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Assignment Lesson8

1. Find encoder and decoder of LZ78? If we have:

   Input string: “abdcaedbdcecabbdeacb”
2. Find encoder and decoder of LZ77? If we have:

   Input string: “cdaabbefacbdegfeeabfedegg”

Answers

1. Find encoder and decoder of LZ78? If we have:

   Input string: “abdcaedbdcecabbdeacb”
   + Encoder
   - Find all different character “a, b, c, d, e” and based dictionary

Entry	Codeword
a	1
b	2
c	3
d	4
e	5

Based Dictionary

a	b	d	c	a	e	d	b	d	c	e	c	a	b	b	d	e	a	c	b	EOF
start																				

- Start from “a”.
  - “a” has in the base dictionary
  - So, we take “ab”.
  - “ab” doesn’t have in the dictionary.
  - We add “ab” to output dictionary.
  - The last codeword is 5.
  - New codeword must be 6.

Entry	Codeword	Output
ab	6	<1,2>

- Find next character:

a	b	d	c	a	e	d	b	d	c	e	c	a	b	b	d	e	a	c	b	EOF
start																				

- Start from “d”.
  - “d” has in the base dictionary

- So, we take “dc”.
- “dc” doesn’t have in the dictionary.
- We add “dc” to output dictionary.
- The last codeword is 6.
- New codeword must be 7.

Entry	Codeword	Output
ab	6	<1,2>
dc	7	<4,3>

➢ Find next character:

a	b	d	c	a	e	d	b	d	c	e	c	a	b	b	d	e	a	c	b	EOF
start																				

➢ Start from “a”.
- “a” has in the base dictionary
- So, we take “ae”.
- “ae” doesn’t have in the dictionary.
- We add “ae” to output dictionary.
- The last codeword is 7.
- New codeword must be 8.

Entry	Codeword	Output
ab	6	<1,2>
dc	7	<4,3>
ae	8	<1,5>

➢ Find next character:

a	b	d	c	a	e	d	b	d	c	e	c	a	b	b	d	e	a	c	b	EOF
start																				

➢ Start from “d”.
- “d” has in the base dictionary
- So, we take “db”.
- “db” doesn’t have in the dictionary.
- We add “db” to output dictionary.
- The last codeword is 8.
- New codeword must be 9.

Entry	Codeword	Output
ab	6	<1,2>
dc	7	<4,3>
ae	8	<1,5>
db	9	<4,2>

➢ Find next character:

a	b	d	c	a	e	d	b	d	c	e	c	a	b	b	d	e	a	c	b	EOF
start																				

➢ Start from “d”.
- “d” has in the base dictionary
- So, we take “dc”.

- “dc” has in the dictionary
- So, we take “dce”
- “dce” doesn’t have in the dictionary.
- We add “dce” to output dictionary.
- The last codeword is 9.
- New codeword must be 10.

Entry	Codeword	Output
ab	6	<1,2>
dc	7	<4,3>
ae	8	<1,5>
db	9	<4,2>
dce	10	<7,5>

➢ Find next character:

a	b	d	c	a	e	d	b	d	c	e	c	a	b	b	d	e	a	c	b	EOF
start																				

➢ Start from “c”.

- “c” has in the base dictionary
- So, we take “ca”.
- “ca” doesn’t have in the dictionary.
- We add “ca” to output dictionary.
- The last codeword is 10.
- New codeword must be 11.

Entry	Codeword	Output
ab	6	<1,2>
dc	7	<4,3>
ae	8	<1,5>
db	9	<4,2>
dce	10	<7,5>
ca	11	<3,1>

➢ Find next character:

a	b	d	c	a	e	d	b	d	c	e	c	a	b	b	d	e	a	c	b	EOF
start																				

➢ Start from “b”.

- “b” has in the base dictionary
- So, we take “bb”.
- “bb” doesn’t have in the dictionary.
- We add “bb” to output dictionary.
- The last codeword is 11.
- New codeword must be 12.

