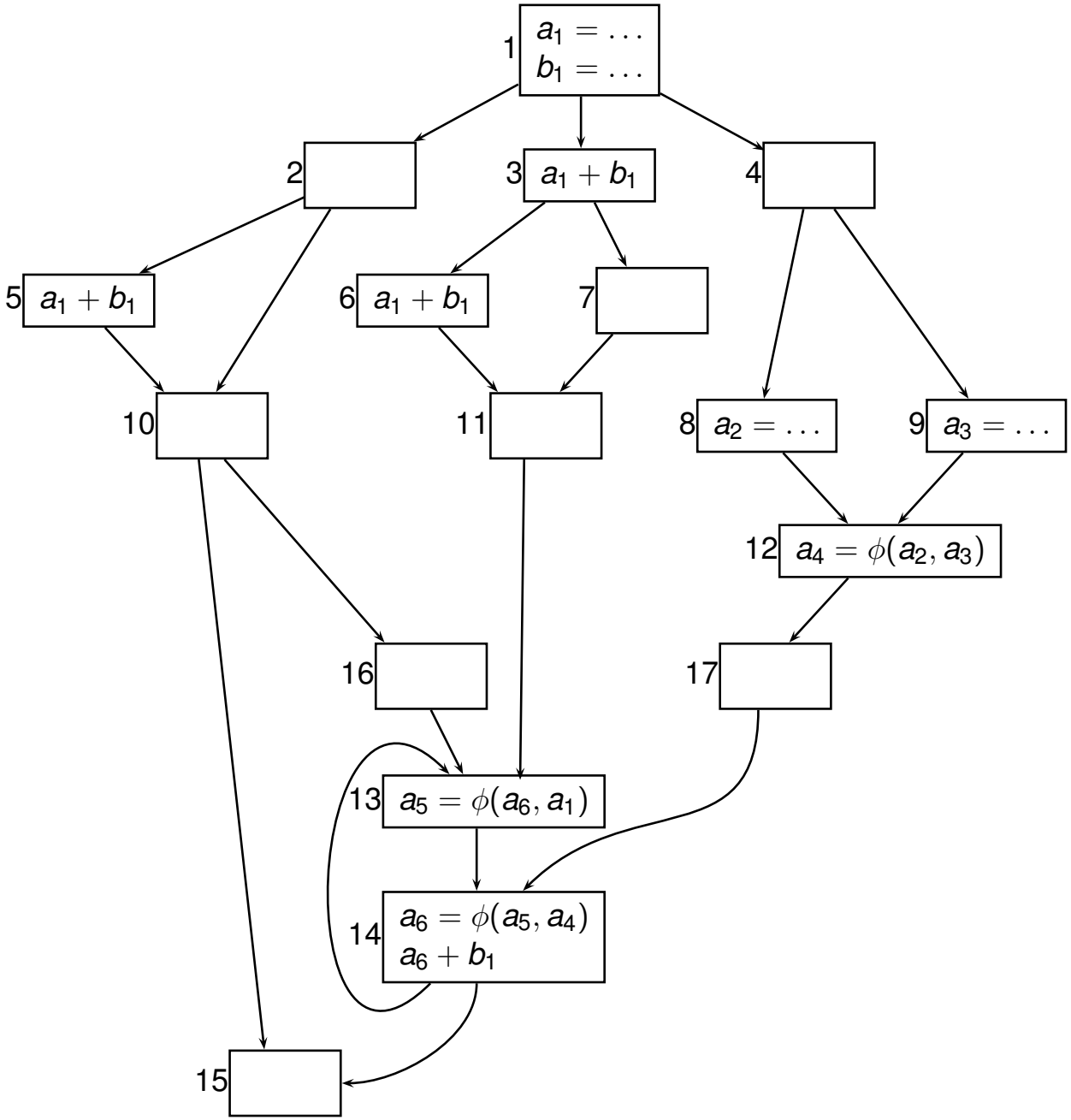
CS738: Advanced Compiler Optimizations

SSAPRE: Example

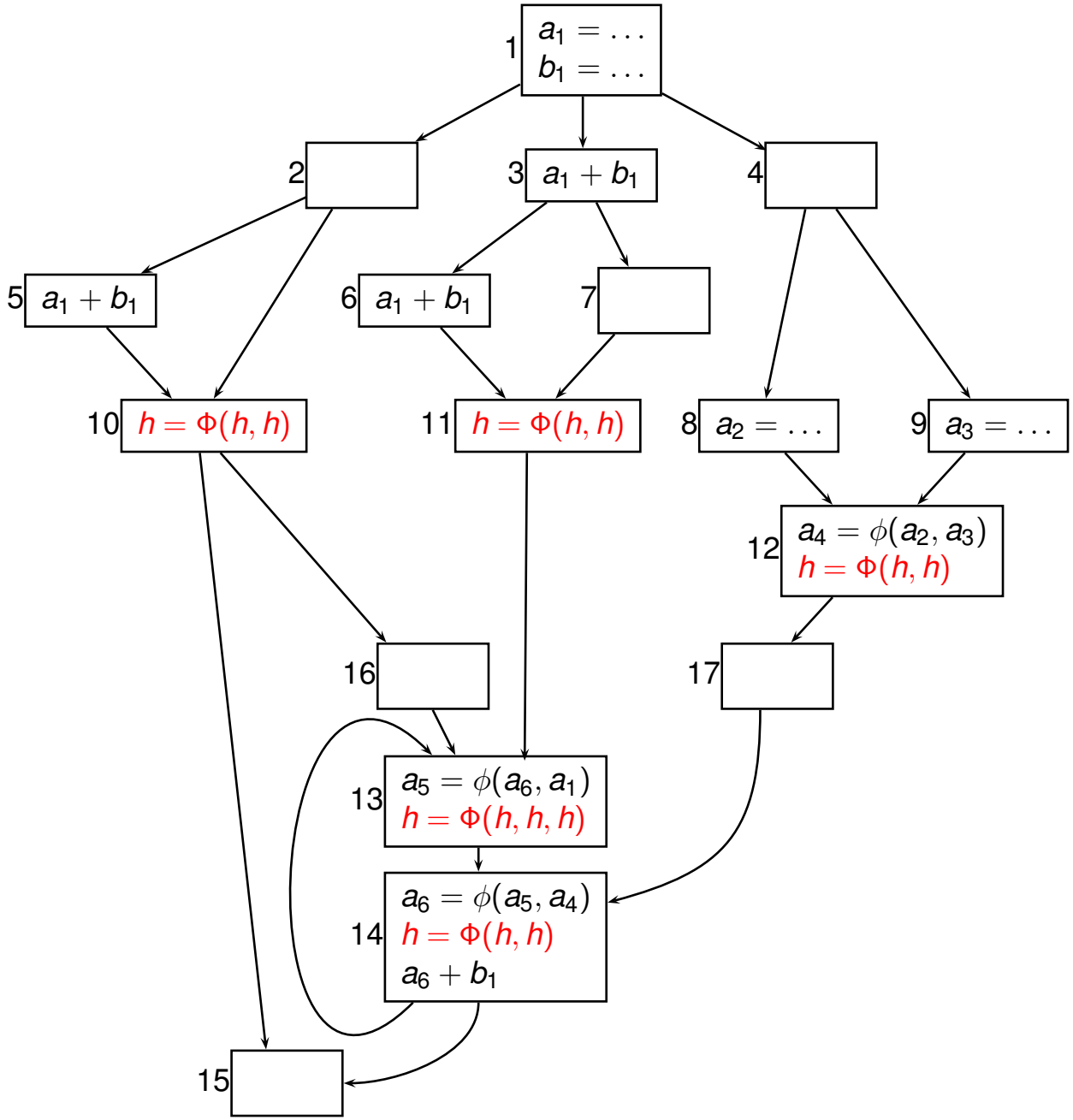
Amey Karkare
karkare@cse.iitk.ac.in

http://www.cse.iitk.ac.in/~karkare/cs738
Department of CSE, IIT Kanpur

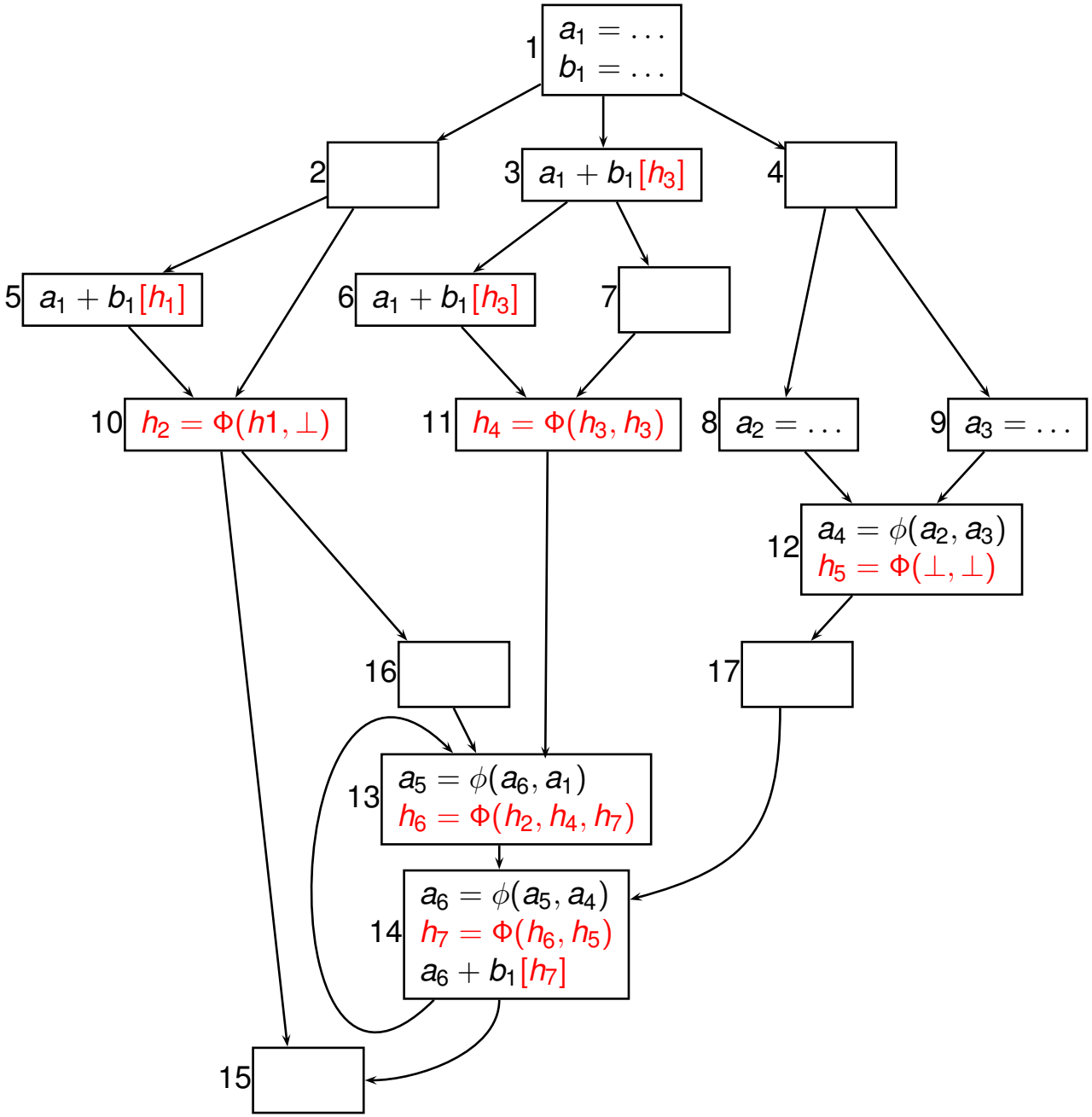
Example


1
$a_1 = \ldots$
$b_1 = \ldots$
2
3
$a_1 + b_1$
4
5
$a_1 + b_1$
6
$a_1 + b_1$
7
10
11
8
$a_2 = \ldots$
9
$a_3 = \ldots$
12
$a_4 = \phi(a_2, a_3)$
