Dataflow Analysis: examples

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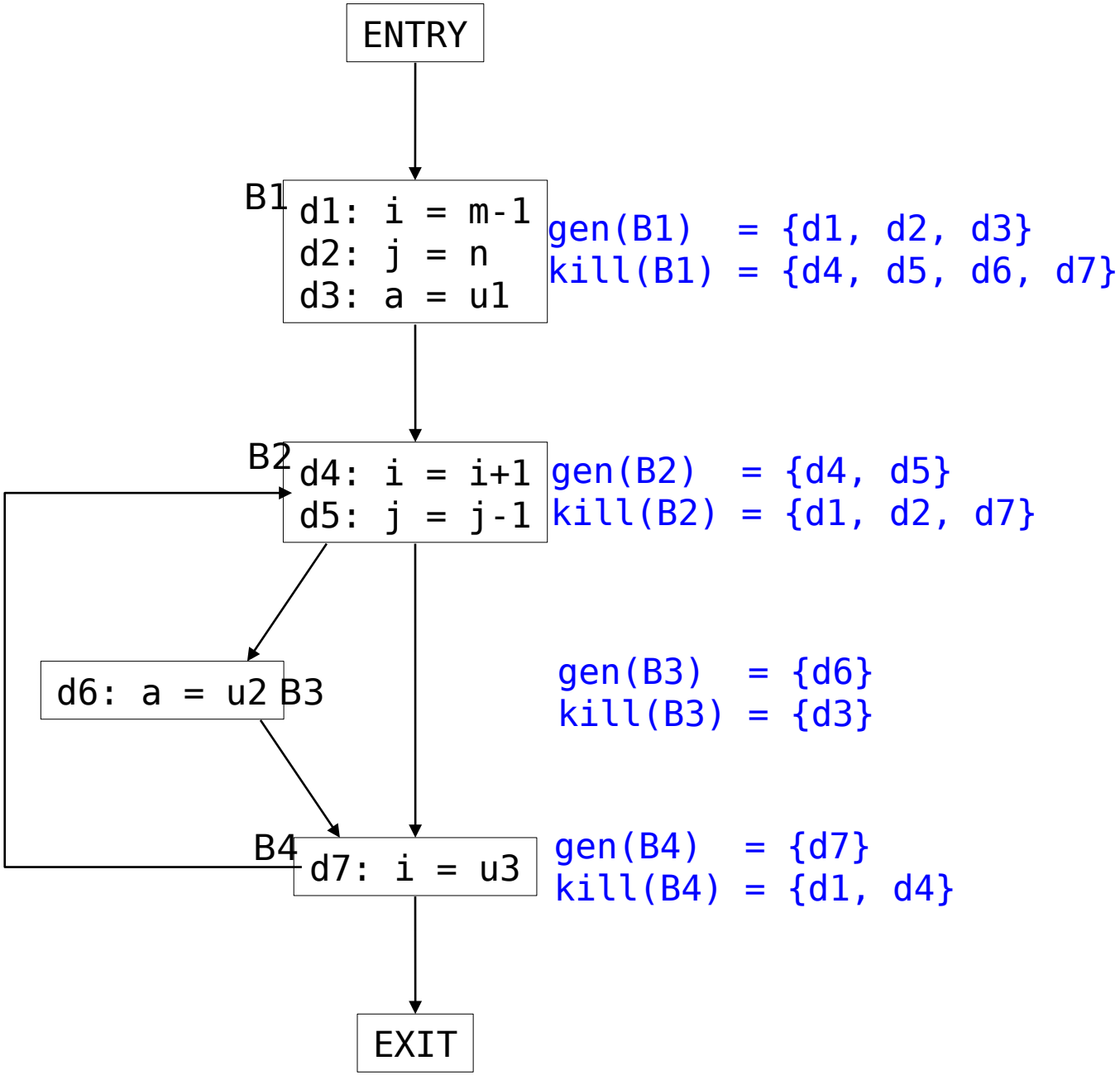