Entry	Codeword	Output
ab	6	<1,2>
dc	7	<4,3>
ae	8	<1,5>
db	9	<4,2>

dce	10	<7,5>
ca	11	<3,1>
bb	12	<2,2>

- Find next character:

a	b	d	c	a	e	d	b	d	c	e	c	a	b	b	d	e	a	c	b	EOF
start																				

- Start from “d”.
  - “d” has in the base dictionary
  - So, we take “de”.
  - “de” doesn’t have in the dictionary.
  - We add “de” to output dictionary.
  - The last codeword is 12.
  - New codeword must be 13.

Entry	Codeword	Output
ab	6	<1,2>
dc	7	<4,3>
ae	8	<1,5>
db	9	<4,2>
dce	10	<7,5>
ca	11	<3,1>
bb	12	<2,2>
de	13	<4,5>

- Find next character:

a	b	d	c	a	e	d	b	d	c	e	c	a	b	b	d	e	a	c	b	EOF
start																				

- Start from “a”.
  - “a” has in the base dictionary
  - So, we take “ac”.
  - “ac” doesn’t have in the dictionary.
  - We add “ac” to output dictionary.
  - The last codeword is 13.
  - New codeword must be 14.

Entry	Codeword	Output
ab	6	<1,2>
dc	7	<4,3>
ae	8	<1,5>
db	9	<4,2>
dce	10	<7,5>
ca	11	<3,1>
bb	12	<2,2>
de	13	<4,5>
ac	14	<1,3>

➢ Find next character:

a	b	d	c	a	e	d	b	d	c	e	c	a	b	b	d	e	a	c	b	EOF
start																				

➢ Start from "b".

- "b" has in the base dictionary
- But, there is no next character (EOF)
- We just add codeword to "Output".

Entry	Codeword	Output
ab	6	<1,2>
dc	7	<4,3>
ae	8	<1,5>
db	9	<4,2>
dce	10	<7,5>
ca	11	<3,1>
bb	12	<2,2>
de	13	<4,5>
ac	14	<1,3>
EOF	EOF	<2,>

Thus, Encoder = { <1,2>, <4,3>, <1,5>, <4,2>, <7,5>, <3,1>, <2,2>, <4,5>, <1,3>, <2,> }
+ Decoder:

➢ We need to use base Dictionary and encoder:

Entry	Codeword
a	1
b	2
c	3
d	4
e	5

Base Dictionary

⇨ Encoder = { <1,2>, <4,3>, <1,5>, <4,2>, <7,5>, <3,1>, <2,2>, <4,5>, <1,3>, <2,> }

➢ Next, build an output dictionary

<1,2>	<4,3>	<1,5>	<4,2>	<7,5>	<3,1>	<2,2>	<4,5>	<1,3>	<2,>	EOF
Output										

➢ Output Dictionary start from <1,2>

- Codeword: "1" is "a" and "2" is "b"
- Entry is "ab".
- So, output is also "ab".
- New codeword is 6.

Input	Codeword	Entry	Output
<1,2>	6	ab	ab

➢ Next, build an output dictionary

<1,2>	<4,3>	<1,5>	<4,2>	<7,5>	<3,1>	<2,2>	<4,5>	<1,3>	<2,>	EOF
Output										

➢ Output Dictionary start from <4,3>

- Codeword: “4” is “d” and “3” is “c”
- Entry is “dc”.
- So, output is also “dc”.
- New codeword is 7.

Input	Codeword	Entry	Output
<1,2>	6	ab	ab
<4,3>	7	dc	dc

➢ Next, build an output dictionary

<1,2>	<4,3>	<1,5>	<4,2>	<7,5>	<3,1>	<2,2>	<4,5>	<1,3>	<2,>	EOF
Output										

➢ Output Dictionary start from <1,5>

- Codeword: “1” is “a” and “5” is “e”
- Entry is “ae”.
- So, output is also “ae”.
- New codeword is 8.

Input	Codeword	Entry	Output
<1,2>	6	ab	ab
<4,3>	7	dc	dc
<1,5>	8	ae	ae

➢ Next, build an output dictionary

<1,2>	<4,3>	<1,5>	<4,2>	<7,5>	<3,1>	<2,2>	<4,5>	<1,3>	<2,>	EOF
Output										

➢ Output Dictionary start from <4,2>

- Codeword: “4” is “d” and “2” is “b”
- Entry is “db”.
- So, output is also “db”.
- New codeword is 9.

