

Construct a **Turing machine** that **accepts** the language:

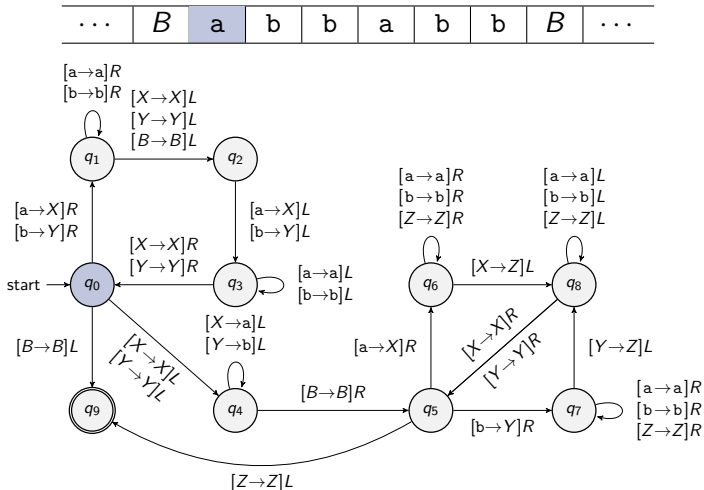
$$L(M) = \{ww \mid w \in \{a, b\}^*\}$$

...	<i>B</i>	a	b	b	a	b	b	<i>B</i>	...
-----	----------	---	---	---	---	---	---	----------	-----

- 1: Find the middle of the input by repeatedly replacing leftmost and rightmost a's (or b's) with *X*'s (or *Y*'s)
- 2: Replace all *X*'s (or *Y*'s) with a's (or b's) in the first half
- 3: **while** there are input symbols in the first half **do**
- 4: Replace a (or b) with *X* (or *Y*) in the first half
- 5: Find and Replace *X* (or *Y*) with *Z* in the second half

Construct a **Turing machine** that **accepts** the language:

$$L(M) = \{ww \mid w \in \{a, b\}^*\}$$

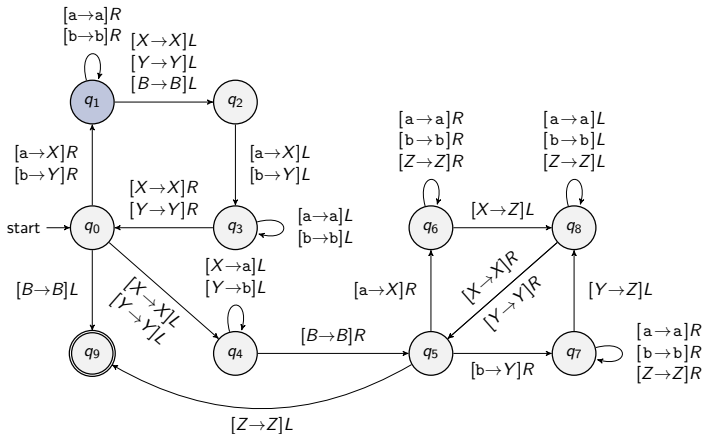


Find the middle of the input.

Construct a **Turing machine** that **accepts** the language:

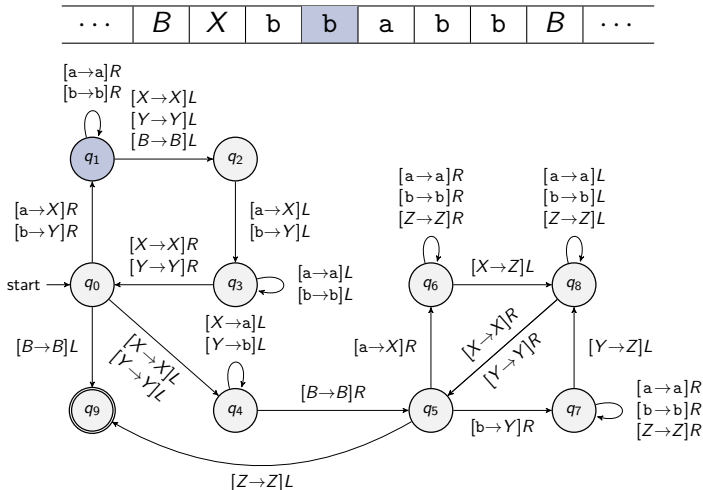
$$L(M) = \{ww \mid w \in \{a, b\}^*\}$$

...	B	X	b	b	a	b	b	B	...
-----	---	---	---	---	---	---	---	---	-----



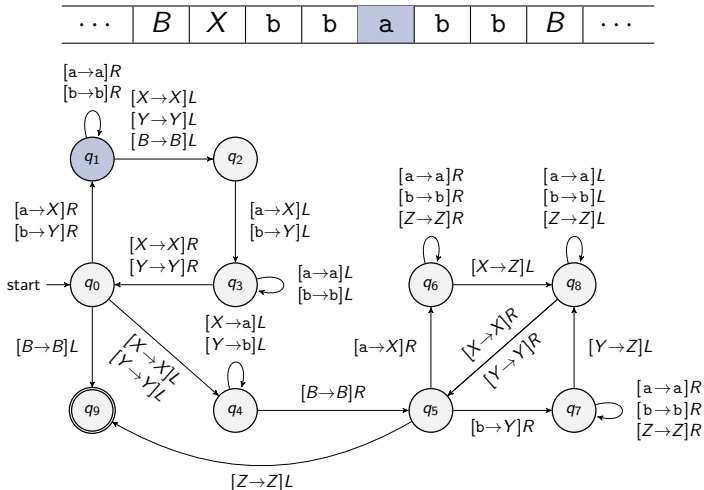
Construct a **Turing machine** that **accepts** the language:

$$L(M) = \{ww \mid w \in \{a, b\}^*\}$$



Construct a **Turing machine** that **accepts** the language:

