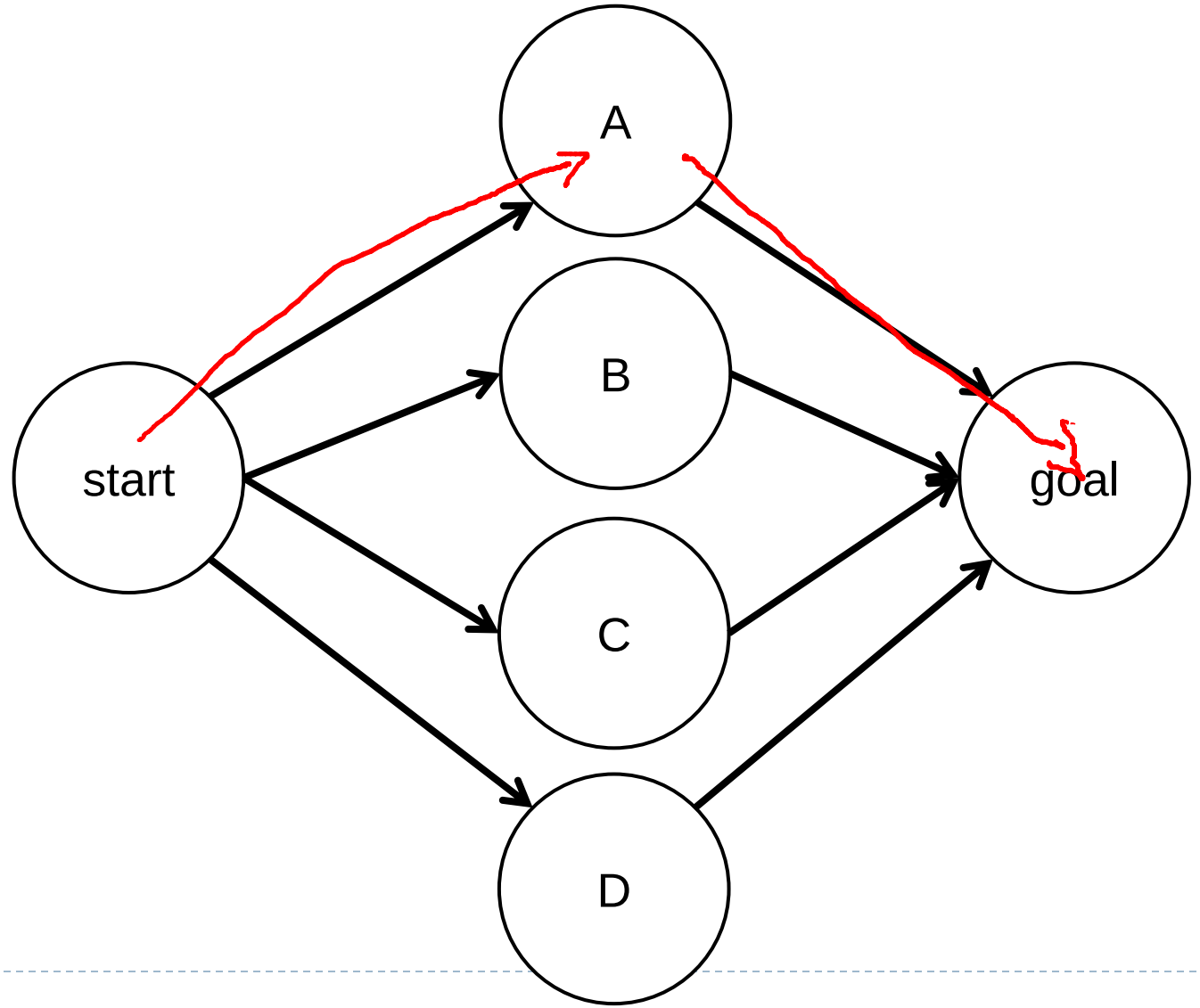
an example



misconception #4

in search spaces with uniform cost and $h(s) = 0$, A* is the same as breadth-first search