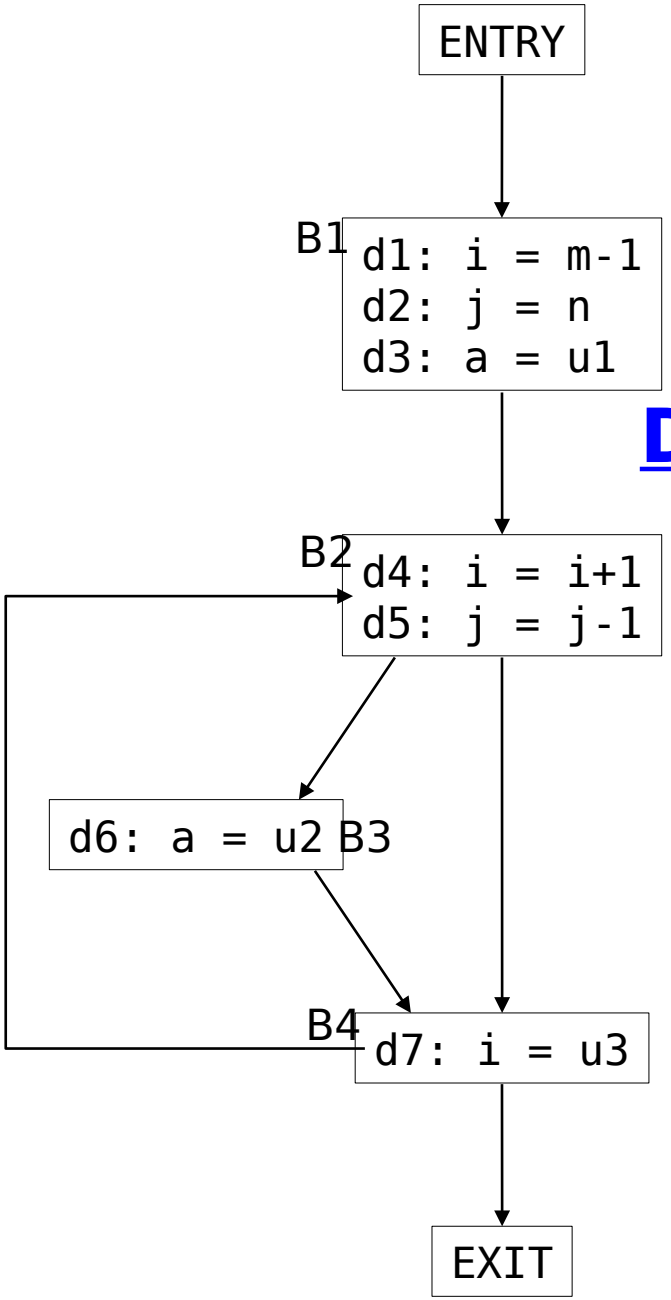
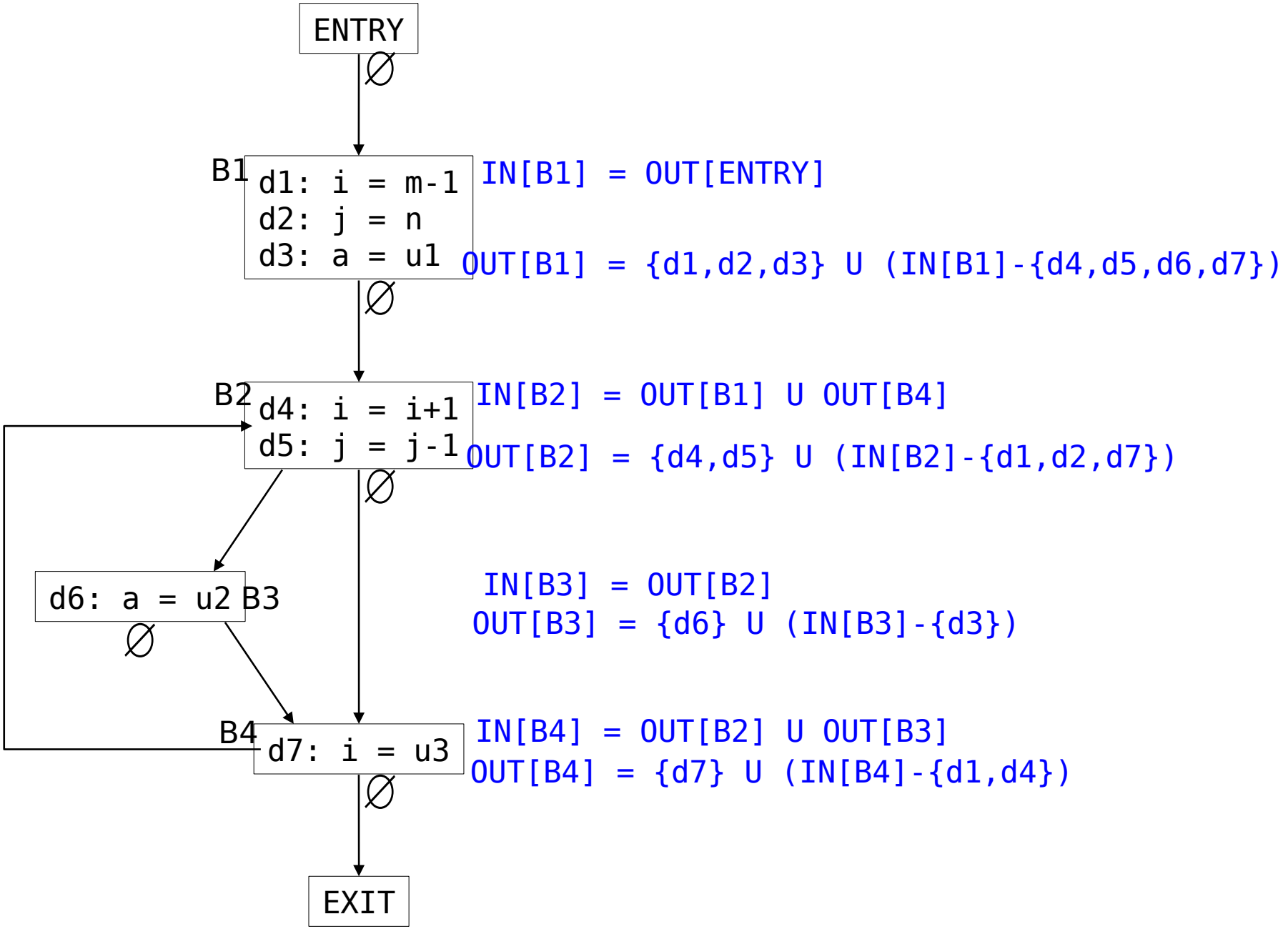
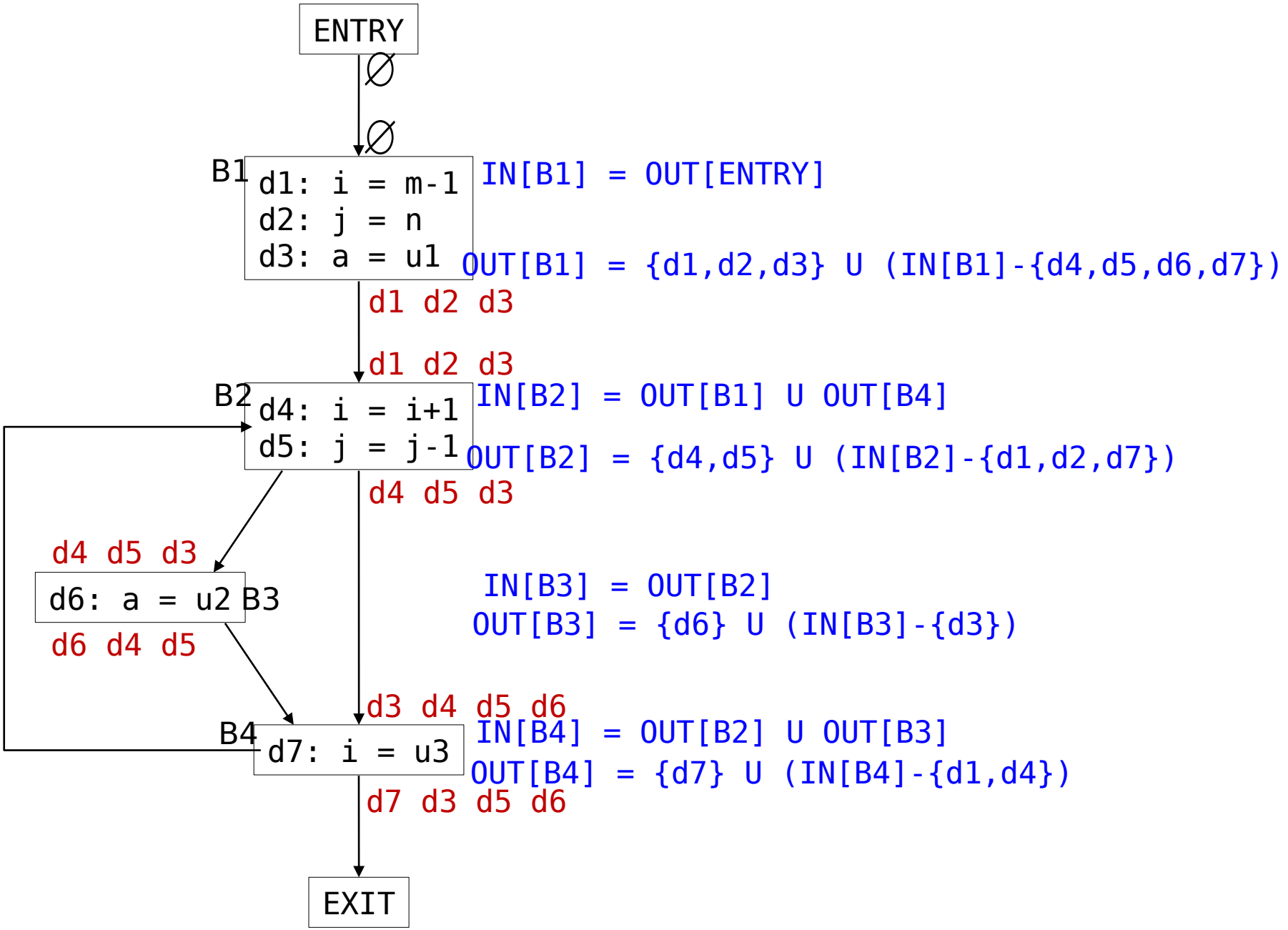
Reaching definitions