Input	Codeword	Entry	Output
<1,2>	6	ab	ab
<4,3>	7	dc	dc
<1,5>	8	ae	ae
<4,2>	9	db	db

➢ Next, build an output dictionary

<1,2>	<4,3>	<1,5>	<4,2>	<7,5>	<3,1>	<2,2>	<4,5>	<1,3>	<2,>	EOF
Output										

➢ Output Dictionary start from <7,5>

- Codeword: “7” is “dc” and “5” is “e”
- Entry is “dce”.
- So, output is also “dce”.
- New codeword is 10.

Input	Codeword	Entry	Output
<1,2>	6	ab	ab
<4,3>	7	dc	dc
<1,5>	8	ae	ae
<4,2>	9	db	db
<7,5>	10	dce	dce

➢ Next, build an output dictionary

<1,2>	<4,3>	<1,5>	<4,2>	<7,5>	<3,1>	<2,2>	<4,5>	<1,3>	<2,>	EOF
Output										

➢ Output Dictionary start from <3,1>

- Codeword: “3” is “c” and “1” is “a”
- Entry is “ca”.
- So, output is also “ca”.
- New codeword is 11.

Input	Codeword	Entry	Output
<1,2>	6	ab	ab
<4,3>	7	dc	dc
<1,5>	8	ae	ae
<4,2>	9	db	db
<7,5>	10	dce	dce
<3,1>	11	ca	ca

➢ Next, build an output dictionary

<1,2>	<4,3>	<1,5>	<4,2>	<7,5>	<3,1>	<2,2>	<4,5>	<1,3>	<2,>	EOF
Output										

➢ Output Dictionary start from <2,2>

- Codeword: “2” is “b” and “2” is “b”
- Entry is “bb”.
- So, output is also “bb”.
- New codeword is 12.

Input	Codeword	Entry	Output
<1,2>	6	ab	ab
<4,3>	7	dc	dc
<1,5>	8	ae	ae
<4,2>	9	db	db
<7,5>	10	dce	dce
<3,1>	11	ca	ca
<2,2>	12	bb	bb

➢ Next, build an output dictionary

<1,2>	<4,3>	<1,5>	<4,2>	<7,5>	<3,1>	<2,2>	<4,5>	<1,3>	<2,>	EOF
Output										

➢ Output Dictionary start from <4,5>

- Codeword: “4” is “d” and “5” is “e”
- Entry is “de”.
- So, output is also “de”.
- New codeword is 13.

Input	Codeword	Entry	Output
<1,2>	6	ab	ab
<4,3>	7	dc	dc
<1,5>	8	ae	ae
<4,2>	9	db	db
<7,5>	10	dce	dce
<3,1>	11	ca	ca
<2,2>	12	bb	bb
<4,5>	13	de	de

➢ Next, build an output dictionary

<1,2>	<4,3>	<1,5>	<4,2>	<7,5>	<3,1>	<2,2>	<4,5>	<1,3>	<2,>	EOF
Output										

➢ Output Dictionary start from <1,3>

- Codeword: “1” is “a” and “3” is “c”
- Entry is “ac”.
- So, output is also “ac”.
- New codeword is 14.

Input	Codeword	Entry	Output
<1,2>	6	ab	ab
<4,3>	7	dc	dc
<1,5>	8	ae	ae
<4,2>	9	db	db
<7,5>	10	dce	dce
<3,1>	11	ca	ca
<2,2>	12	bb	bb
<4,5>	13	de	de
<1,3>	14	ac	ac

➢ Next, build an output dictionary

<1,2>	<4,3>	<1,5>	<4,2>	<7,5>	<3,1>	<2,2>	<4,5>	<1,3>	<2,>	EOF
Output										

➢ Output Dictionary start from <2,>

- Codeword: “2” is “b” and “” is “eof”
- Entry is “b”.
- So, output is also “b”.
- New codeword is EOF.