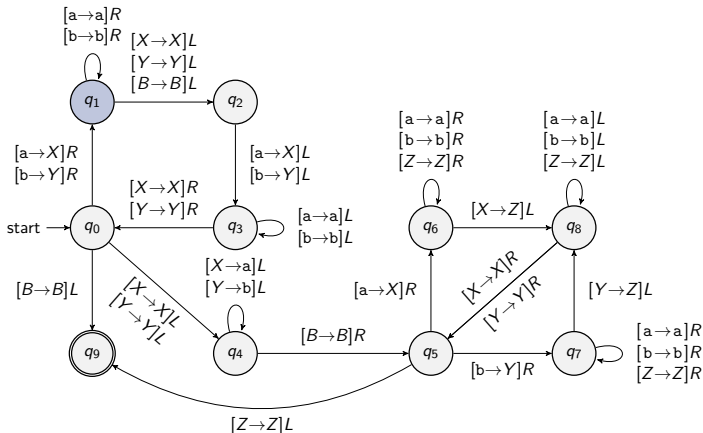
$$L(M) = \{ww \mid w \in \{a, b\}^*\}$$



Construct a **Turing machine** that **accepts** the language:

$$L(M) = \{ww \mid w \in \{a, b\}^*\}$$

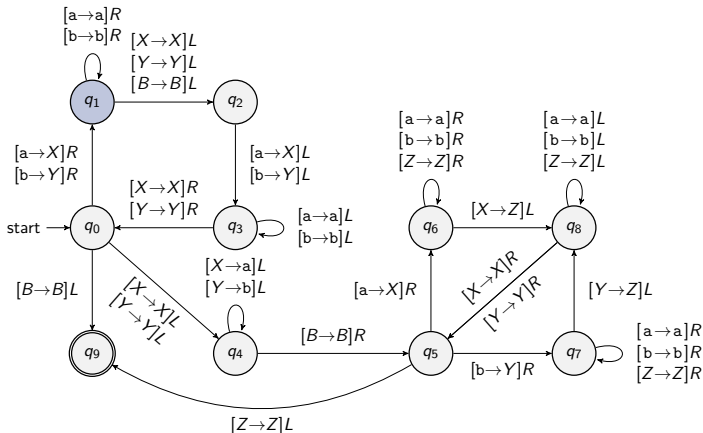
...	B	X	b	b	a	b	b	B	...
-----	---	---	---	---	---	---	---	---	-----



Construct a **Turing machine** that **accepts** the language:

$$L(M) = \{ww \mid w \in \{a, b\}^*\}$$

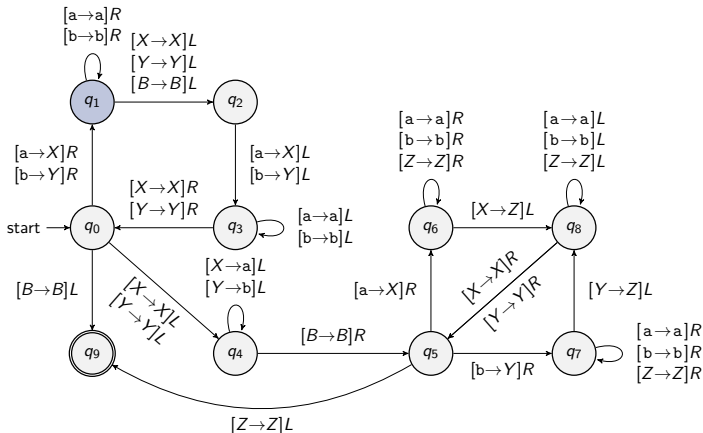
...	B	X	b	b	a	b	B	...
-----	---	---	---	---	---	---	---	-----



Construct a **Turing machine** that **accepts** the language:

$$L(M) = \{ww \mid w \in \{a, b\}^*\}$$

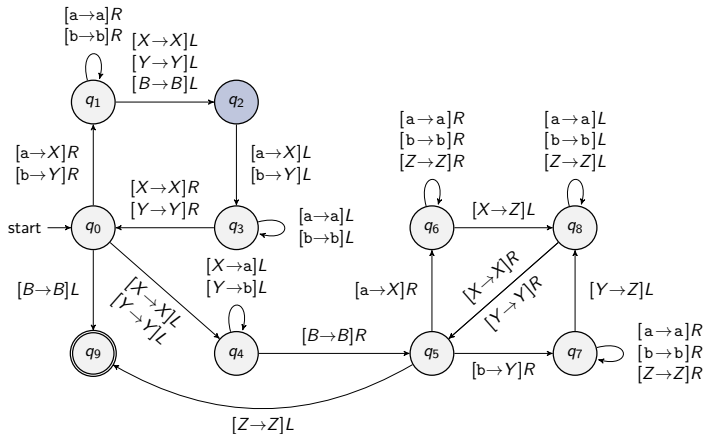
...	<i>B</i>	<i>X</i>	b	b	a	b	b	<i>B</i>	...
-----	----------	----------	---	---	---	---	---	----------	-----