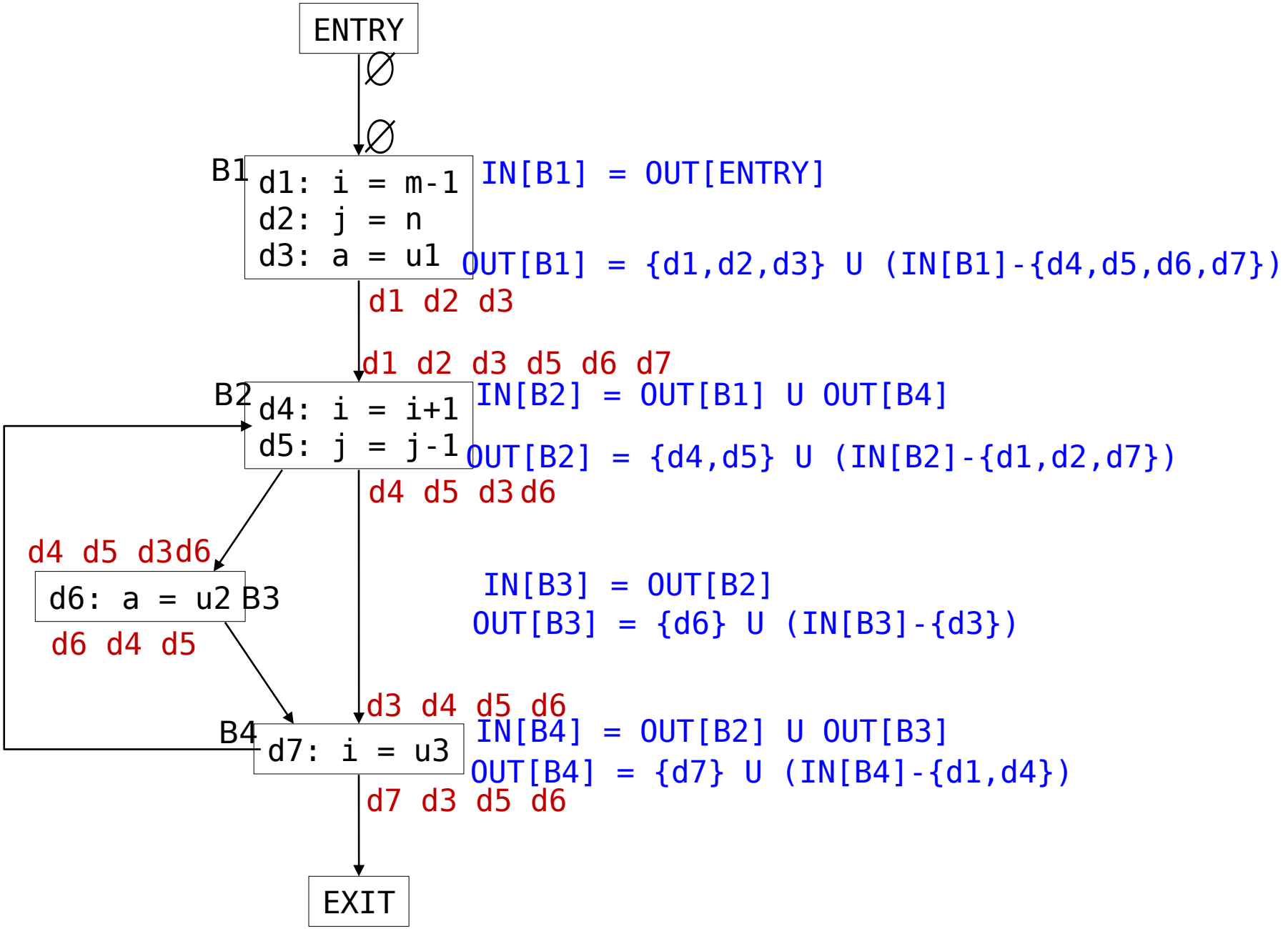

ENTRY
B1
d1: i = m-1
d2: j = n
d3: a = u1
gen(B1) = {d1, d2, d3}
kill(B1) = {d4, d5, d6, d7}
B2
d4: i = i+1
d5: j = j-1
gen(B2) = {d4, d5}
kill(B2) = {d1, d2, d7}
d6: a = u2
B3
gen(B3) = {d6}
kill(B3) = {d3}
B4
d7: i = u3
gen(B4) = {d7}
kill(B4) = {d1, d4}
EXIT



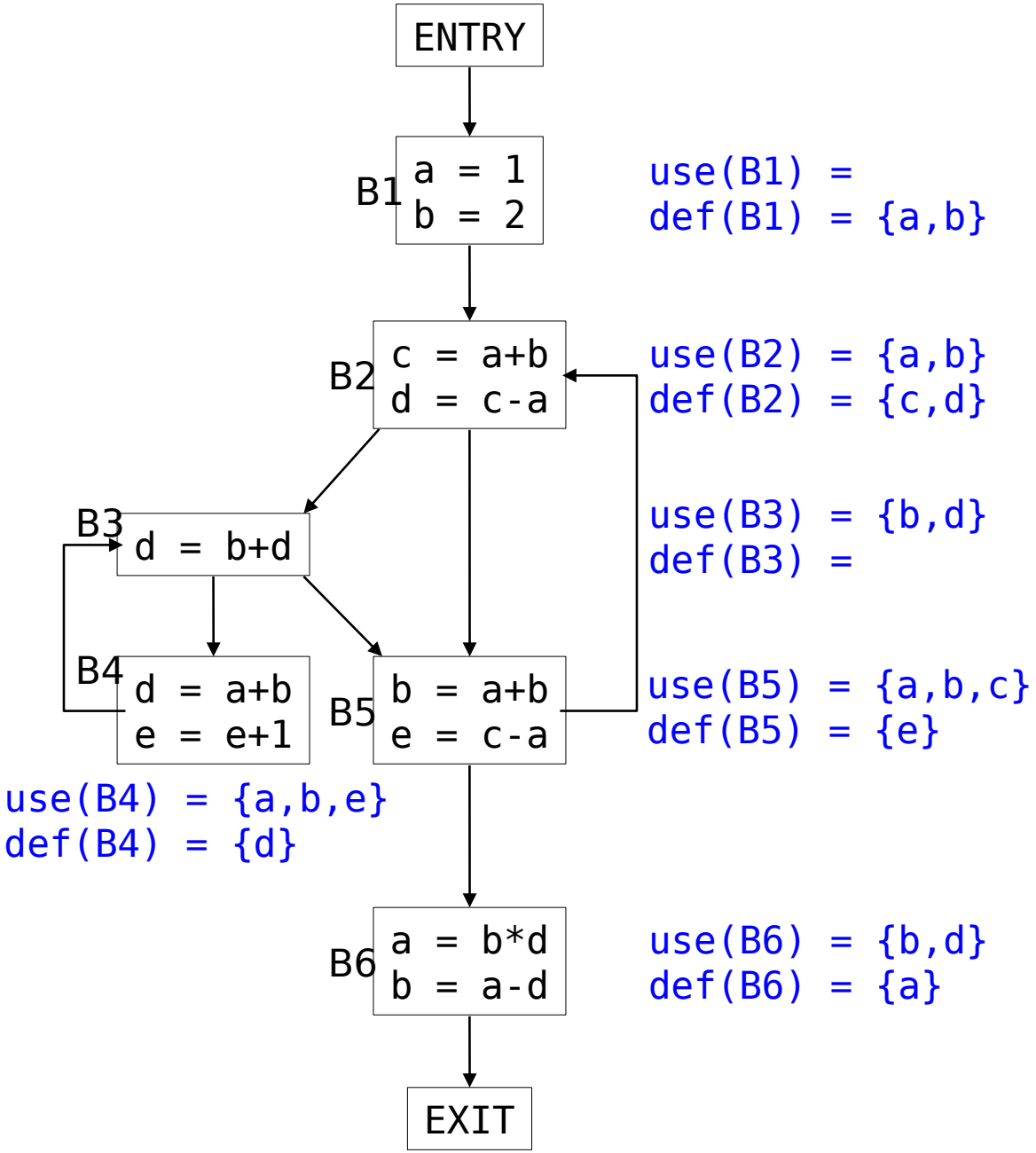
Dataflow equations (forward)