Input	Codeword	Entry	Output
<1,2>	6	ab	ab
<4,3>	7	dc	dc
<1,5>	8	ae	ae
<4,2>	9	db	db
<7,5>	10	dce	dce
<3,1>	11	ca	ca
<2,2>	12	bb	bb
<4,5>	13	de	de
<1,3>	14	ac	ac
<2,>	EOF	b	b

Thus, Decoder = abdcaedbdcecabbacb

2. Find encoder and decoder of LZ78? If we have:
   Input string: "cdaabbefacbdegfeeabfedegg"
   + Encoder
   - Find all different character "a, b, c, d, e, f, g" and based dictionary

Entry	Codeword
a	1
b	2
c	3
d	4
e	5
f	6
g	7

Based Dictionary

c	d	a	a	b	b	e	f	a	c	b	d	e	g	f	e	e	a	b	f	e	d	e	g	g	EOF
start																									

- Start from "c".
  - "c" has in the base dictionary
  - So, we take "cd".
  - "cd" doesn't have in the dictionary.
  - We add "cd" to output dictionary.
  - The last codeword is 7.
  - New codeword must be 8.

Entry	Codeword	Output
cd	8	<3,4>

- Find next character:

c	d	a	a	b	b	e	f	a	c	b	d	e	g	f	e	e	a	b	f	e	d	e	g	g	EOF
start																									

- Start from “a”.
  - “a” has in the base dictionary
  - So, we take “aa”.
  - “aa” doesn’t have in the dictionary.
  - We add “aa” to output dictionary.
  - The last codeword is 8.
  - New codeword must be 9.

Entry	Codeword	Output
cd	8	<3,4>
aa	9	<1,1>

- Find next character:

c	d	a	a	b	b	e	f	a	c	b	d	e	g	f	e	e	a	b	f	e	d	e	g	g	EOF
start																									

- Start from “b”.
  - “b” has in the base dictionary
  - So, we take “bb”.
  - “bb” doesn’t have in the dictionary.
  - We add “bb” to output dictionary.
  - The last codeword is 9.
  - New codeword must be 10.

Entry	Codeword	Output
cd	8	<3,4>
aa	9	<1,1>
bb	10	<2,2>

- Find next character:

c	d	a	a	b	b	e	f	a	c	b	d	e	g	f	e	e	a	b	f	e	d	e	g	g	EOF
start																									

- Start from “e”.
  - “e” has in the base dictionary
  - So, we take “ef”.
  - “ef” doesn’t have in the dictionary.
  - We add “ef” to output dictionary.
  - The last codeword is 10.
  - New codeword must be 11.

Entry	Codeword	Output
cd	8	<3,4>
aa	9	<1,1>
bb	10	<2,2>
ef	11	<5,6>

- Find next character:

c	d	a	a	b	b	e	f	a	c	b	d	e	g	f	e	e	a	b	f	e	d	e	g	g	EOF
start																									

- Start from “a”.

- “a” has in the base dictionary
- So, we take “ac”.
- “ac” doesn’t have in the dictionary.
- We add “ac” to output dictionary.
- The last codeword is 11.
- New codeword must be 12.

Entry	Codeword	Output
cd	8	<3,4>
aa	9	<1,1>
bb	10	<2,2>
ef	11	<5,6>
ac	12	<1,3>

➢ Find next character:

c	d	a	a	b	b	e	f	a	c	b	d	e	g	f	e	e	a	b	f	e	d	e	g	g	EOF
start																									

➢ Start from “b”.
- “b” has in the base dictionary
- So, we take “bd”.
- “bd” doesn’t have in the dictionary.
- We add “bd” to output dictionary.
- The last codeword is 12.
- New codeword must be 13.

Entry	Codeword	Output
cd	8	<3,4>
aa	9	<1,1>
bb	10	<2,2>
ef	11	<5,6>
ac	12	<1,3>
bd	13	<2,4>

➢ Find next character:

c	d	a	a	b	b	e	f	a	c	b	d	e	g	f	e	e	a	b	f	e	d	e	g	g	EOF
start																									

➢ Start from “e”.
- “e” has in the base dictionary
- So, we take “eg”.
- “eg” doesn’t have in the dictionary.
- We add “eg” to output dictionary.
- The last codeword is 13.
- New codeword must be 14.