Construct a **Turing machine** that **accepts** the language:

$$L(M) = \{ww \mid w \in \{a, b\}^*\}$$

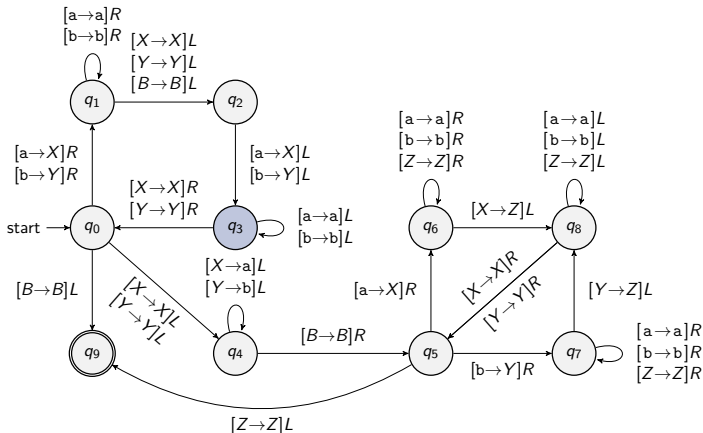
...	B	X	b	b	a	b	B	...
-----	---	---	---	---	---	---	---	-----



Construct a **Turing machine** that **accepts** the language:

$$L(M) = \{ww \mid w \in \{a, b\}^*\}$$

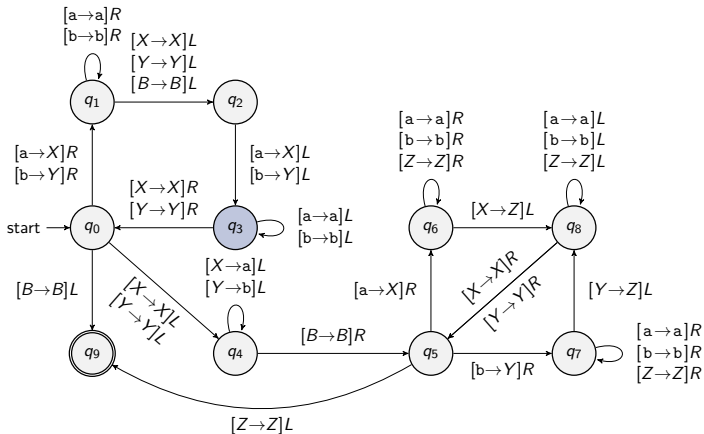
...	B	X	b	b	a	b	Y	B	...
-----	---	---	---	---	---	---	---	---	-----



Construct a **Turing machine** that **accepts** the language:

$$L(M) = \{ww \mid w \in \{a, b\}^*\}$$

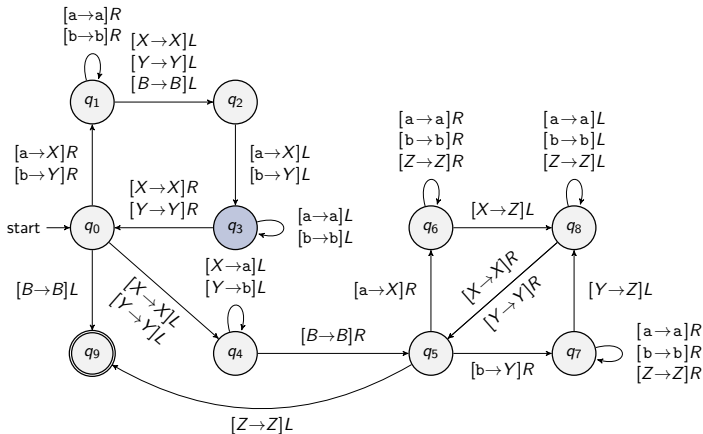
...	B	X	b	b	a	b	Y	B	...
-----	---	---	---	---	---	---	---	---	-----



Construct a **Turing machine** that **accepts** the language:

$$L(M) = \{ww \mid w \in \{a, b\}^*\}$$

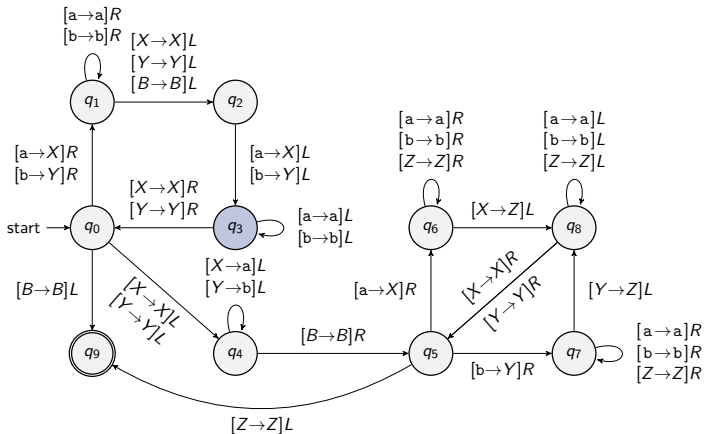
...	B	X	b	b	a	b	Y	B	...
-----	---	---	---	---	---	---	---	---	-----