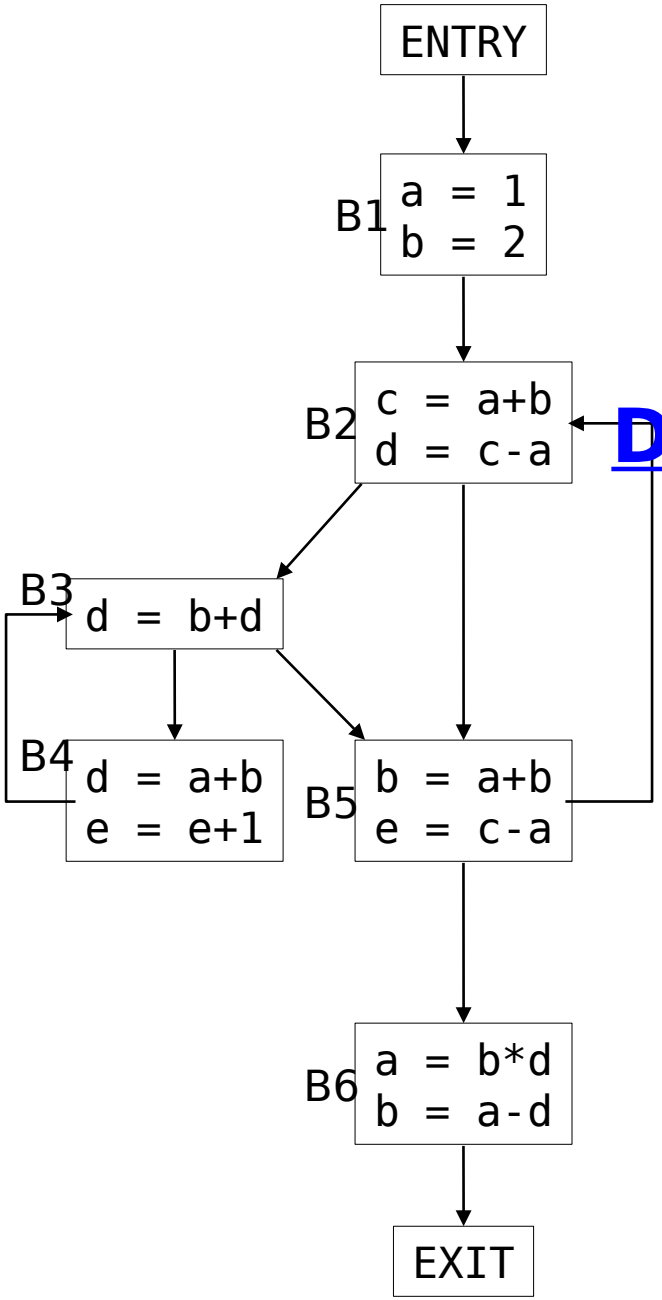

ENTRY
∅
B1
d1: i = m-1
d2: j = n
d3: a = u1
IN[B1] = OUT[ENTRY]
OUT[B1] = {d1,d2,d3} U (IN[B1]-{d4,d5,d6,d7})
∅
B2
d4: i = i+1
d5: j = j-1
IN[B2] = OUT[B1] U OUT[B4]
OUT[B2] = {d4,d5} U (IN[B2]-{d1,d2,d7})
∅
d6: a = u2
B3
∅
IN[B3] = OUT[B2]
OUT[B3] = {d6} U (IN[B3]-{d3})
B4
d7: i = u3
IN[B4] = OUT[B2] U OUT[B3]
OUT[B4] = {d7} U (IN[B4]-{d1,d4})
∅
EXIT


ENTRY
∅
∅
B1
d1: i = m-1
d2: j = n
d3: a = u1
IN[B1] = OUT[ENTRY]
OUT[B1] = {d1,d2,d3} U (IN[B1]-{d4,d5,d6,d7})
d1 d2 d3
d1 d2 d3
B2
d4: i = i+1
d5: j = j-1
IN[B2] = OUT[B1] U OUT[B4]
OUT[B2] = {d4,d5} U (IN[B2]-{d1,d2,d7})
d4 d5 d3
d4 d5 d3
d6: a = u2
B3
IN[B3] = OUT[B2]
OUT[B3] = {d6} U (IN[B3]-{d3})
d6 d4 d5
d3 d4 d5 d6
B4
d7: i = u3
IN[B4] = OUT[B2] U OUT[B3]
OUT[B4] = {d7} U (IN[B4]-{d1,d4})
d7 d3 d5 d6
EXIT