16
17
13
$a_5 = \phi(a_6, a_1)$
14
$a_6 = \phi(a_5, a_4)$
$a_6 + b_1$
15

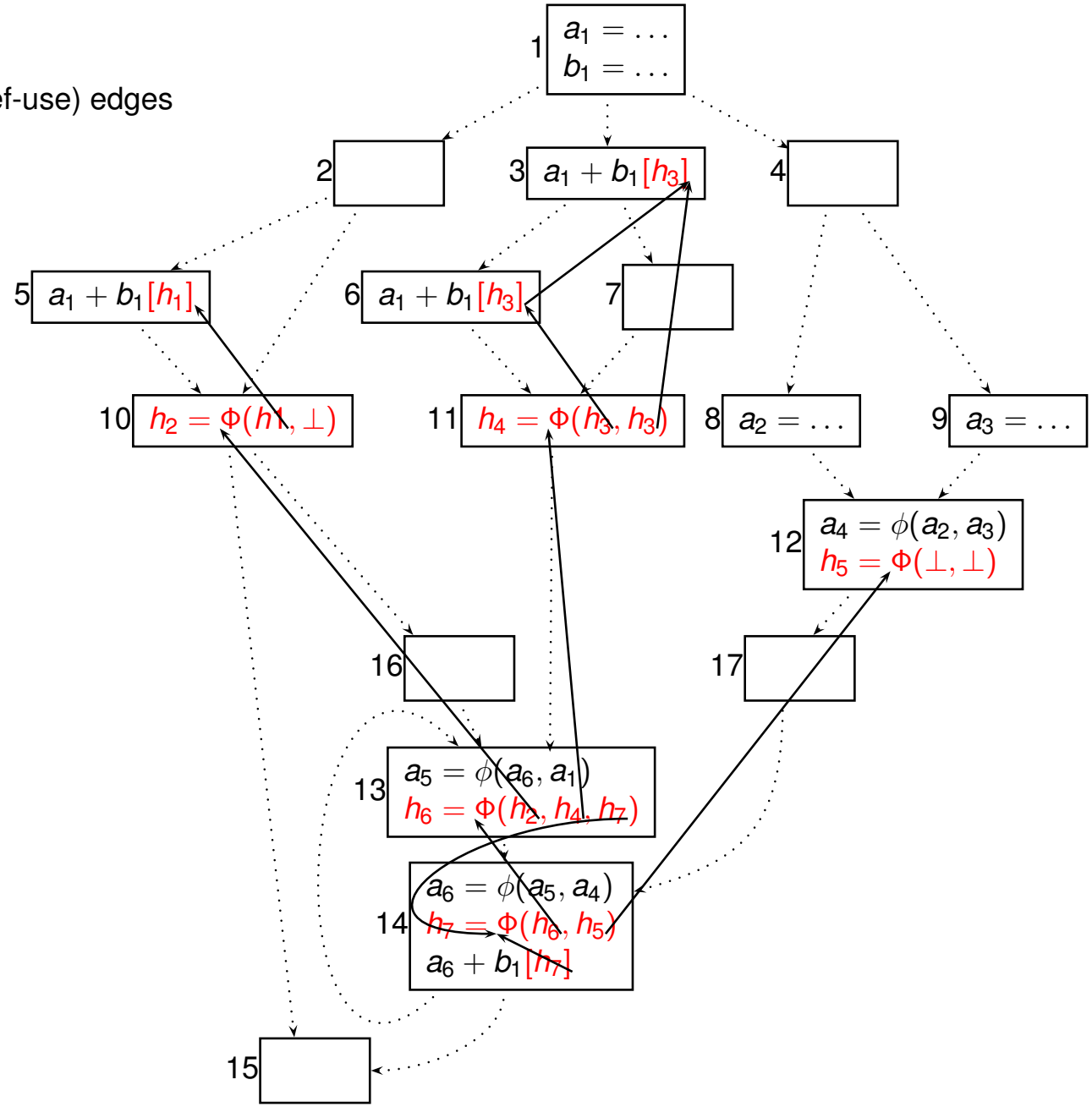
Φ insertion


1
$a_1 = \ldots$
$b_1 = \ldots$
2
3
$a_1 + b_1$
4
5
$a_1 + b_1$
6
$a_1 + b_1$
7
10
$h = \Phi(h, h)$
11
$h = \Phi(h, h)$
8
$a_2 = \ldots$
9
$a_3 = \ldots$
12
$a_4 = \phi(a_2, a_3)$
$h = \Phi(h, h)$
16
17
13
$a_5 = \phi(a_6, a_1)$
$h = \Phi(h, h, h)$
14
$a_6 = \phi(a_5, a_4)$
$h = \Phi(h, h)$
$a_6 + b_1$
15