Construct a **Turing machine** that **accepts** the language:

$$L(M) = \{ww \mid w \in \{a, b\}^*\}$$

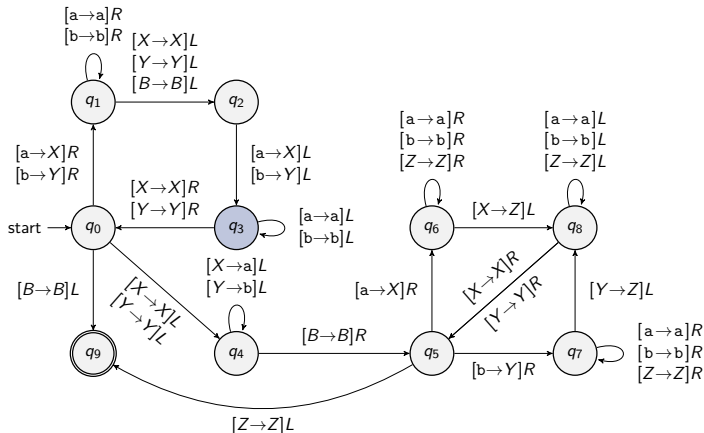
...	B	X	b	b	a	b	Y	B	...
-----	---	---	---	---	---	---	---	---	-----



Construct a **Turing machine** that **accepts** the language:

$$L(M) = \{ww \mid w \in \{a, b\}^*\}$$

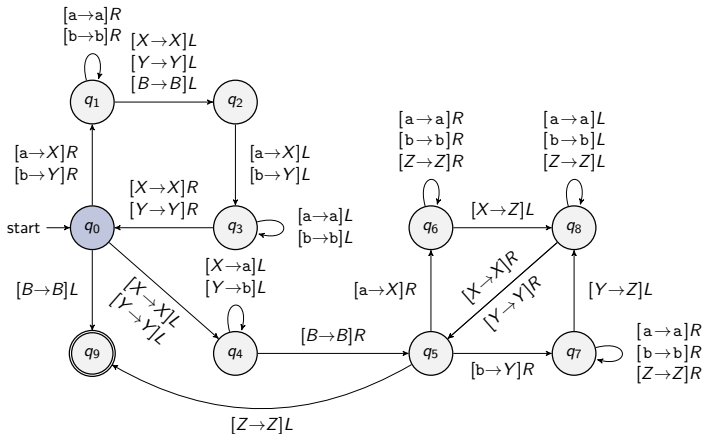
...	B	X	b	b	a	b	Y	B	...
-----	---	---	---	---	---	---	---	---	-----



Construct a **Turing machine** that **accepts** the language:

$$L(M) = \{ww \mid w \in \{a, b\}^*\}$$

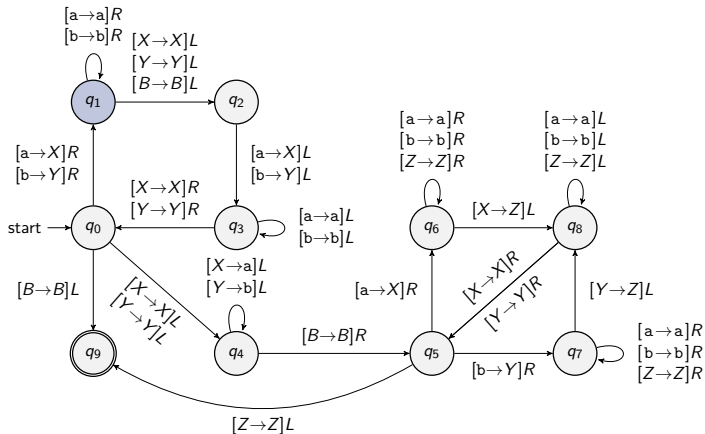
...	B	X	b	b	a	b	Y	B	...
-----	---	---	---	---	---	---	---	---	-----



Construct a **Turing machine** that **accepts** the language:

$$L(M) = \{ww \mid w \in \{a, b\}^*\}$$

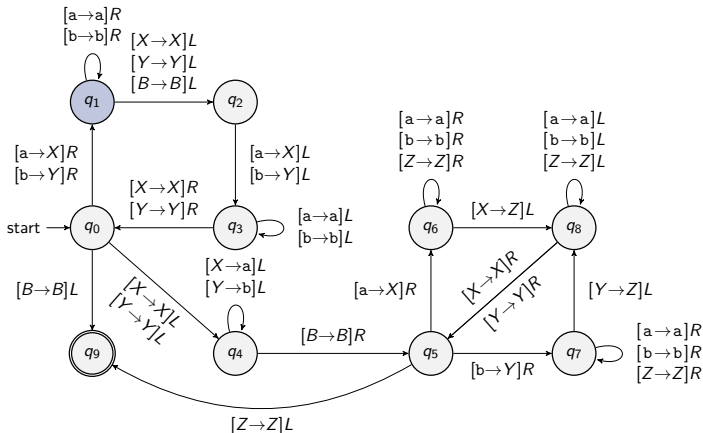
...	B	X	Y	b	a	b	Y	B	...
-----	---	---	---	---	---	---	---	---	-----