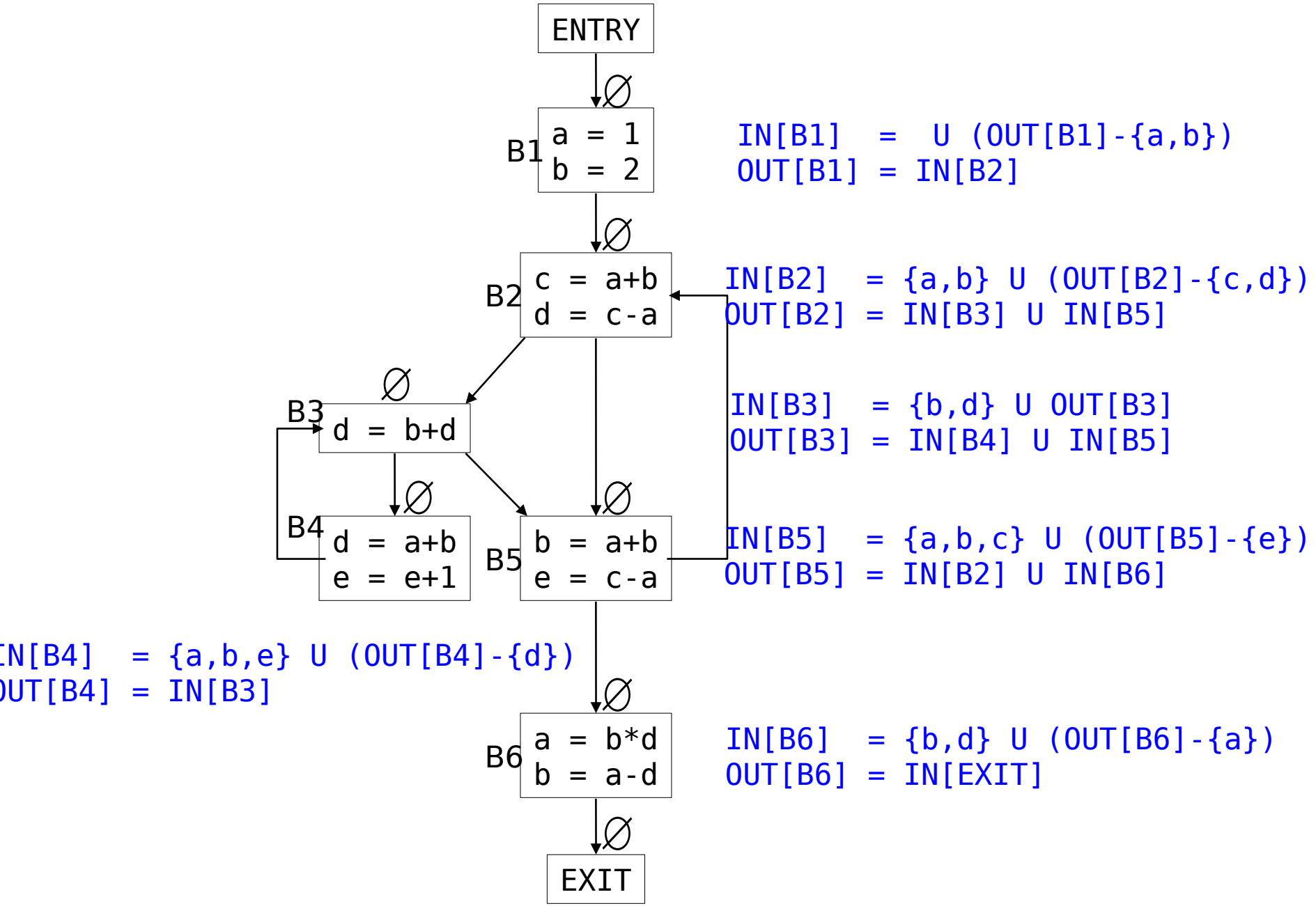

ENTRY
∅
∅
B1
d1: i = m-1
d2: j = n
d3: a = u1
IN[B1] = OUT[ENTRY]
OUT[B1] = {d1,d2,d3} U (IN[B1]-{d4,d5,d6,d7})
d1 d2 d3
d1 d2 d3 d5 d6 d7
B2
d4: i = i+1
d5: j = j-1
IN[B2] = OUT[B1] U OUT[B4]
OUT[B2] = {d4,d5} U (IN[B2]-{d1,d2,d7})
d4 d5 d3 d6
d4 d5 d3d6
d6: a = u2
B3
IN[B3] = OUT[B2]
OUT[B3] = {d6} U (IN[B3]-{d3})
d6 d4 d5
d3 d4 d5 d6
B4
d7: i = u3
IN[B4] = OUT[B2] U OUT[B3]
OUT[B4] = {d7} U (IN[B4]-{d1,d4})
d7 d3 d5 d6
EXIT