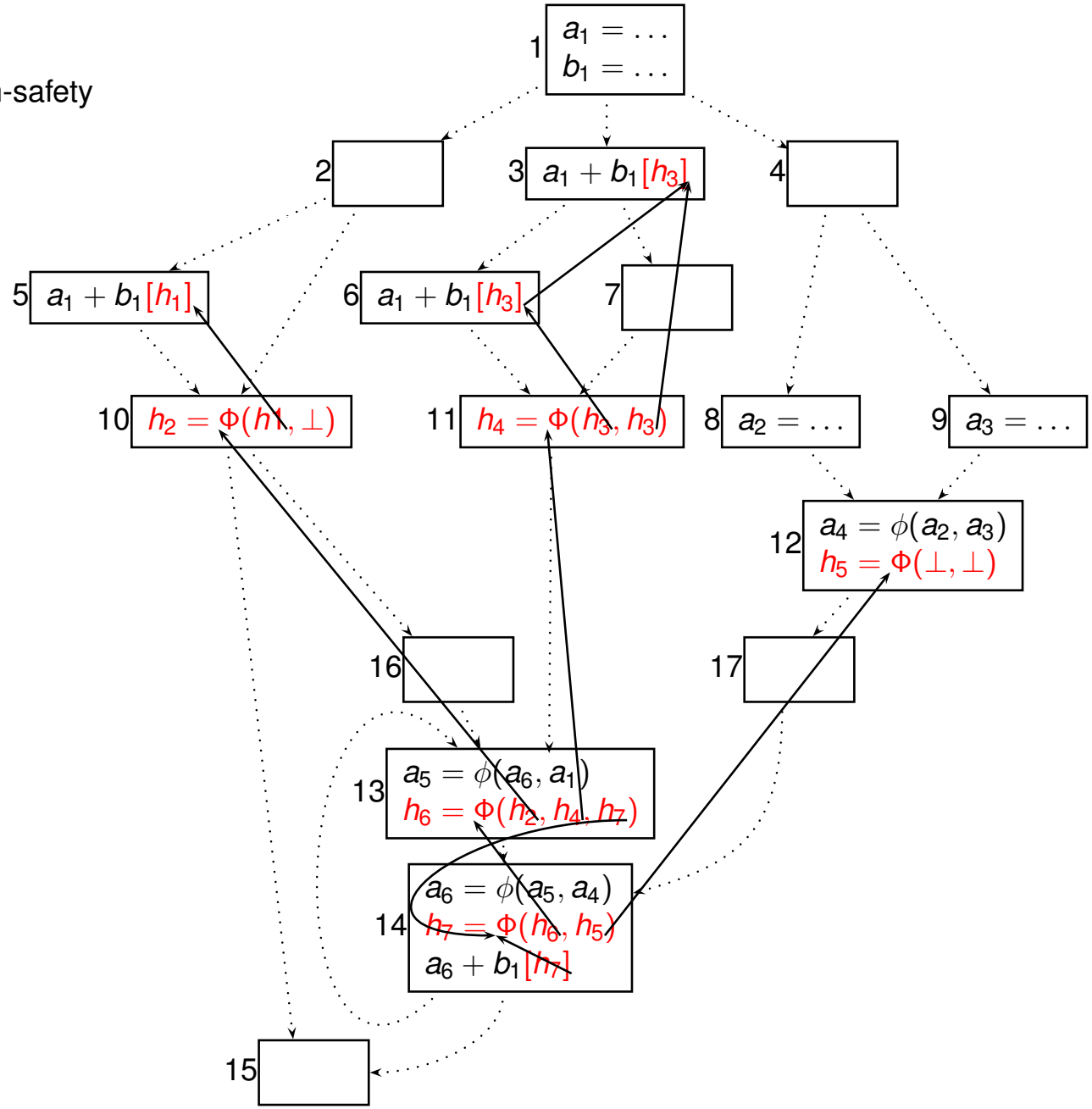
Rename


1
$a_1 = \ldots$
$b_1 = \ldots$
2
3
$a_1 + b_1[h_3]$
4
5
$a_1 + b_1[h_1]$
6
$a_1 + b_1[h_3]$
7
10
$h_2 = \Phi(h1, \bot)$
11
$h_4 = \Phi(h_3, h_3)$
8
$a_2 = \ldots$
9
$a_3 = \ldots$
12
$a_4 = \phi(a_2, a_3)$
$h_5 = \Phi(\bot, \bot)$
16
17
13
$a_5 = \phi(a_6, a_1)$
$h_6 = \Phi(h_2, h_4, h_7)$
14
$a_6 = \phi(a_5, a_4)$
$h_7 = \Phi(h_6, h_5)$
$a_6 + b_1[h_7]$
15