Construct a **Turing machine** that **accepts** the language:

$$L(M) = \{ww \mid w \in \{a, b\}^*\}$$

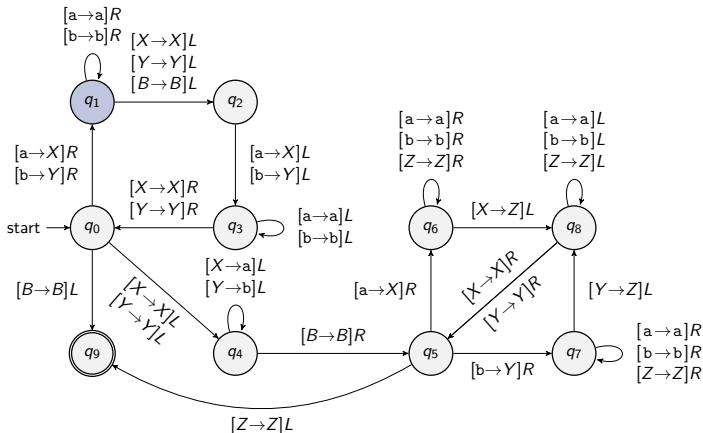
...	B	X	Y	b	a	b	Y	B	...
-----	---	---	---	---	---	---	---	---	-----



Construct a **Turing machine** that **accepts** the language:

$$L(M) = \{ww \mid w \in \{a, b\}^*\}$$

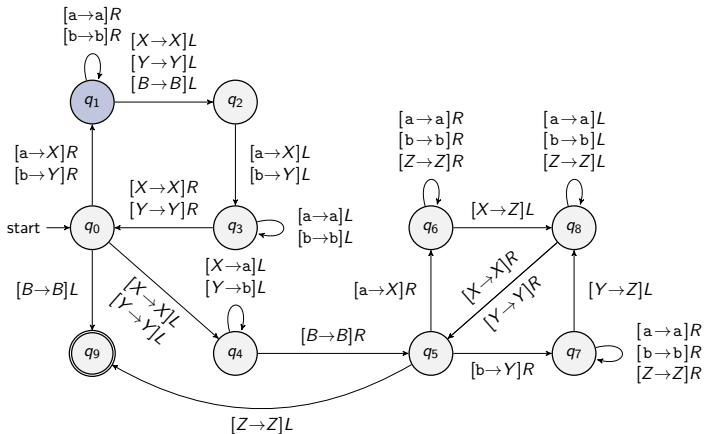
...	B	X	Y	b	a	b	Y	B	...
-----	---	---	---	---	---	---	---	---	-----



Construct a **Turing machine** that **accepts** the language:

$$L(M) = \{ww \mid w \in \{a, b\}^*\}$$

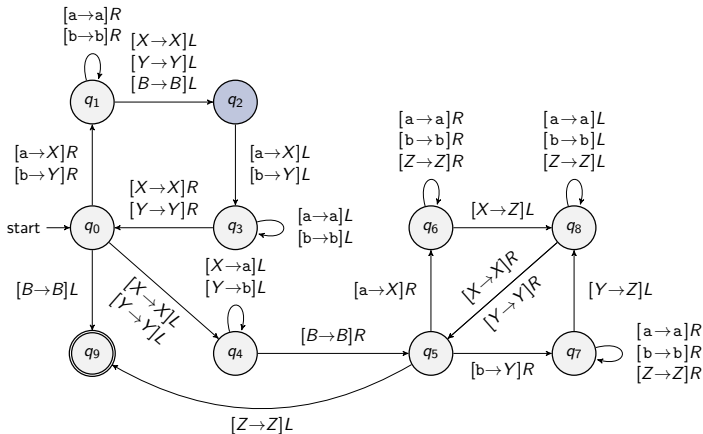
...	B	X	Y	b	a	b	Y	B	...
-----	---	---	---	---	---	---	---	---	-----



Construct a **Turing machine** that **accepts** the language:

$$L(M) = \{ww \mid w \in \{a, b\}^*\}$$

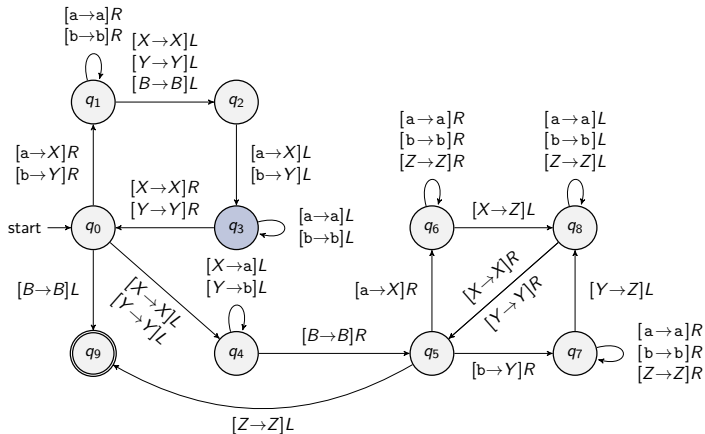
...	B	X	Y	b	a	b	Y	B	...
-----	---	---	---	---	---	---	---	---	-----



Construct a **Turing machine** that **accepts** the language:

$$L(M) = \{ww \mid w \in \{a, b\}^*\}$$

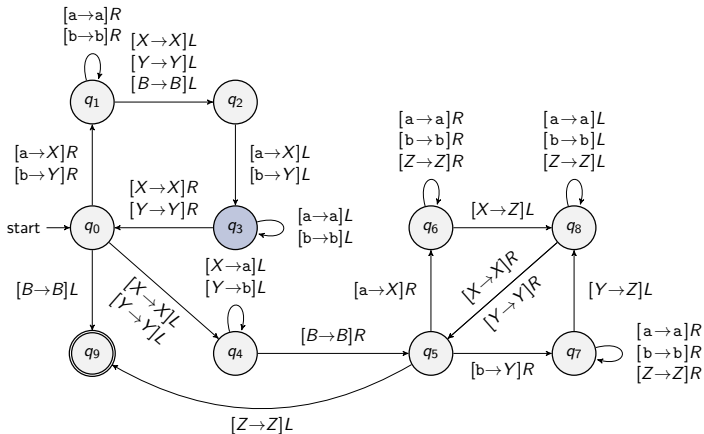
...	B	X	Y	b	a	Y	Y	B	...
-----	---	---	---	---	---	---	---	---	-----