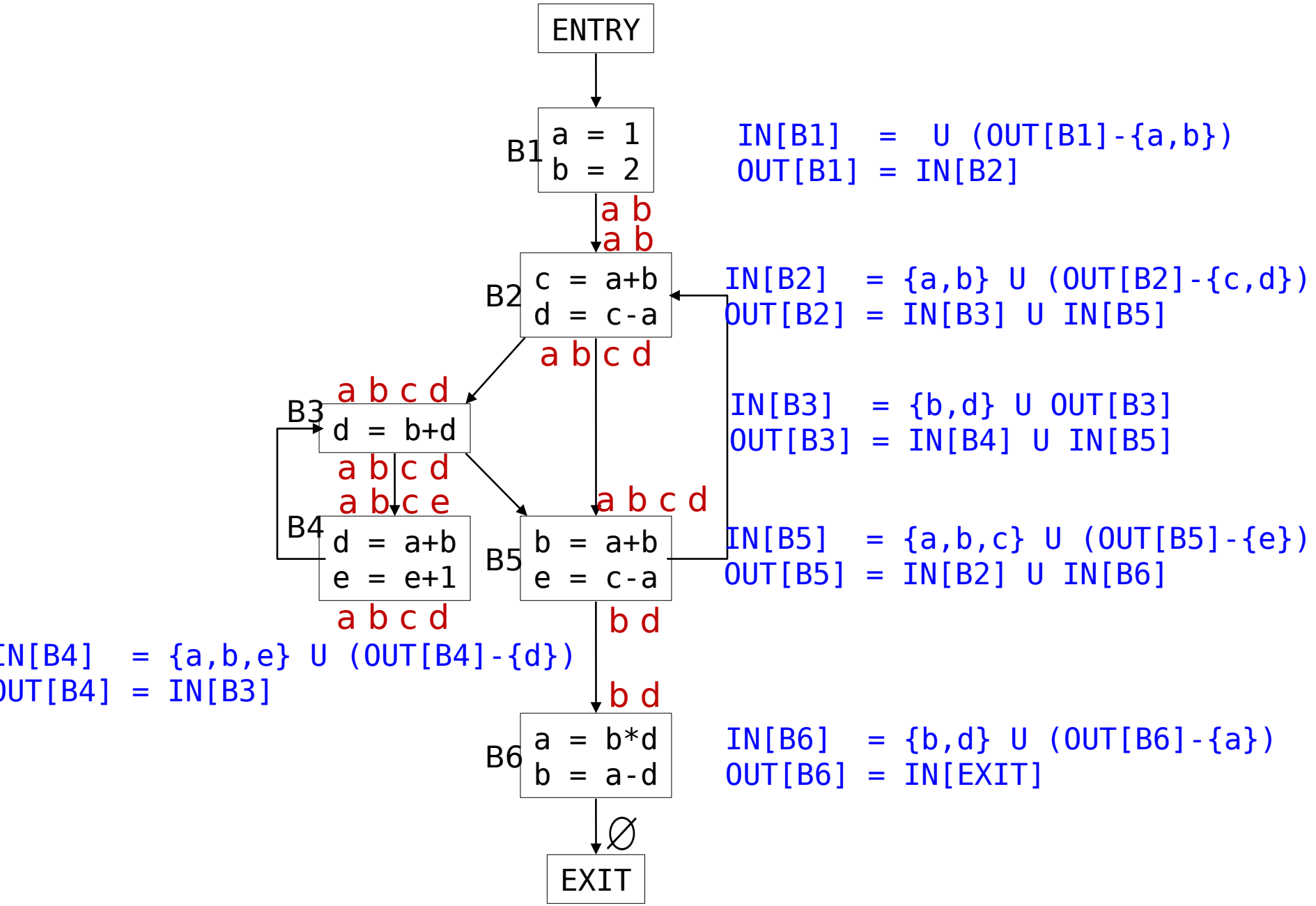
Live variables

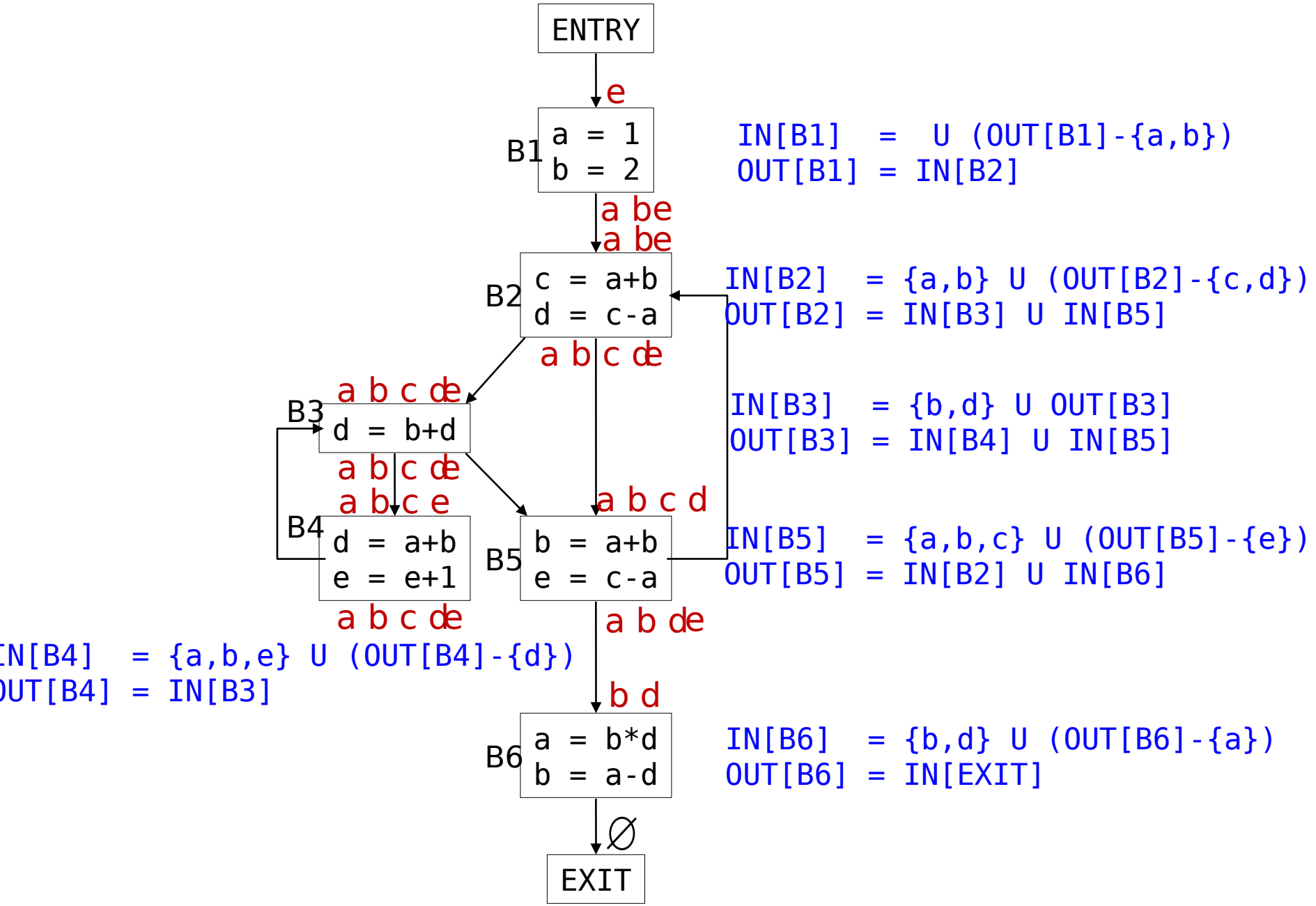

ENTRY
B1
a = 1
b = 2
use(B1) =
def(B1) = {a,b}
B2
c = a+b
d = c-a
use(B2) = {a,b}
def(B2) = {c,d}
B3
d = b+d
use(B3) = {b,d}
def(B3) =
B4
d = a+b
e = e+1
B5
b = a+b
e = c-a
use(B5) = {a,b,c}
def(B5) = {e}
use(B4) = {a,b,e}
def(B4) = {d}
B6
a = b*d
b = a-d
use(B6) = {b,d}
def(B6) = {a}
EXIT



Dataflow equations (backward

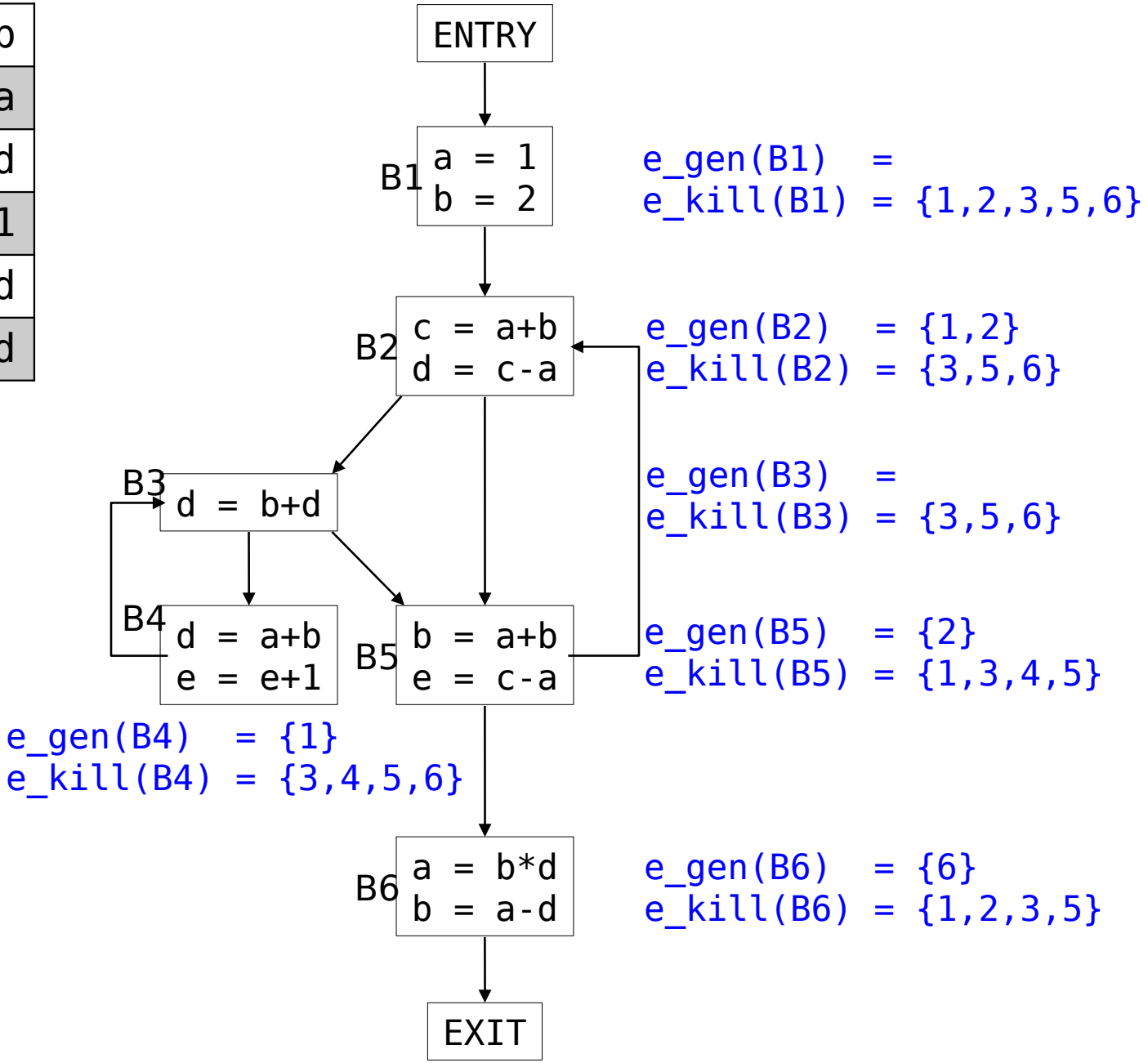

ENTRY
∅
B1
a = 1
b = 2
IN[B1] = U (OUT[B1]-{a,b})
OUT[B1] = IN[B2]
∅
B2
c = a+b
d = c-a
IN[B2] = {a,b} U (OUT[B2]-{c,d})
OUT[B2] = IN[B3] U IN[B5]
∅
B3
d = b+d
IN[B3] = {b,d} U OUT[B3]
OUT[B3] = IN[B4] U IN[B5]
∅
∅
B4
d = a+b
e = e+1
B5
b = a+b
e = c-a
IN[B5] = {a,b,c} U (OUT[B5]-{e})
OUT[B5] = IN[B2] U IN[B6]
IN[B4] = {a,b,e} U (OUT[B4]-{d})
OUT[B4] = IN[B3]
∅
B6
a = b*d
b = a-d
IN[B6] = {b,d} U (OUT[B6]-{a})
OUT[B6] = IN[EXIT]
∅
EXIT