FRG (def-use) edges

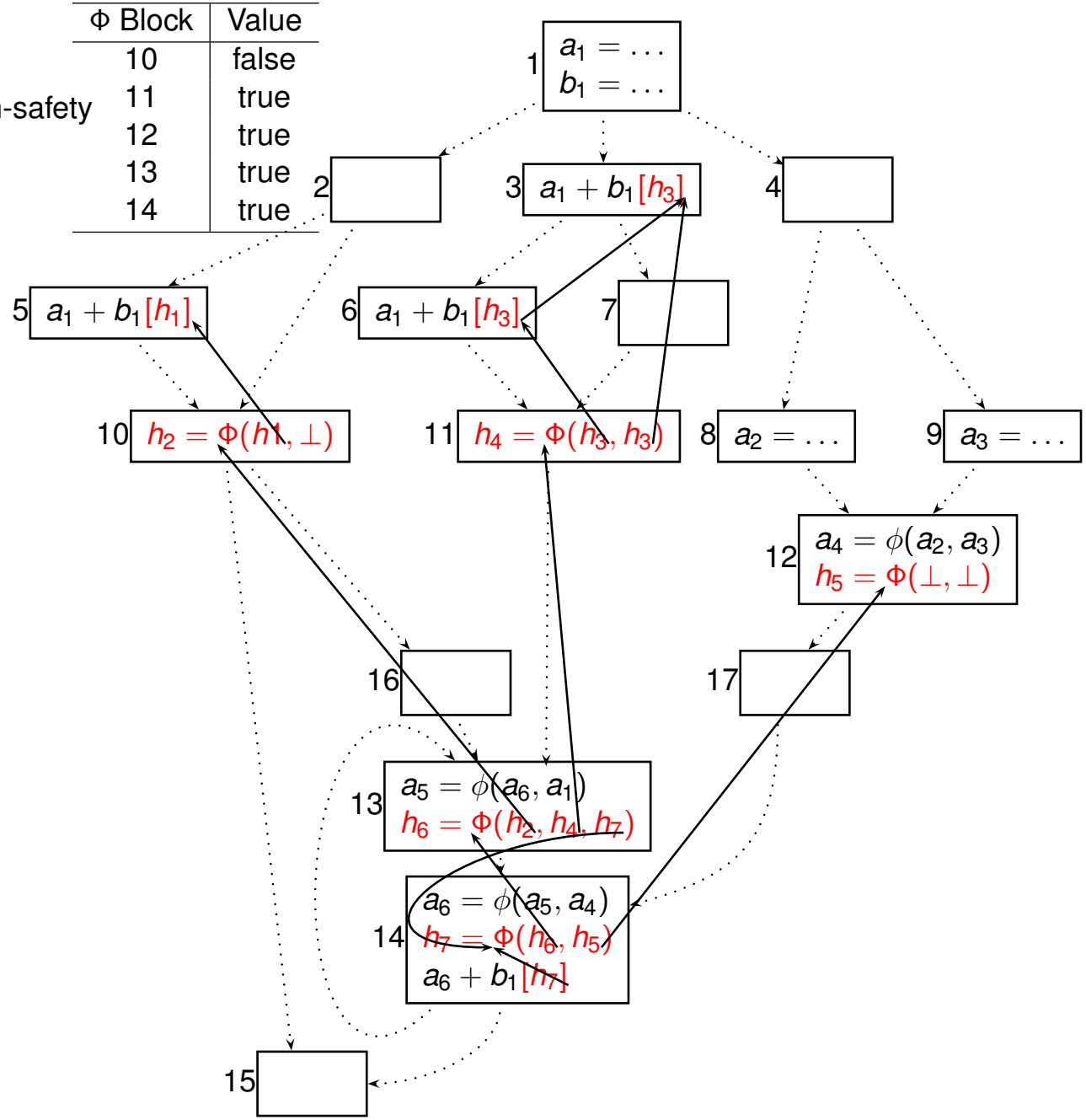


Down-safety

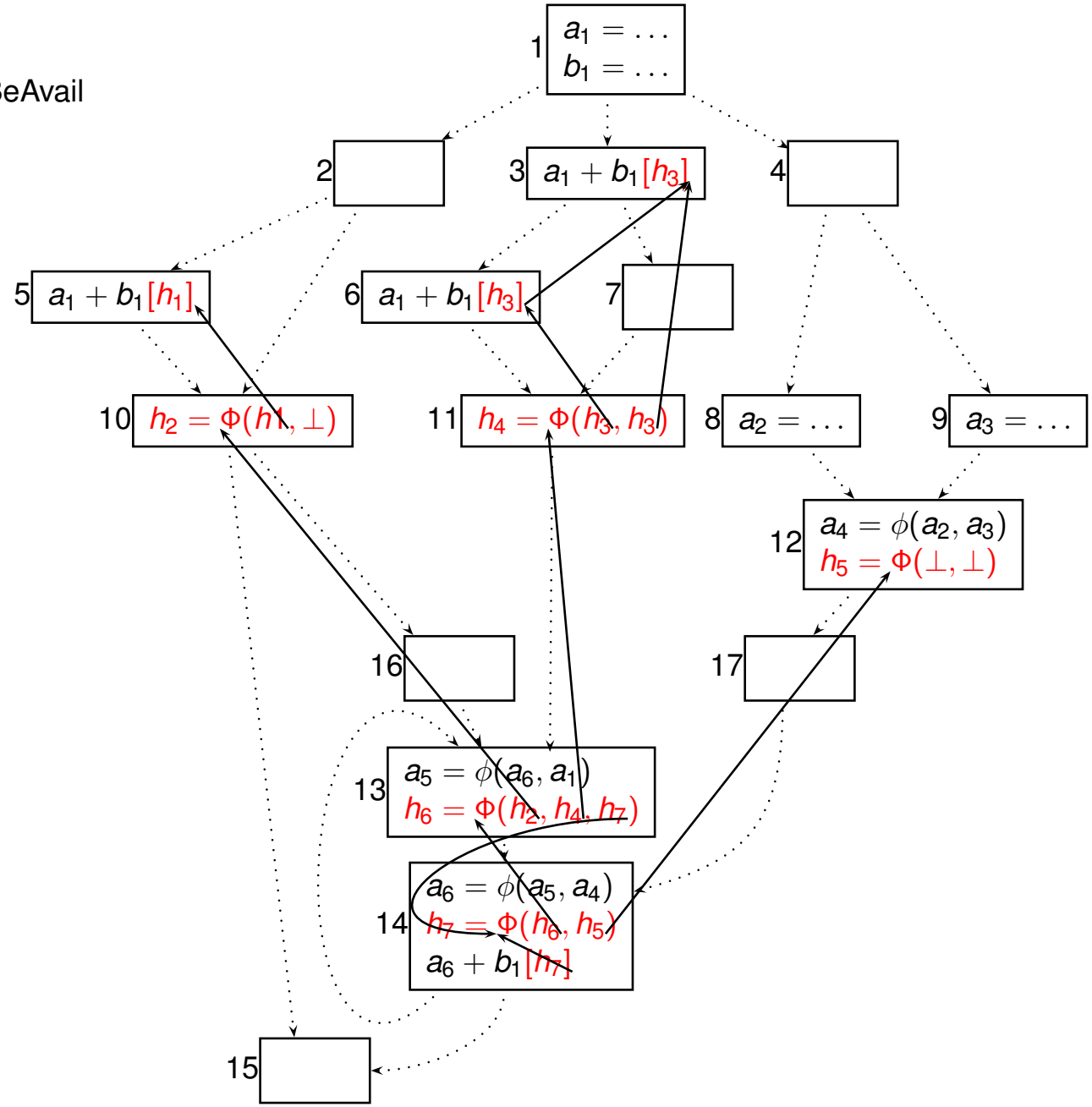

1
$a_1 = \ldots$
$b_1 = \ldots$
2
3
$a_1 + b_1[h_3]$
4
5
$a_1 + b_1[h_1]$
6
$a_1 + b_1[h_3]$
7
10
$h_2 = \Phi(h1, \bot)$
11
$h_4 = \Phi(h_3, h_3)$
8
$a_2 = \ldots$
9
$a_3 = \ldots$
12
$a_4 = \phi(a_2, a_3)$
$h_5 = \Phi(\bot, \bot)$
16
17
13
$a_5 = \phi(a_6, a_1)$
$h_6 = \Phi(h_2, h_4, h_7)$
14
$a_6 = \phi(a_5, a_4)$
$h_7 = \Phi(h_6, h_5)$
$a_6 + b_1[h_7]$
15