Construct a **Turing machine** that **accepts** the language:

$$L(M) = \{ww \mid w \in \{a, b\}^*\}$$

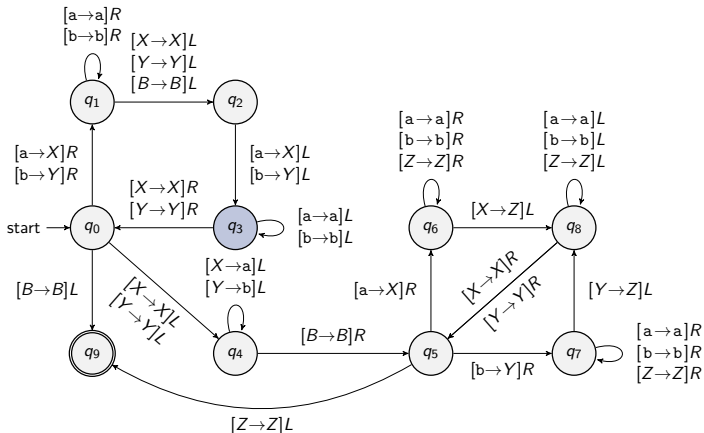
...	B	X	Y	b	a	Y	Y	B	...
-----	---	---	---	---	---	---	---	---	-----



Construct a **Turing machine** that **accepts** the language:

$$L(M) = \{ww \mid w \in \{a, b\}^*\}$$

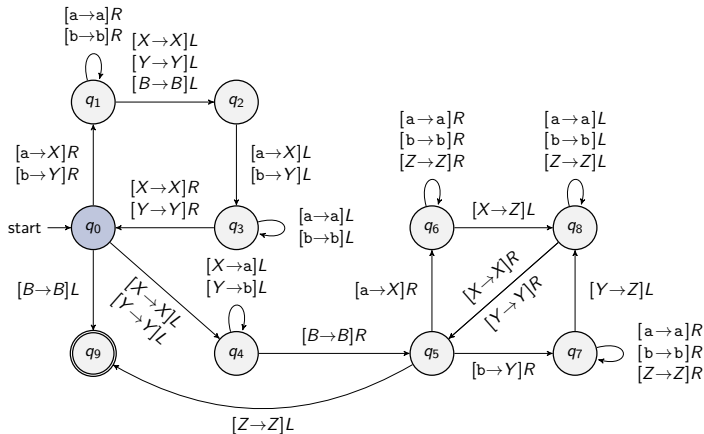
...	B	X	Y	b	a	Y	Y	B	...
-----	---	---	---	---	---	---	---	---	-----



Construct a **Turing machine** that **accepts** the language:

$$L(M) = \{ww \mid w \in \{a, b\}^*\}$$

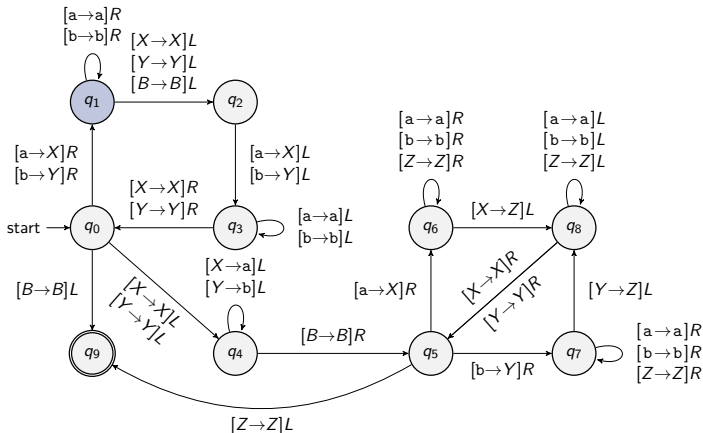
...	B	X	Y	b	a	Y	Y	B	...
-----	---	---	---	---	---	---	---	---	-----



Construct a **Turing machine** that **accepts** the language:

$$L(M) = \{ww \mid w \in \{a, b\}^*\}$$

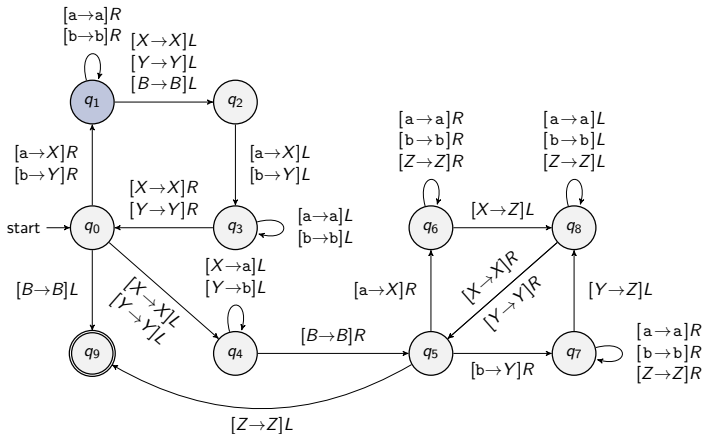
...	B	X	Y	Y	a	Y	Y	B	...
-----	---	---	---	---	---	---	---	---	-----