Entry	Codeword	Output

cd	8	<3,4>
aa	9	<1,1>
bb	10	<2,2>
ef	11	<5,6>
ac	12	<1,3>
bd	13	<2,4>
eg	14	<5,7>

- Find next character:

c	d	a	a	b	b	e	f	a	c	b	d	e	g	f	e	e	a	b	f	e	d	e	g	g	EOF
start																									

- Start from "f".
  - "f" has in the base dictionary
  - So, we take "fe".
  - "fe" doesn't have in the dictionary.
  - We add "fe" to output dictionary.
  - The last codeword is 14.
  - New codeword must be 15.

Entry	Codeword	Output
cd	8	<3,4>
aa	9	<1,1>
bb	10	<2,2>
ef	11	<5,6>
ac	12	<1,3>
bd	13	<2,4>
eg	14	<5,7>
fe	15	<6,5>

- Find next character:

c	d	a	a	b	b	e	f	a	c	b	d	e	g	f	e	e	a	b	f	e	d	e	g	g	eof
start																									

- Start from "e".
  - "e" has in the base dictionary
  - So, we take "ea".
  - "ea" doesn't have in the dictionary.
  - We add "ea" to output dictionary.
  - The last codeword is 15.
  - New codeword must be 16.

Entry	Codeword	Output
cd	8	<3,4>
aa	9	<1,1>
bb	10	<2,2>
ef	11	<5,6>
ac	12	<1,3>
bd	13	<2,4>
eg	14	<5,7>
fe	15	<6,5>
ea	16	<5,1>

➢ Find next character:

c	d	a	a	b	b	e	f	a	c	b	d	e	g	f	e	e	a	b	f	e	d	e	g	g	eof
start																									

➢ Start from “b”.

- “b” has in the base dictionary
- So, we take “bf”.
- “bf” doesn’t have in the dictionary.
- We add “bf” to output dictionary.
- The last codeword is 16.
- New codeword must be 17.

Entry	Codeword	Output
cd	8	<3,4>
aa	9	<1,1>
bb	10	<2,2>
ef	11	<5,6>
ac	12	<1,3>
bd	13	<2,4>
eg	14	<5,7>
fe	15	<6,5>
ea	16	<5,1>
bf	17	<2,6>

➢ Find next character:

c	d	a	a	b	b	e	f	a	c	b	d	e	g	f	e	e	a	b	f	e	d	e	g	g	eof
start																									

➢ Start from “e”.

- “e” has in the base dictionary
- So, we take “ed”.
- “ed” doesn’t have in the dictionary.
- We add “ed” to output dictionary.
- The last codeword is 17.
- New codeword must be 18.

Entry	Codeword	Output
cd	8	<3,4>
aa	9	<1,1>
bb	10	<2,2>
ef	11	<5,6>
ac	12	<1,3>
bd	13	<2,4>
eg	14	<5,7>
fe	15	<6,5>
ea	16	<5,1>
bf	17	<2,6>
ed	18	<5,4>

➢ Find next character:

c	d	a	a	b	b	e	f	a	c	b	d	e	g	f	e	e	a	b	f	e	d	e	g	g	eof

start																							

- Start from "e".
  - "e" has in the base dictionary
  - So, we take "eg".
  - "eg" has in dictionary
  - So, we take "egg"
  - "egg" doesn't have in the dictionary.
  - We add "egg" to output dictionary.
  - The last codeword is 18.
  - New codeword must be EOF.

Entry	Codeword	Output
cd	8	<3,4>
aa	9	<1,1>
bb	10	<2,2>
ef	11	<5,6>
ac	12	<1,3>
bd	13	<2,4>
eg	14	<5,7>
fe	15	<6,5>
ea	16	<5,1>
bf	17	<2,6>
ed	18	<5,4>
egg	EOF	<14,7>

Thus, Encoder = { <3,4>, <1,1>, <2,2>, <5,6>, <1,3>, <2,4>, <5,7>,<6,5>, <5,1>, <2,6>, <5,4>, <14,7>}

+ Decoder:

- We need to use base Dictionary and encoder:

Entry	Codeword
a	1
b	2
c	3
d	4
e	5
f	6
g	7

Base Dictionary

⇨ Encoder = {<3,4>, <1,1>, <2,2>, <5,6>, <1,3>, <2,4>, <5,7>, <6,5>, <5,1>, <2,6>, <5,4>, <14,7>}

- Next, build an output dictionary

<3,4>	<1,1>	<2,2>	<5,6>	<1,3>	<2,4>	<5,7>	<6,5>	<5,1>	<2,6>	<5,4>	<14,7>	EOF
Output												

- Output Dictionary start from <3,4>

- Codeword: “3” is “c” and “4” is “d”
- Entry is “cd”.
- So, output is also “cd”.
- New codeword is 8.