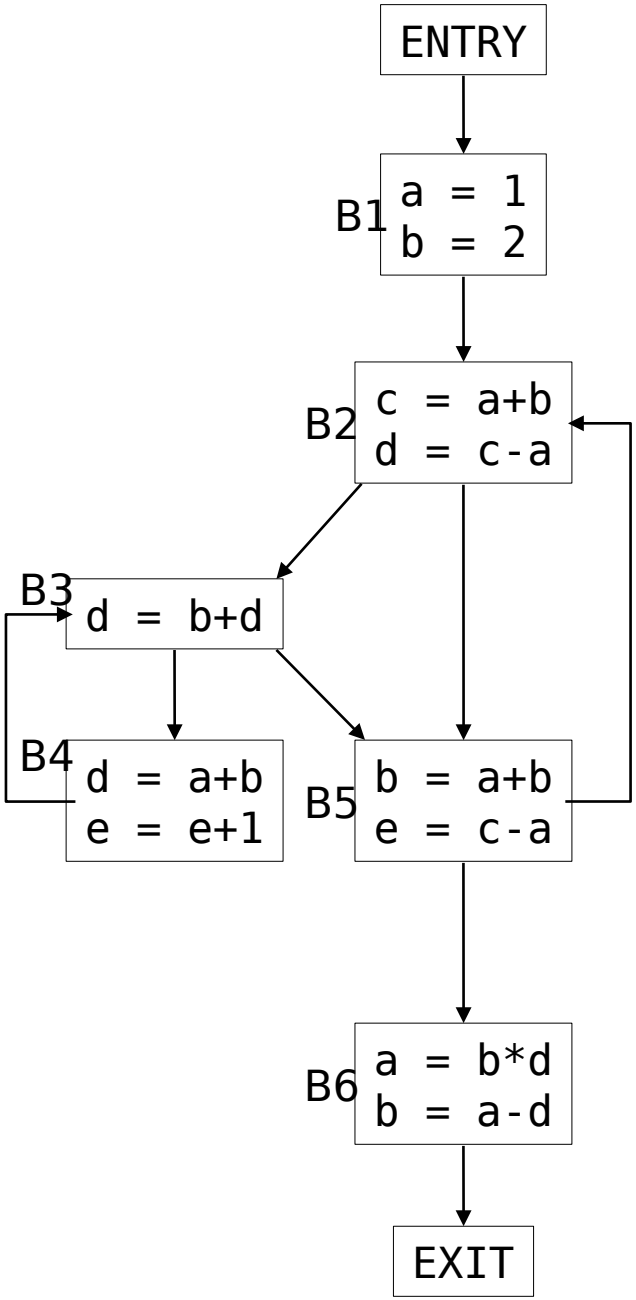

ENTRY
B1
a = 1
b = 2
a b
a b
B2
c = a+b
d = c-a
a b c d
a b c d
B3
d = b+d
a b c d
a b c e
B4
d = a+b
e = e+1
a b c d
a b c d
B5
b = a+b
e = c-a
b d
b d
B6
a = b*d
b = a-d
∅
EXIT
IN[B1] = U (OUT[B1]-{a,b})
OUT[B1] = IN[B2]
IN[B2] = {a,b} U (OUT[B2]-{c,d})
OUT[B2] = IN[B3] U IN[B5]
IN[B3] = {b,d} U OUT[B3]
OUT[B3] = IN[B4] U IN[B5]
IN[B5] = {a,b,c} U (OUT[B5]-{e})
OUT[B5] = IN[B2] U IN[B6]
IN[B4] = {a,b,e} U (OUT[B4]-{d})
OUT[B4] = IN[B3]
IN[B6] = {b,d} U (OUT[B6]-{a})
OUT[B6] = IN[EXIT]


ENTRY
e
B1
a = 1
b = 2
IN[B1] = U (OUT[B1]-{a,b})
OUT[B1] = IN[B2]
a be
a be
B2
c = a+b
d = c-a
IN[B2] = {a,b} U (OUT[B2]-{c,d})
OUT[B2] = IN[B3] U IN[B5]
a b c de
a b c de
B3
d = b+d
IN[B3] = {b,d} U OUT[B3]
OUT[B3] = IN[B4] U IN[B5]
a b c de
a b c e
a b c d
B4
d = a+b
e = e+1
B5
b = a+b
e = c-a
IN[B5] = {a,b,c} U (OUT[B5]-{e})
OUT[B5] = IN[B2] U IN[B6]
a b c de
a b de
IN[B4] = {a,b,e} U (OUT[B4]-{d})
OUT[B4] = IN[B3]
b d
B6
a = b*d
b = a-d
IN[B6] = {b,d} U (OUT[B6]-{a})
OUT[B6] = IN[EXIT]
∅
EXIT