Construct a **Turing machine** that **accepts** the language:

$$L(M) = \{ww \mid w \in \{a, b\}^*\}$$

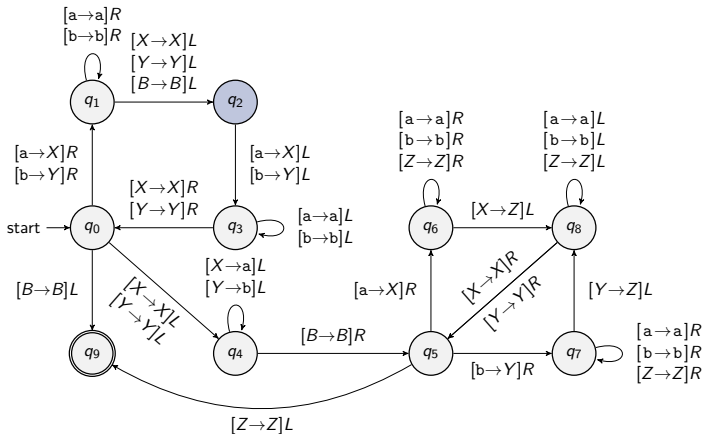
...	B	X	Y	Y	a	Y	Y	B	...
-----	---	---	---	---	---	---	---	---	-----



Construct a **Turing machine** that **accepts** the language:

$$L(M) = \{ww \mid w \in \{a, b\}^*\}$$

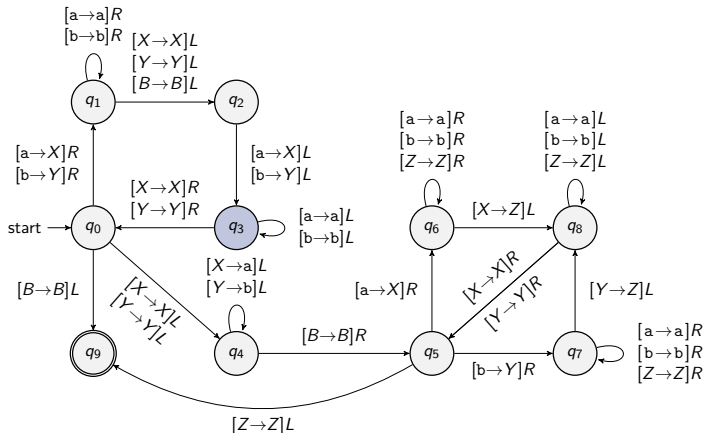
...	B	X	Y	Y	a	Y	Y	B	...
-----	---	---	---	---	---	---	---	---	-----



Construct a **Turing machine** that **accepts** the language:

$$L(M) = \{ww \mid w \in \{a, b\}^*\}$$

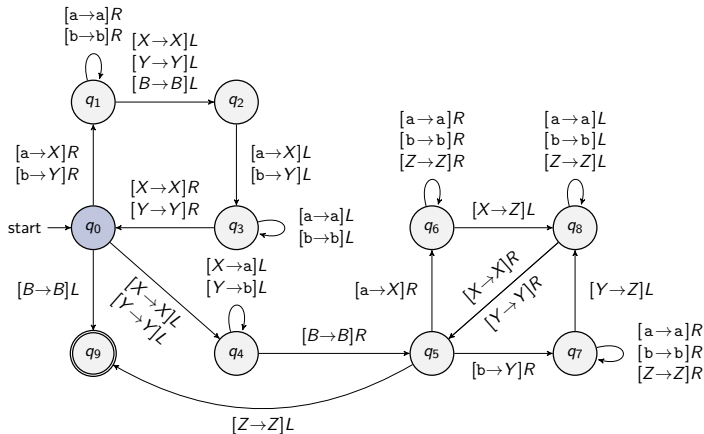
...	B	X	Y	Y	X	Y	Y	B	...
-----	---	---	---	---	---	---	---	---	-----



Construct a **Turing machine** that **accepts** the language:

$$L(M) = \{ww \mid w \in \{a, b\}^*\}$$

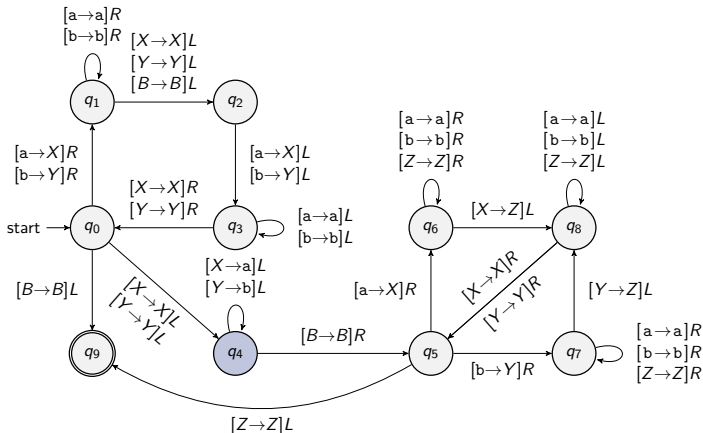
...	B	X	Y	Y	X	Y	Y	B	...
-----	---	---	---	---	---	---	---	---	-----