Down-safety

Φ Block	Value
10	false
11	true
12	true
13	true
14	true

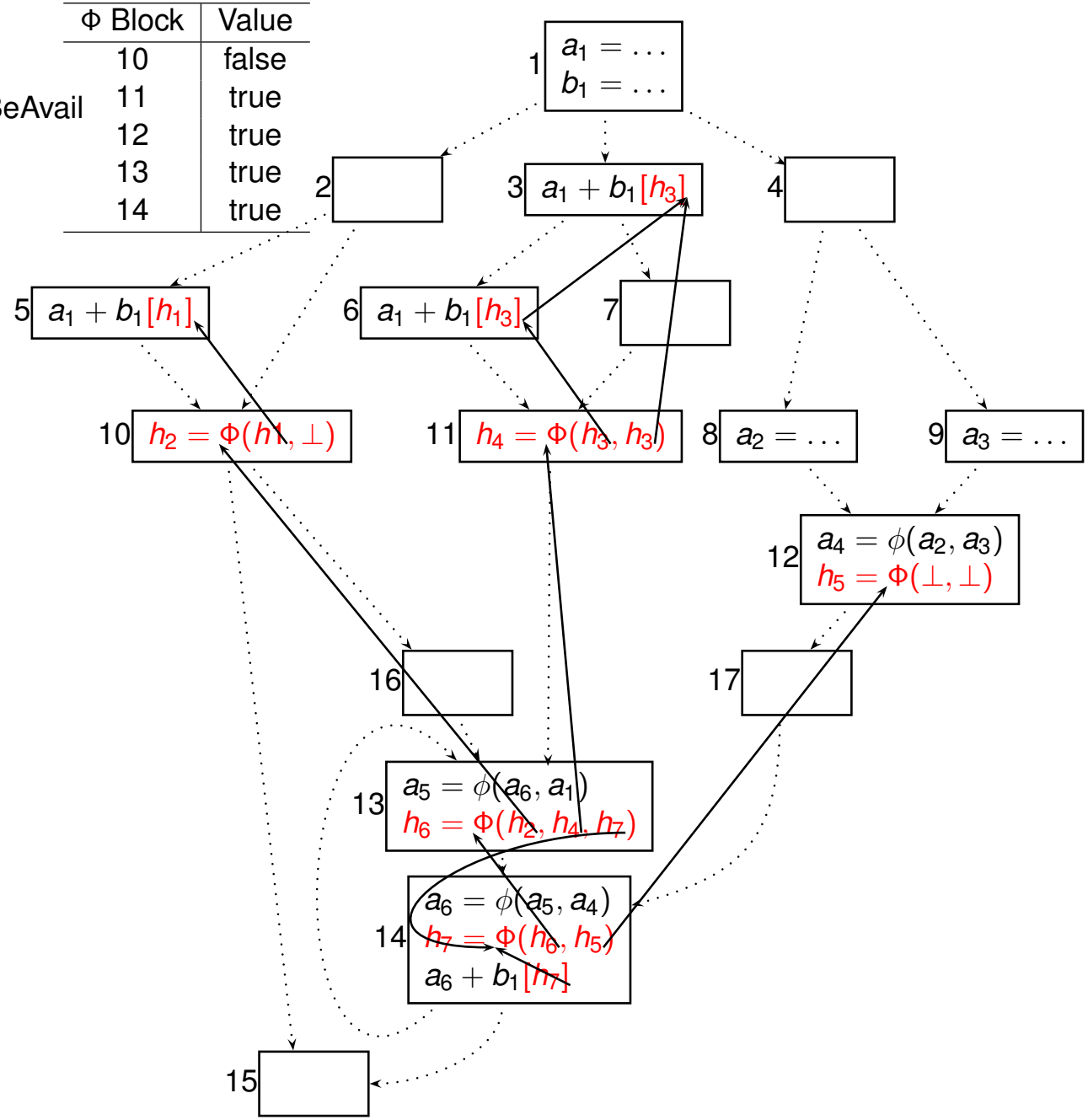


CanBeAvail

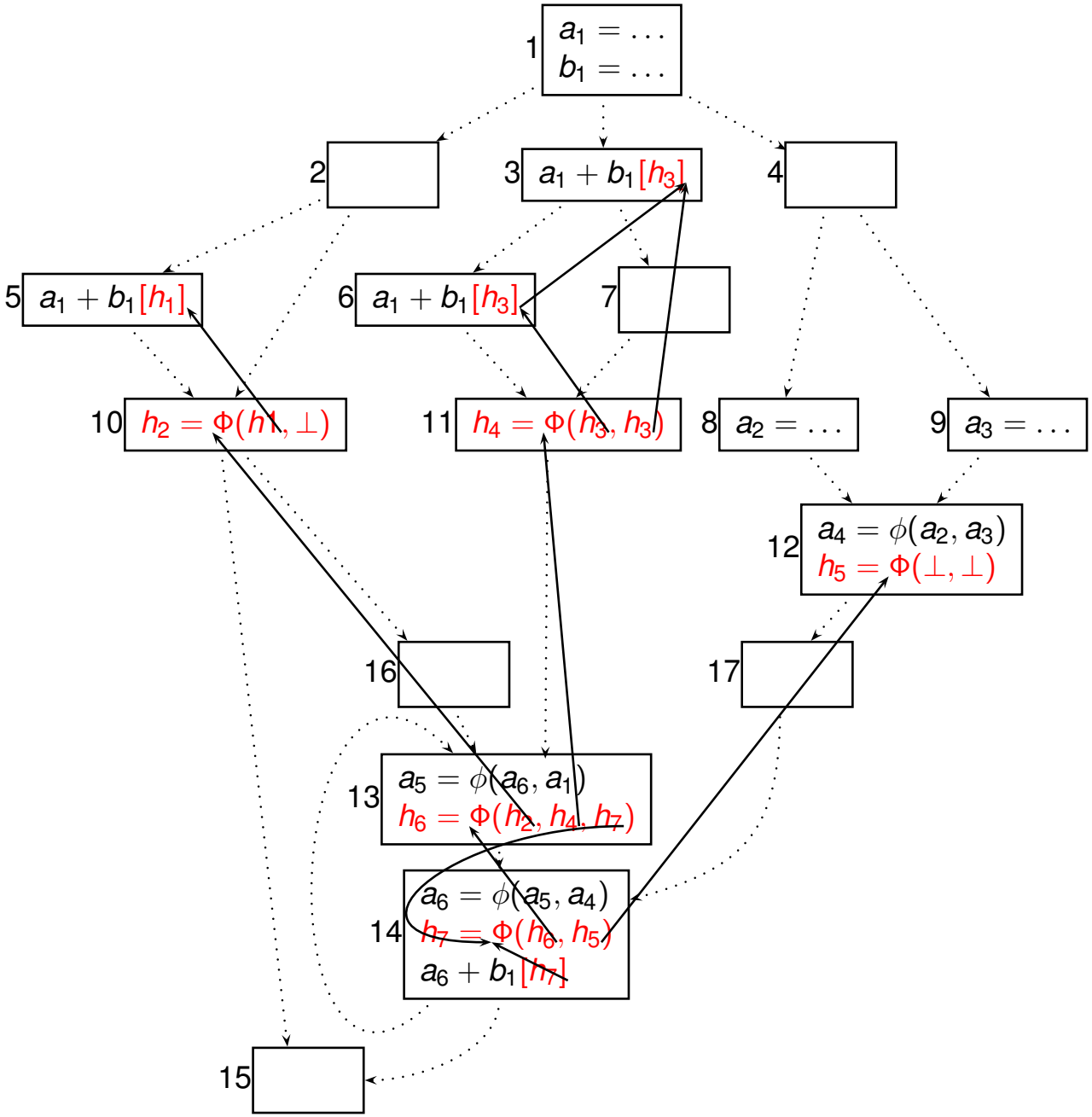

1
$a_1 = \ldots$
$b_1 = \ldots$
2
3
$a_1 + b_1[h_3]$
4
5
$a_1 + b_1[h_1]$
6
$a_1 + b_1[h_3]$
7
10
$h_2 = \Phi(h1, \bot)$
11
$h_4 = \Phi(h_3, h_3)$
8
$a_2 = \ldots$
9
$a_3 = \ldots$
12
$a_4 = \phi(a_2, a_3)$
$h_5 = \Phi(\bot, \bot)$
16
17
13
$a_5 = \phi(a_6, a_1)$
$h_6 = \Phi(h_2, h_4, h_7)$
14
$a_6 = \phi(a_5, a_4)$
$h_7 = \Phi(h_6, h_5)$
$a_6 + b_1[h_7]$
15

CanBeAvail

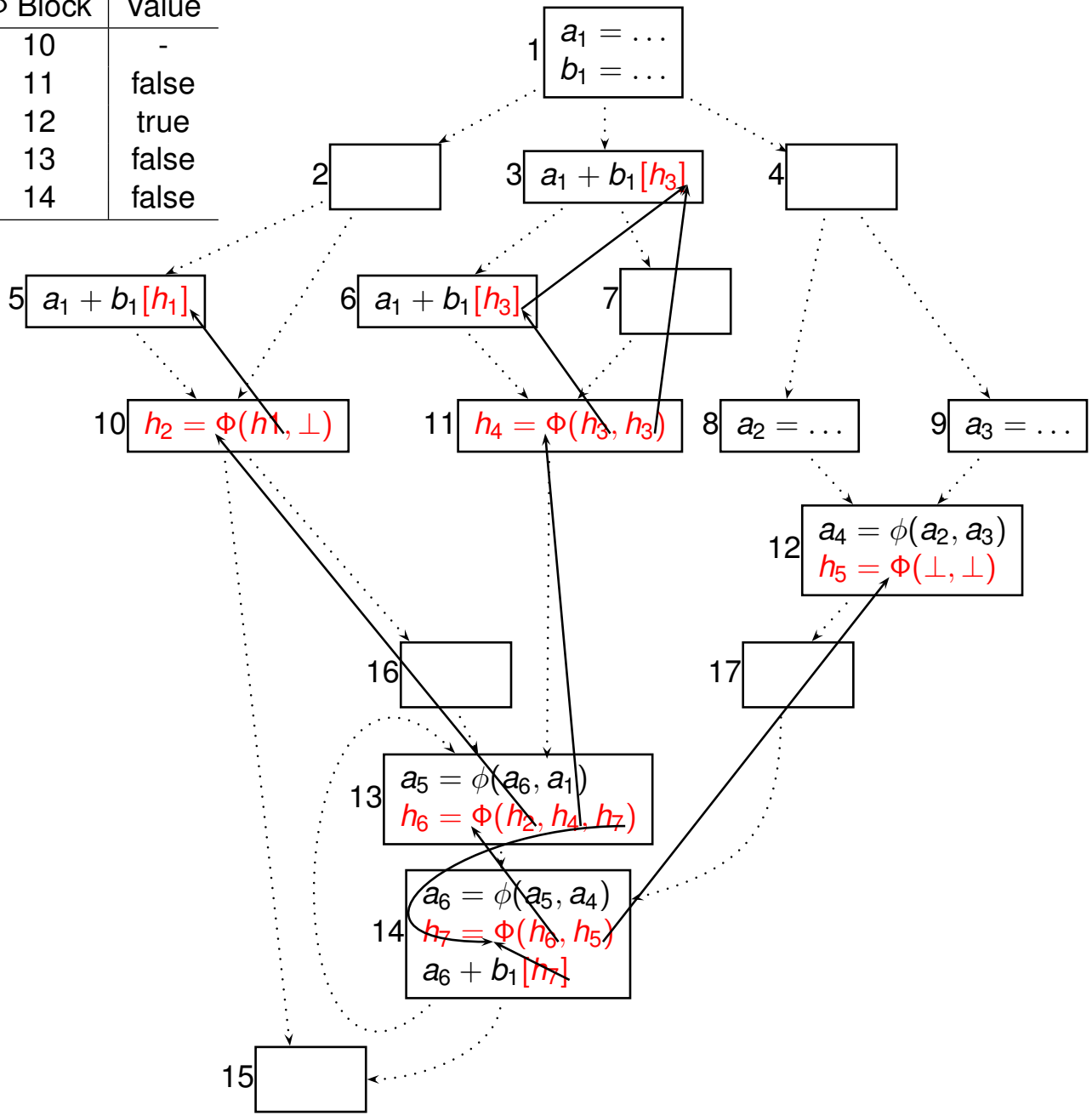
Φ Block	Value
10	false
11	true
12	true
13	true
14	true