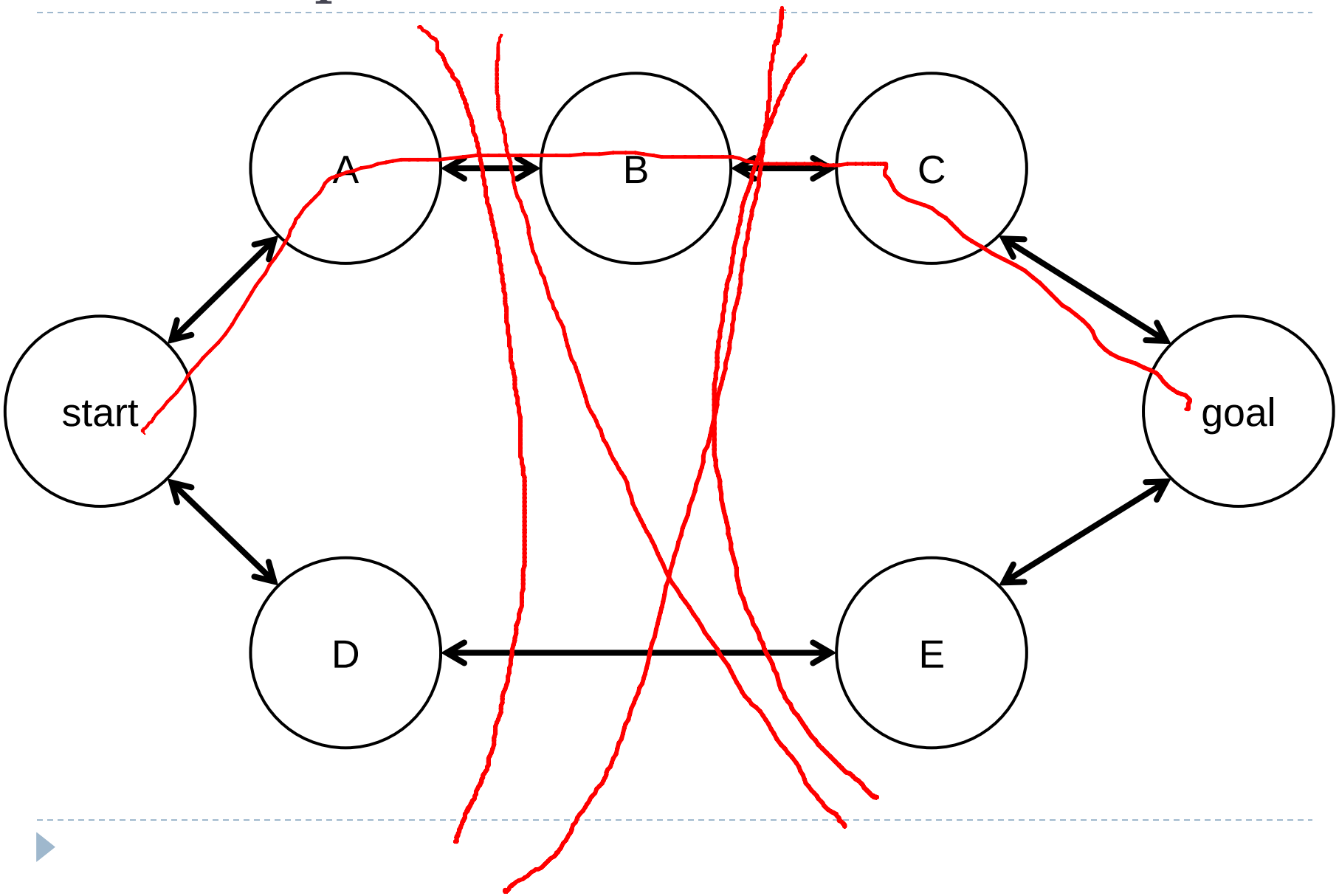
an example



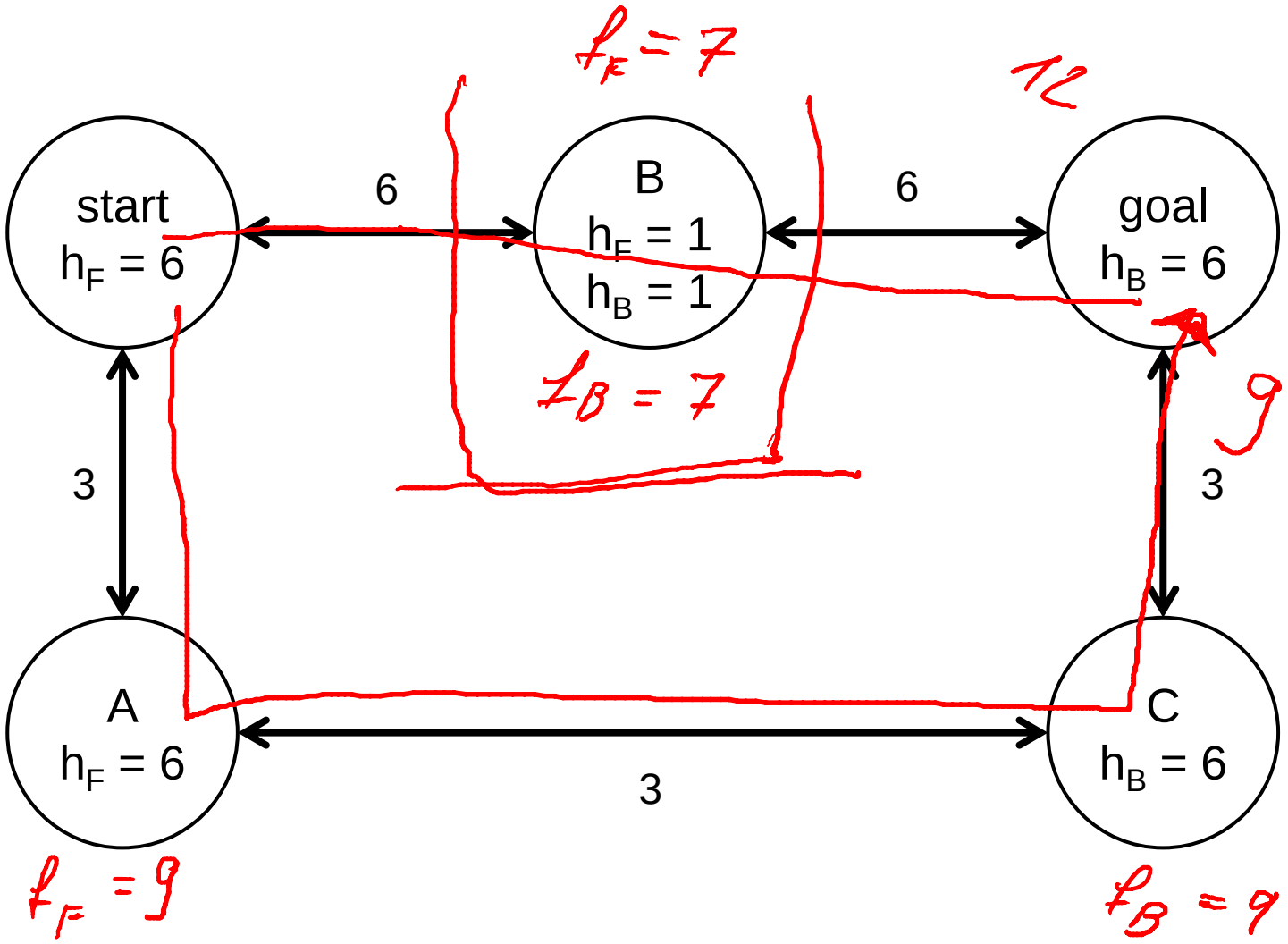
misconception #5

bidirectional search stops when the forward and backward search frontiers meet

an example



an example


start
$h_F = 6$
B
$h_F = 1$
$h_B = 1$
goal
$h_B = 6$
A
$h_F = 6$
C
$h_B = 6$
6
6
3
3
3
$f_F = 7$
12
$f_B = 7$
9
$f_F = 9$
$f_B = 9$

conclusions

- with admissible consistent heuristics, A* is hard to beat
- A* is not a silver bullet
- don’t trust hearsay
- pay attention to details