Available expressions

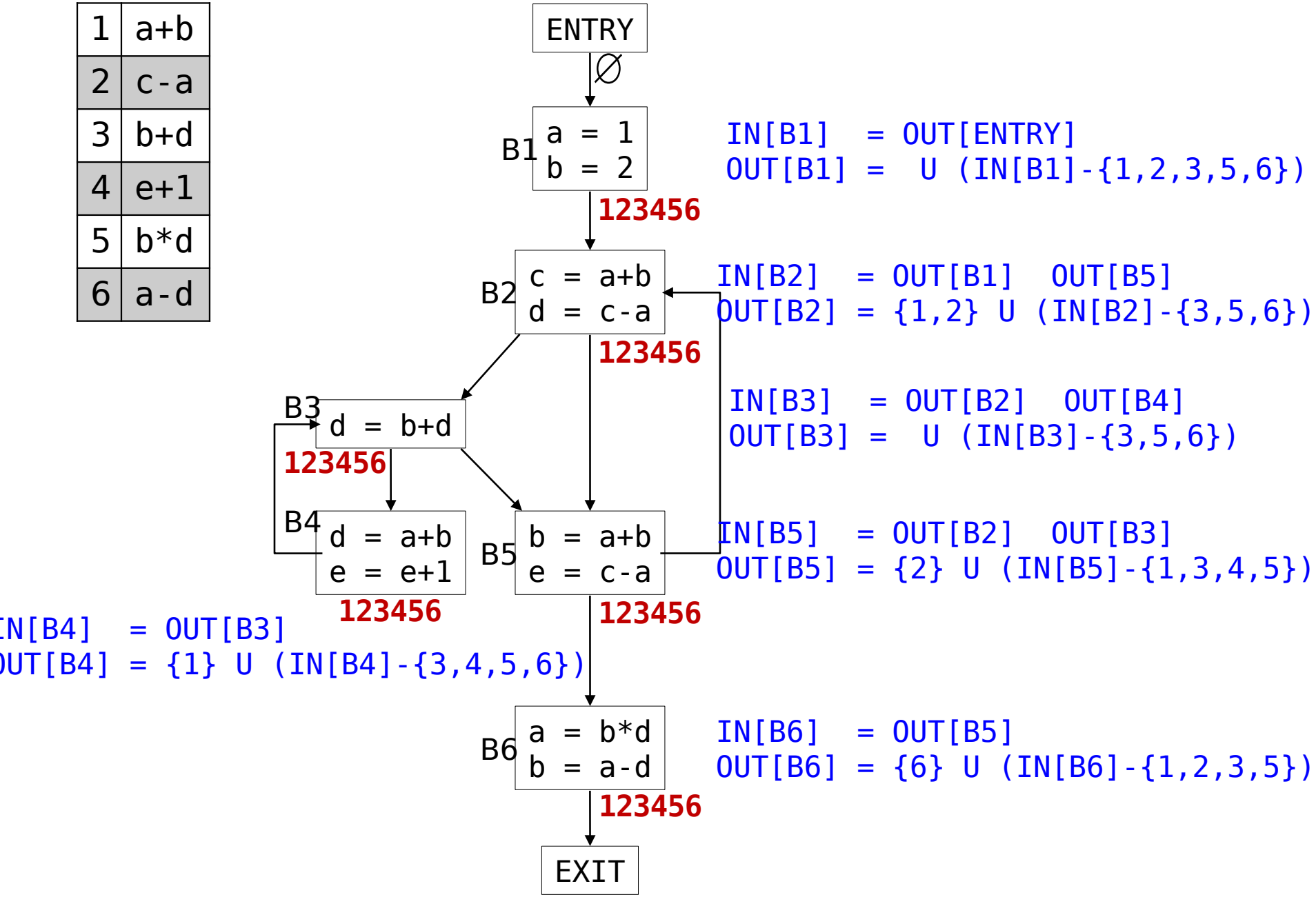
1	a+b
2	c-a
3	b+d
4	e+1
5	b*d
6	a-d



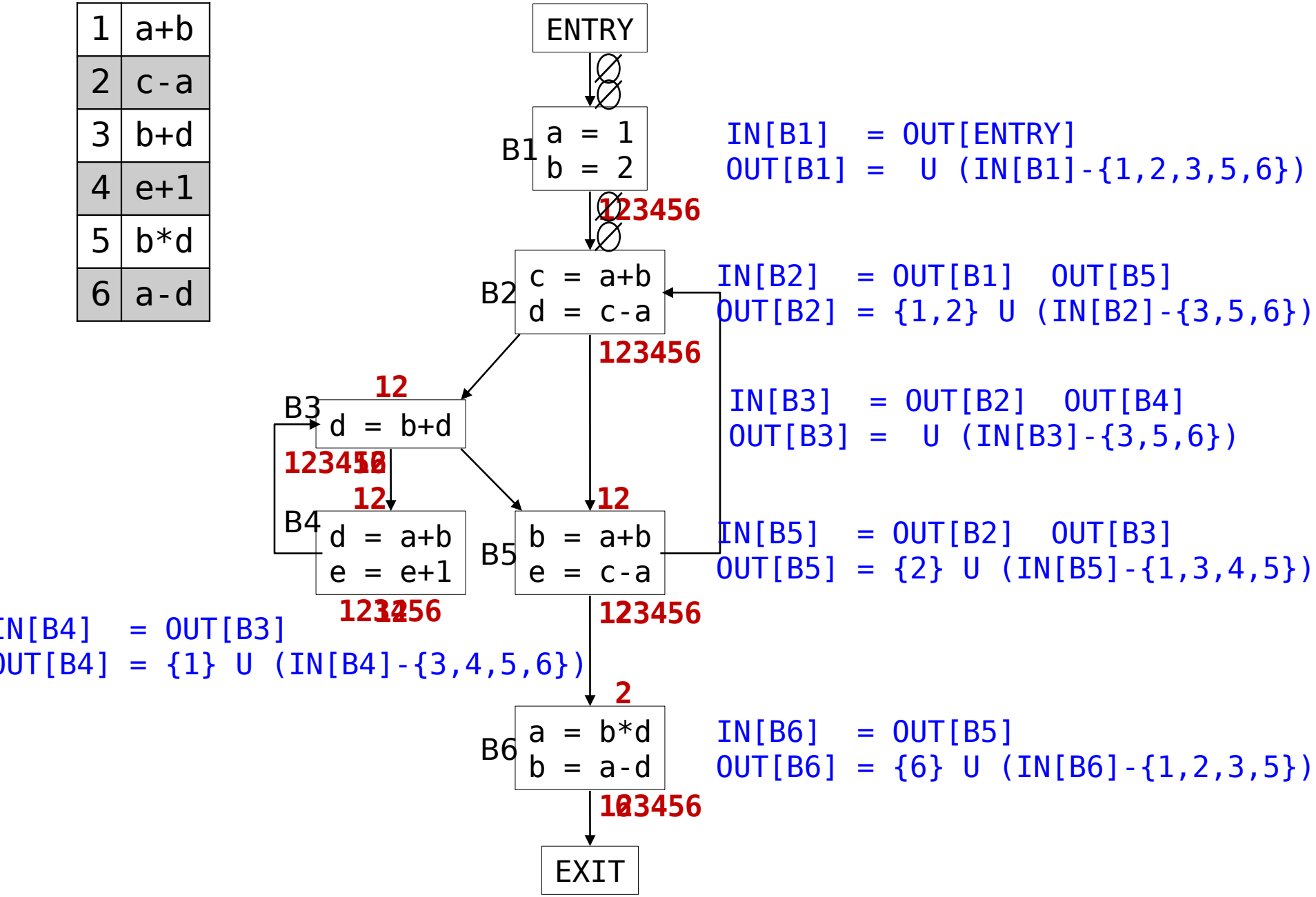


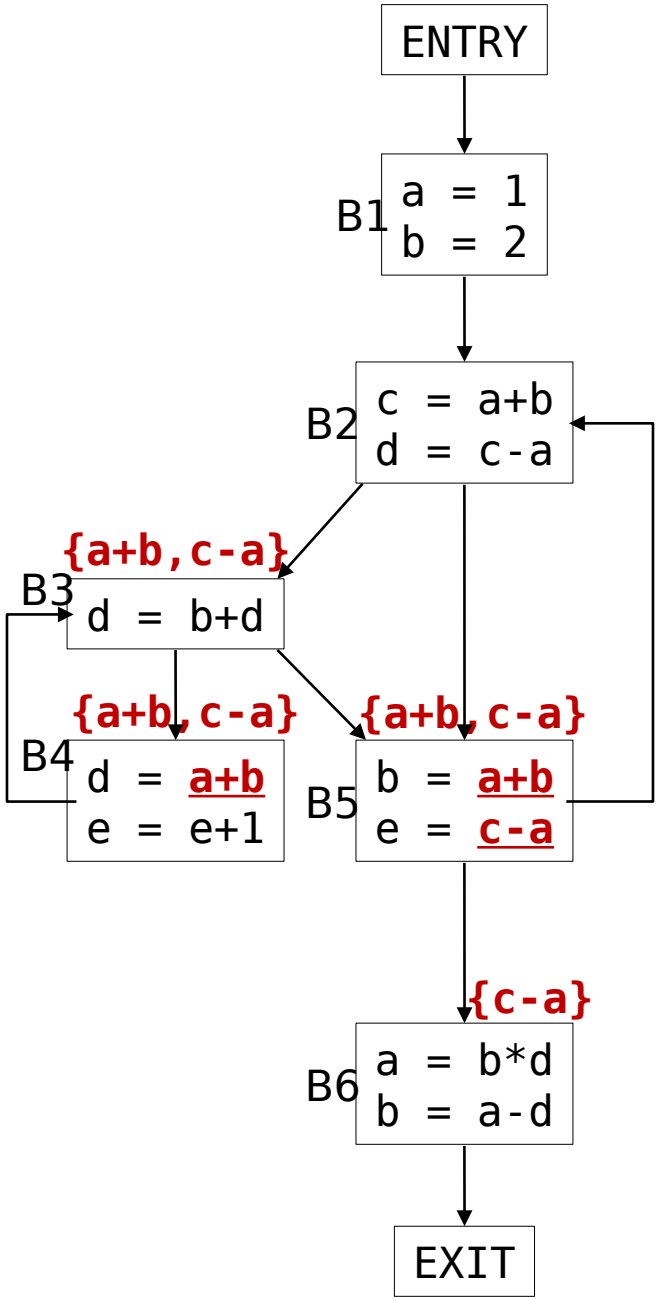
Dataflow equations (forward)

1	a+b
2	c-a
3	b+d
4	e+1
5	b*d
6	a-d



1	a+b
2	c-a
3	b+d
4	e+1
5	b*d
6	a-d




ENTRY
B1
a = 1
b = 2
B2
c = a+b
d = c-a
{a+b,c-a}
B3
d = b+d
{a+b,c-a}
{a+b,c-a}
B4
d = a+b
e = e+1
B5
b = a+b
e = c-a
{c-a}
B6
a = b*d
b = a-d
EXIT