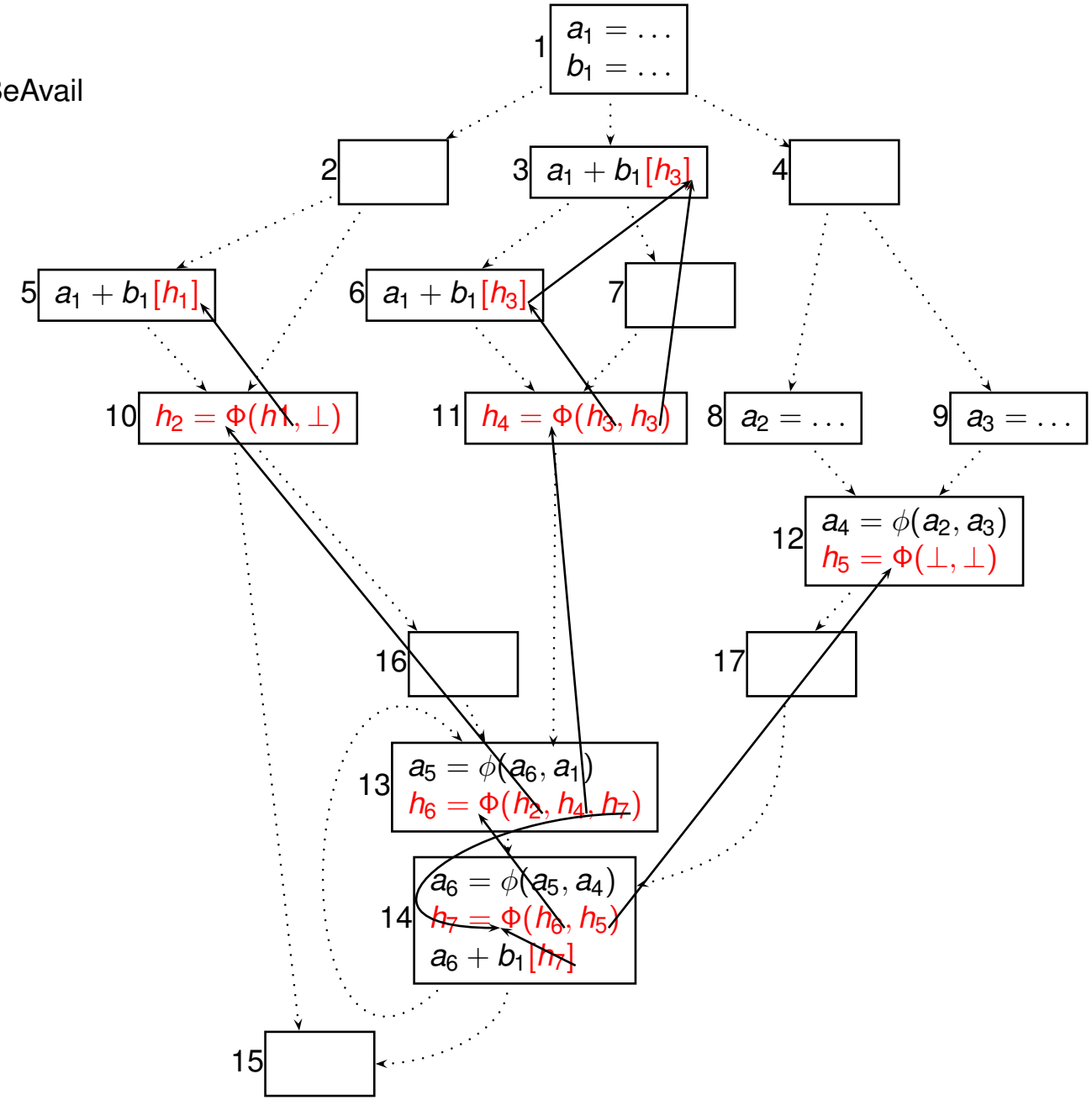
Later


1
$a_1 = \ldots$
$b_1 = \ldots$
2
3
$a_1 + b_1[h_3]$
4
5
$a_1 + b_1[h_1]$
6
$a_1 + b_1[h_3]$
7
10
$h_2 = \Phi(h1, \bot)$
11
$h_4 = \Phi(h_3, h_3)$
8
$a_2 = \ldots$
9
$a_3 = \ldots$
12
$a_4 = \phi(a_2, a_3)$
$h_5 = \Phi(\bot, \bot)$
16
17
13
$a_5 = \phi(a_6, a_1)$
$h_6 = \Phi(h_2, h_4, h_7)$
14
$a_6 = \phi(a_5, a_4)$
$h_7 = \Phi(h_6, h_5)$
$a_6 + b_1[h_7]$
15