Input	Codeword	Entry	Output
<3,4>	8	cd	cd

➢ Next, build an output dictionary

<3,4>	<1,1>	<2,2>	<5,6>	<1,3>	<2,4>	<5,7>	<6,5>	<5,1>	<2,6>	<5,4>	<14,7>	EOF
Output												

➢ Output Dictionary start from <1,1>

- Codeword: “1” is “a”
- Entry is “aa”.
- So, output is also “aa”.
- New codeword is 9.

Input	Codeword	Entry	Output
<3,4>	8	cd	cd
<1,1>	9	aa	aa

➢ Next, build an output dictionary

<3,4>	<1,1>	<2,2>	<5,6>	<1,3>	<2,4>	<5,7>	<6,5>	<5,1>	<2,6>	<5,4>	<14,7>	EOF
Output												

➢ Output Dictionary start from <2,2>

- Codeword: “2” is “b”
- Entry is “bb”.
- So, output is also “bb”.
- New codeword is 10.

Input	Codeword	Entry	Output
<3,4>	8	cd	cd
<1,1>	9	aa	aa
<2,2>	10	bb	bb

➢ Next, build an output dictionary

<3,4>	<1,1>	<2,2>	<5,6>	<1,3>	<2,4>	<5,7>	<6,5>	<5,1>	<2,6>	<5,4>	<14,7>	EOF
Output												

➢ Output Dictionary start from <5,6>

- Codeword: “5” is “e” and “6” is “f”
- Entry is “ef”.
- So, output is also “ef”.
- New codeword is 11.

Input	Codeword	Entry	Output
<3,4>	8	cd	cd
<1,1>	9	aa	aa
<2,2>	10	bb	bb
<5,6>	11	ef	ef

➢ Next, build an output dictionary

<3,4>	<1,1>	<2,2>	<5,6>	<1,3>	<2,4>	<5,7>	<6,5>	<5,1>	<2,6>	<5,4>	<14,7>	EOF
Output												

➢ Output Dictionary start from <1,3>

- Codeword: "1" is "a" and "3" is "c"
- Entry is "ac".
- So, output is also "ac".
- New codeword is 12.

Input	Codeword	Entry	Output
<3,4>	8	cd	cd
<1,1>	9	aa	aa
<2,2>	10	bb	bb
<5,6>	11	ef	ef
<1,3>	12	ac	ac

➢ Next, build an output dictionary

<3,4>	<1,1>	<2,2>	<5,6>	<1,3>	<2,4>	<5,7>	<6,5>	<5,1>	<2,6>	<5,4>	<14,7>	EOF
Output												

➢ Output Dictionary start from <2,4>

- Codeword: "2" is "b" and "4" is "d"
- Entry is "bd".
- So, output is also "bd".
- New codeword is 13.

Input	Codeword	Entry	Output
<3,4>	8	cd	cd
<1,1>	9	aa	aa
<2,2>	10	bb	bb
<5,6>	11	ef	ef
<1,3>	12	ac	ac
<2,4>	13	bd	bd

➢ Next, build an output dictionary

<3,4>	<1,1>	<2,2>	<5,6>	<1,3>	<2,4>	<5,7>	<6,5>	<5,1>	<2,6>	<5,4>	<14,7>	EOF
Output												

➢ Output Dictionary start from <5,7>

- Codeword: "5" is "e" and "7" is "g"
- Entry is "eg".
- So, output is also "eg".
- New codeword is 14.