Φ Block		Value
Later	10	-
	11	false
	12	true
	13	false
	14	false

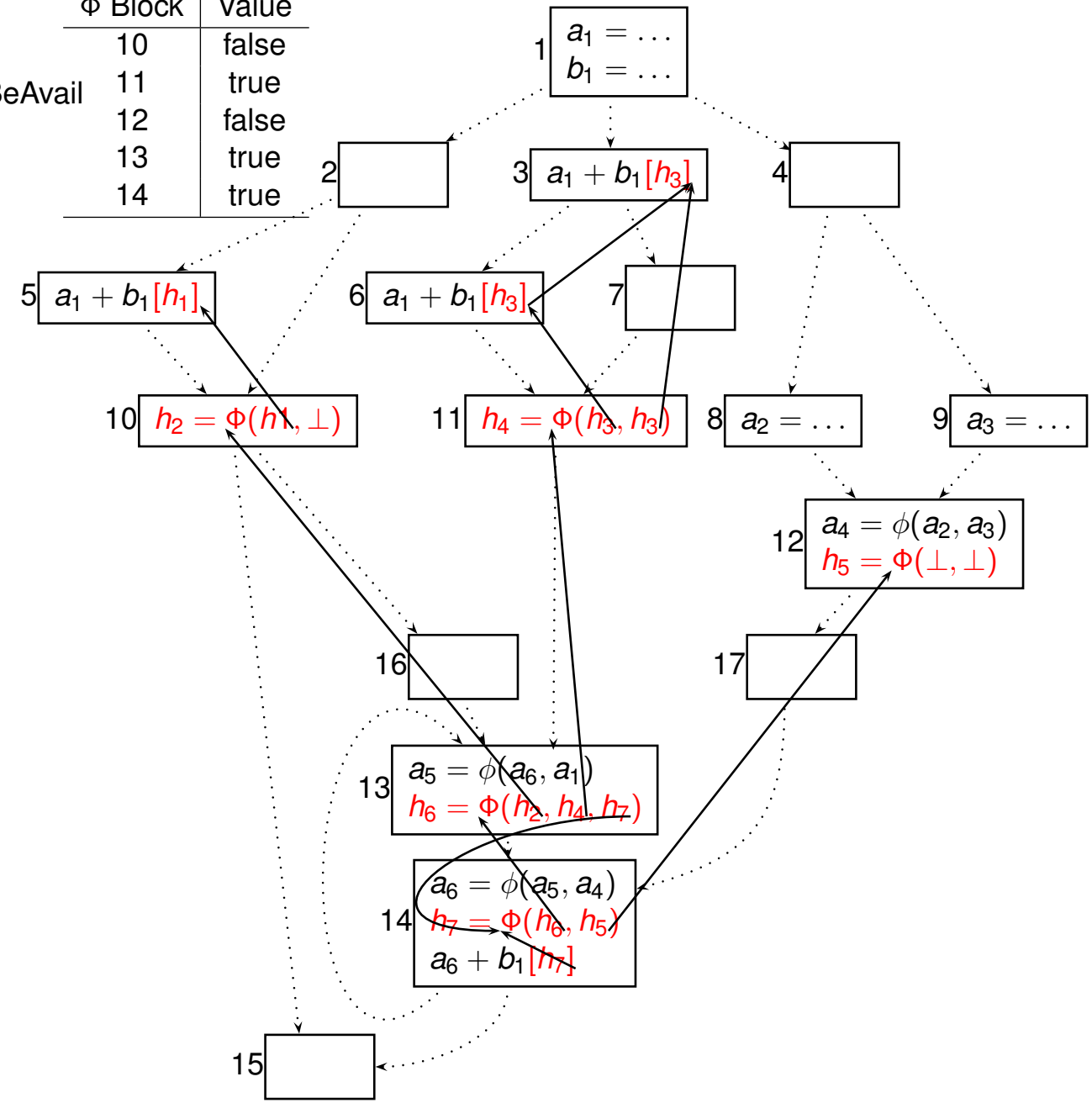


WillBeAvail

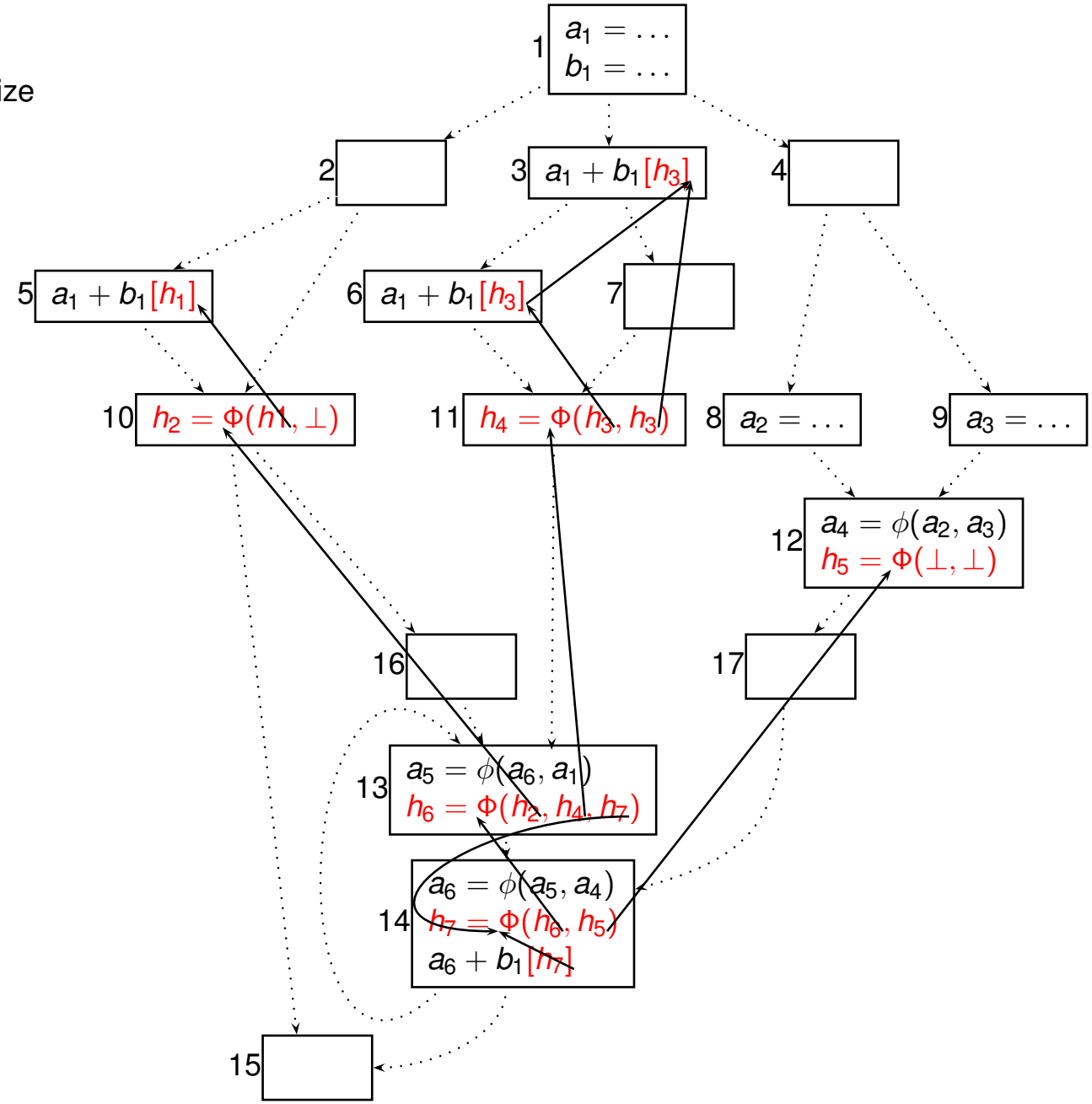


WillBeAvail

Φ Block	Value
10	false
11	true
12	false
13	true
14	true

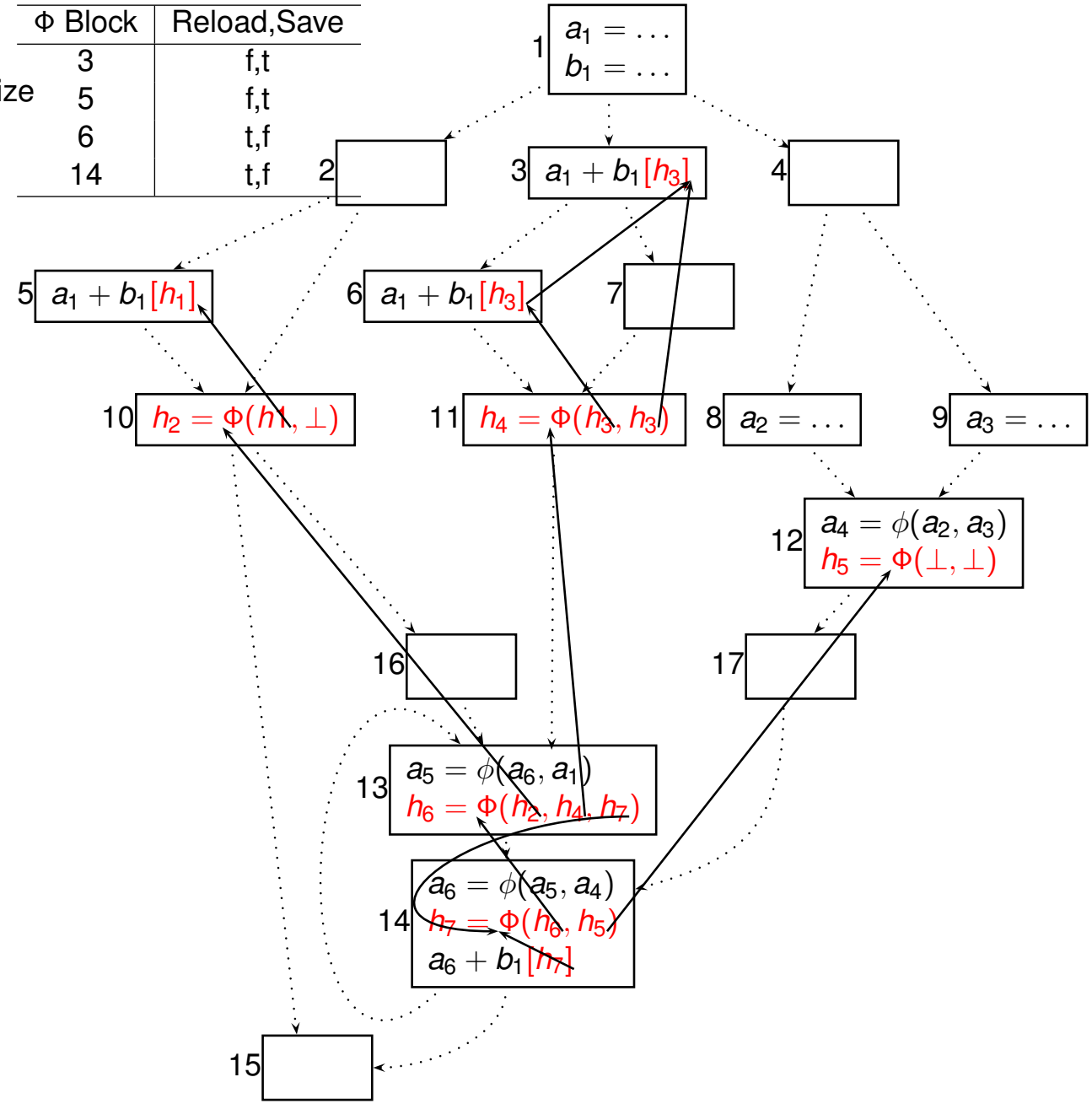


Finalize


1
$a_1 = \ldots$
$b_1 = \ldots$
2
3
$a_1 + b_1[h_3]$
4
5
$a_1 + b_1[h_1]$
6
$a_1 + b_1[h_3]$
7
10
$h_2 = \Phi(h1, \bot)$
11
$h_4 = \Phi(h_3, h_3)$
8
$a_2 = \ldots$
9
$a_3 = \ldots$
12
$a_4 = \phi(a_2, a_3)$
$h_5 = \Phi(\bot, \bot)$
16
17
13
$a_5 = \phi(a_6, a_1)$
$h_6 = \Phi(h_2, h_4, h_7)$
14
$a_6 = \phi(a_5, a_4)$
$h_7 = \Phi(h_6, h_5)$
$a_6 + b_1[h_7]$
15