Input	Codeword	Entry	Output
<3,4>	8	cd	cd
<1,1>	9	aa	aa
<2,2>	10	bb	bb
<5,6>	11	ef	ef
<1,3>	12	ac	ac

<2,4>	13	bd	bd
<5,7>	14	eg	eg

➢ Next, build an output dictionary

<3,4>	<1,1>	<2,2>	<5,6>	<1,3>	<2,4>	<5,7>	<6,5>	<5,1>	<2,6>	<5,4>	<14,7>	EOF
Output												

➢ Output Dictionary start from <6,5>

- Codeword: “6” is “f” and “5” is “e”
- Entry is “fe”.
- So, output is also “fe”.
- New codeword is 15.

Input	Codeword	Entry	Output
<3,4>	8	cd	cd
<1,1>	9	aa	aa
<2,2>	10	bb	bb
<5,6>	11	ef	ef
<1,3>	12	ac	ac
<2,4>	13	bd	bd
<5,7>	14	eg	eg
<6,5>	15	fe	fe

➢ Next, build an output dictionary

<3,4>	<1,1>	<2,2>	<5,6>	<1,3>	<2,4>	<5,7>	<6,5>	<5,1>	<2,6>	<5,4>	<14,7>	EOF
Output												

➢ Output Dictionary start from <5,1>

- Codeword: “5” is “e” and “1” is “a”
- Entry is “ea”.
- So, output is also “ea”.
- New codeword is 16.

Input	Codeword	Entry	Output
<3,4>	8	cd	cd
<1,1>	9	aa	aa
<2,2>	10	bb	bb
<5,6>	11	ef	ef
<1,3>	12	ac	ac
<2,4>	13	bd	bd
<5,7>	14	eg	eg
<6,5>	15	fe	fe
<5,1>	16	ea	ea

➢ Next, build an output dictionary

<3,4>	<1,1>	<2,2>	<5,6>	<1,3>	<2,4>	<5,7>	<6,5>	<5,1>	<2,6>	<5,4>	<14,7>	EOF
Output												

➢ Output Dictionary start from <2,6>

- Codeword: “2” is “b” and “6” is “f”
- Entry is “bf”.
- So, output is also “bf”.

- New codeword is 17.

Input	Codeword	Entry	Output
<3,4>	8	cd	cd
<1,1>	9	aa	aa
<2,2>	10	bb	bb
<5,6>	11	ef	ef
<1,3>	12	ac	ac
<2,4>	13	bd	bd
<5,7>	14	eg	eg
<6,5>	15	fe	fe
<5,1>	16	ea	ea
<2,6>	17	bf	bf

➢ Next, build an output dictionary

<3,4>	<1,1>	<2,2>	<5,6>	<1,3>	<2,4>	<5,7>	<6,5>	<5,1>	<2,6>	<5,4>	<14,7>	EOF
Output												

➢ Output Dictionary start from <5,4>

- Codeword: "5" is "e" and "4" is "d"
- Entry is "ed".
- So, output is also "ed".
- New codeword is 18.

Input	Codeword	Entry	Output
<3,4>	8	cd	cd
<1,1>	9	aa	aa
<2,2>	10	bb	bb
<5,6>	11	ef	ef
<1,3>	12	ac	ac
<2,4>	13	bd	bd
<5,7>	14	eg	eg
<6,5>	15	fe	fe
<5,1>	16	ea	ea
<2,6>	17	bf	bf
<5,4>	18	ed	ed

➢ Next, build an output dictionary

<3,4>	<1,1>	<2,2>	<5,6>	<1,3>	<2,4>	<5,7>	<6,5>	<5,1>	<2,6>	<5,4>	<14,7>	EOF
Output												

➢ Output Dictionary start from <14,7>

- Codeword: "14" is "eg" and "7" is "g"
- Entry is "egg".
- So, output is also "egg".
- New codeword is EOF.

Input	Codeword	Entry	Output
<3,4>	8	cd	cd
<1,1>	9	aa	aa
<2,2>	10	bb	bb

<5,6>	11	ef	ef
<1,3>	12	ac	ac
<2,4>	13	bd	bd
<5,7>	14	eg	eg
<6,5>	15	fe	fe
<5,1>	16	ea	ea
<2,6>	17	bf	bf
<5,4>	18	ed	ed
<14,7>	EOF	eeg	egg

Thus, Decoder = cdaabbefacbdegfeeabfedegg