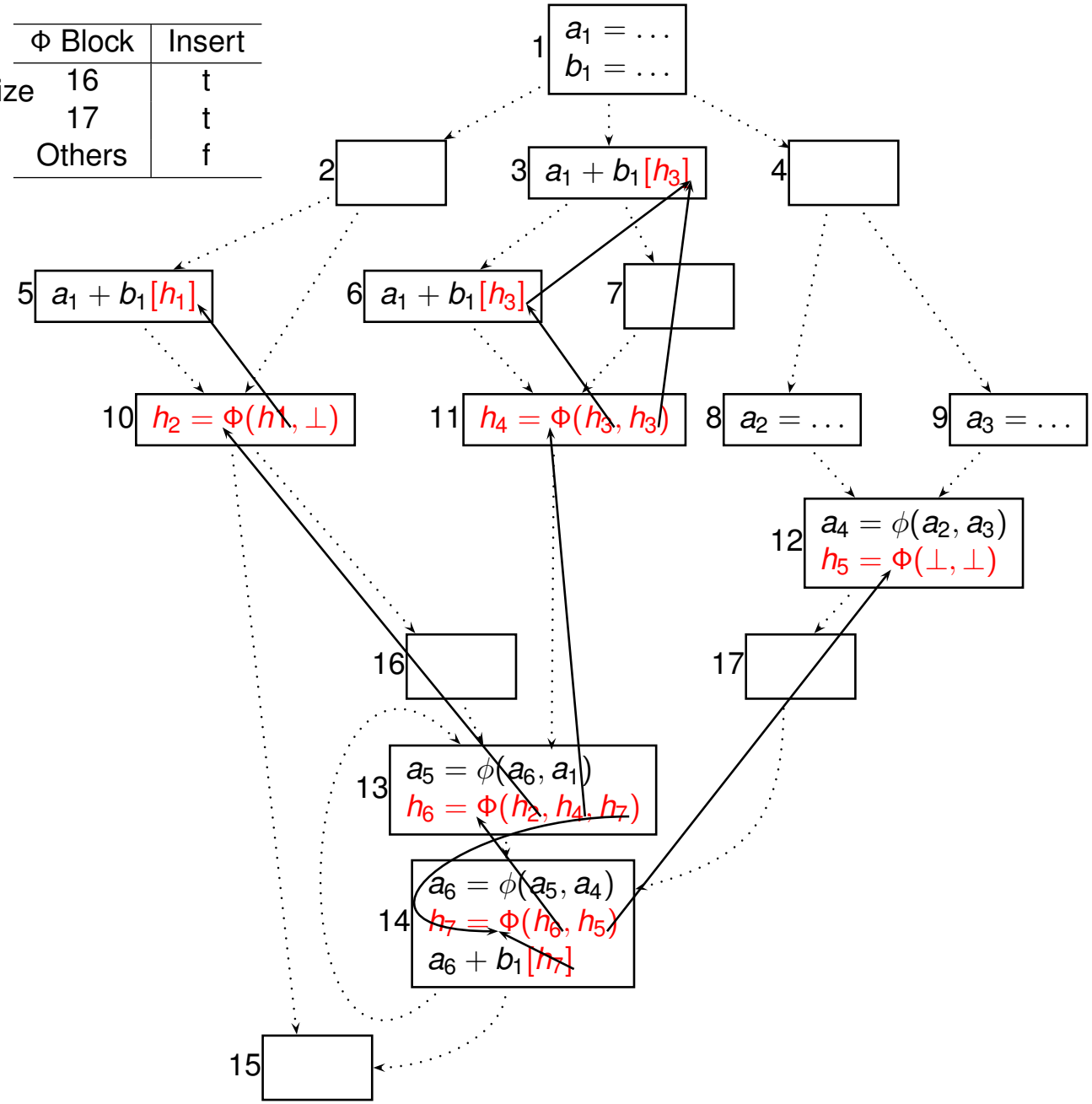
Finalize

Φ Block	Reload,Save
3	f,t
5	f,t
6	t,f
14	t,f

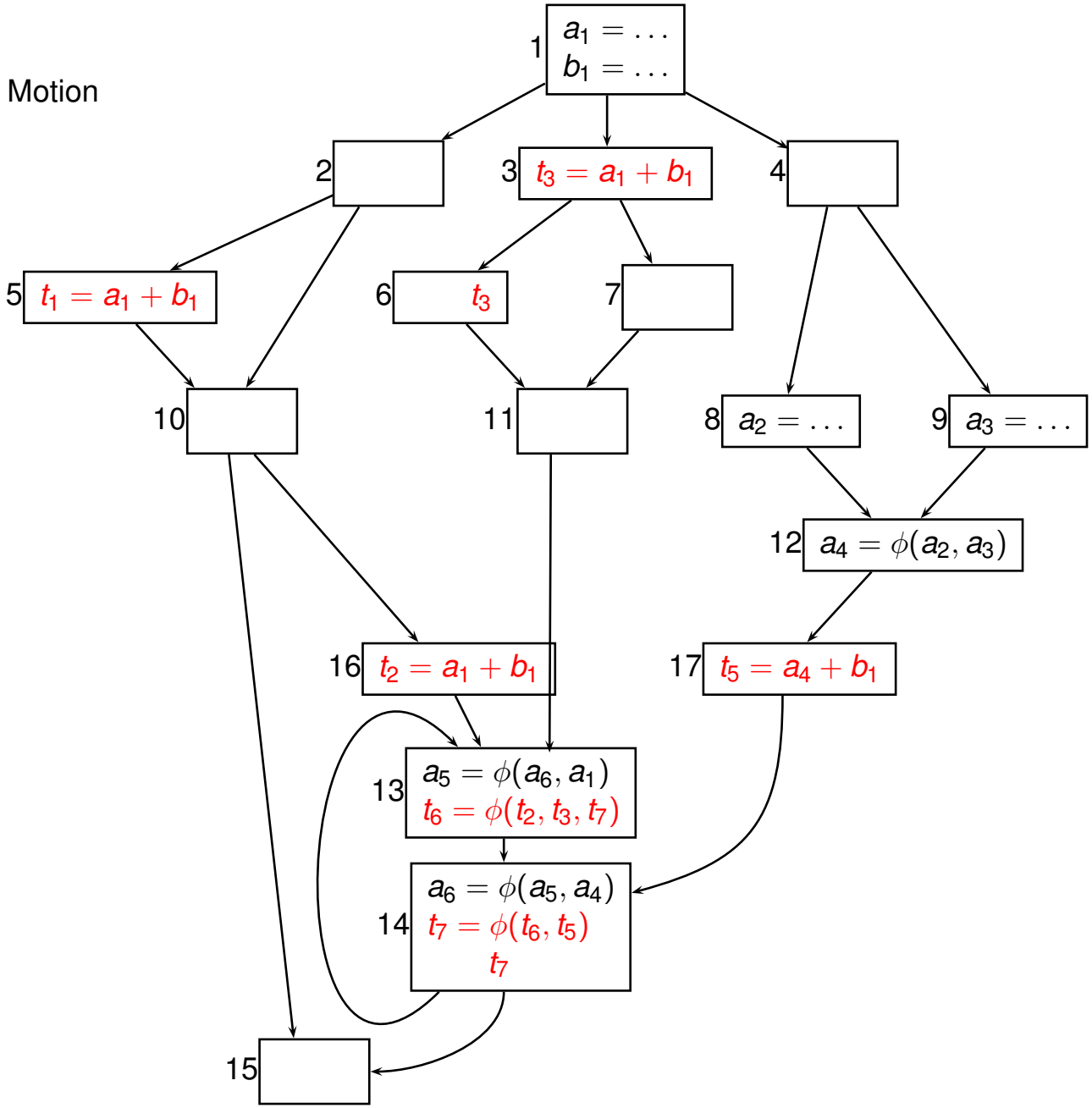


Finalize

Φ Block	Insert
16	t
17	t
Others	f



Code Motion


1
$a_1 = \ldots$
$b_1 = \ldots$
2
3
$t_3 = a_1 + b_1$
4
5
$t_1 = a_1 + b_1$
6
t_3
7
10
11
8
$a_2 = \ldots$
9
$a_3 = \ldots$
12
$a_4 = \phi(a_2, a_3)$
16
$t_2 = a_1 + b_1$
17
$t_5 = a_4 + b_1$
13
$a_5 = \phi(a_6, a_1)$
$t_6 = \phi(t_2, t_3, t_7)$
14
$a_6 = \phi(a_5, a_4)$
$t_7 = \phi(t_6, t_5)$
t_7
15