Construct a **Turing machine** that **accepts** the language:

$$L(M) = \{ww \mid w \in \{a, b\}^*\}$$

...	B	X	Y	Y	X	Y	Y	B	...
-----	---	---	---	---	---	---	---	---	-----

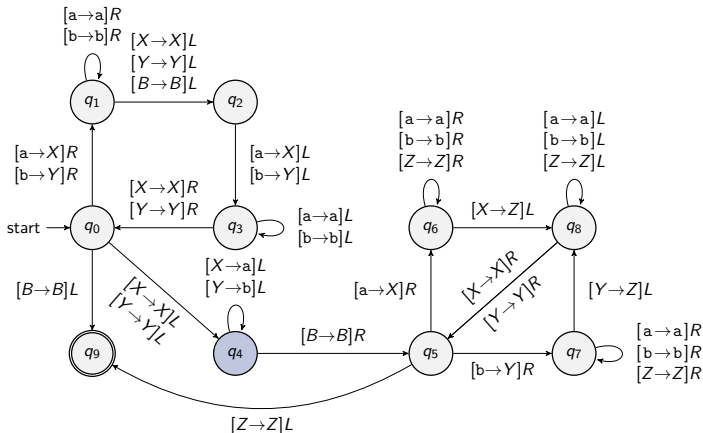


Replace all X 's (or Y 's) with a 's (or b 's) in the first half.

Construct a **Turing machine** that **accepts** the language:

$$L(M) = \{ww \mid w \in \{a, b\}^*\}$$

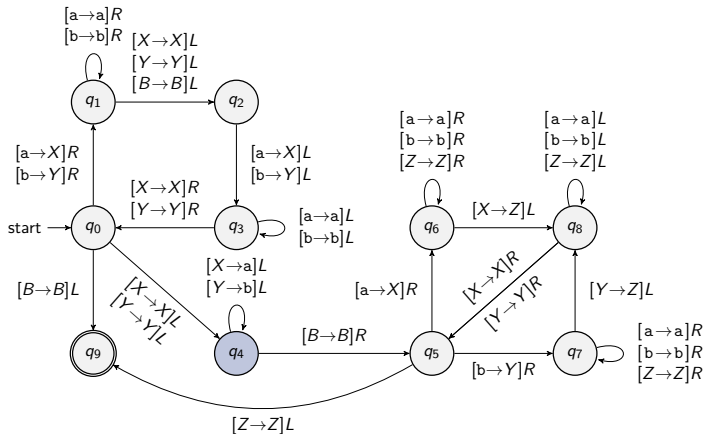
...	B	X	Y	b	X	Y	Y	B	...
-----	---	---	---	---	---	---	---	---	-----



Construct a **Turing machine** that **accepts** the language:

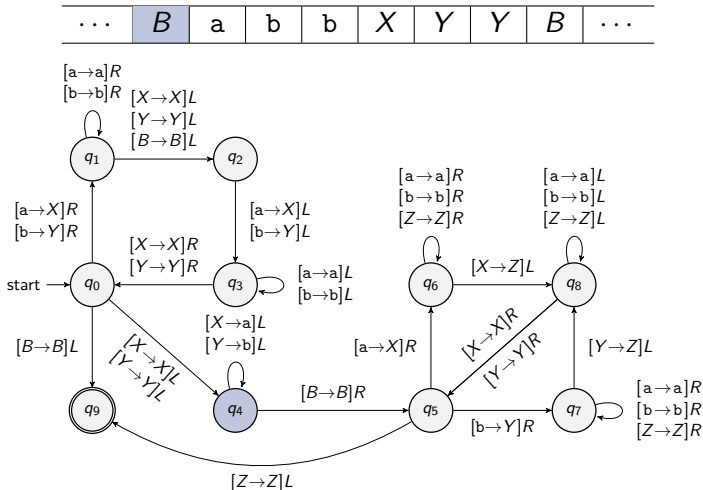
$$L(M) = \{ww \mid w \in \{a, b\}^*\}$$

...	B	X	b	b	X	Y	Y	B	...
-----	---	---	---	---	---	---	---	---	-----



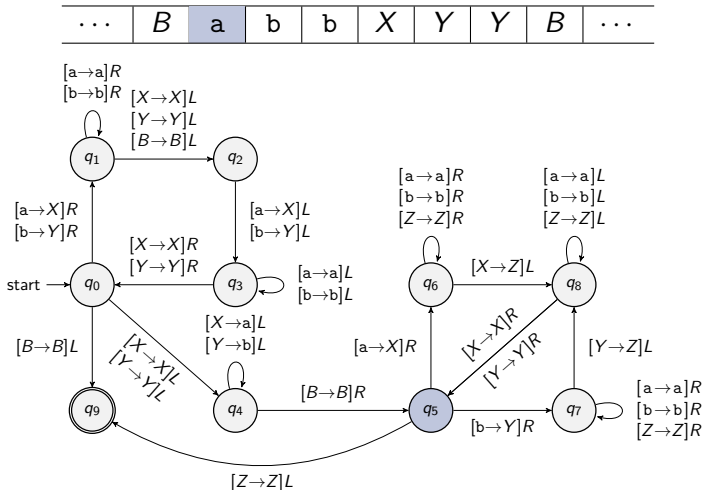
Construct a **Turing machine** that **accepts** the language:

$$L(M) = \{ww \mid w \in \{a, b\}^*\}$$



Construct a **Turing machine** that **accepts** the language:

$$L(M) = \{ww \mid w \in \{a, b\}^*\}$$

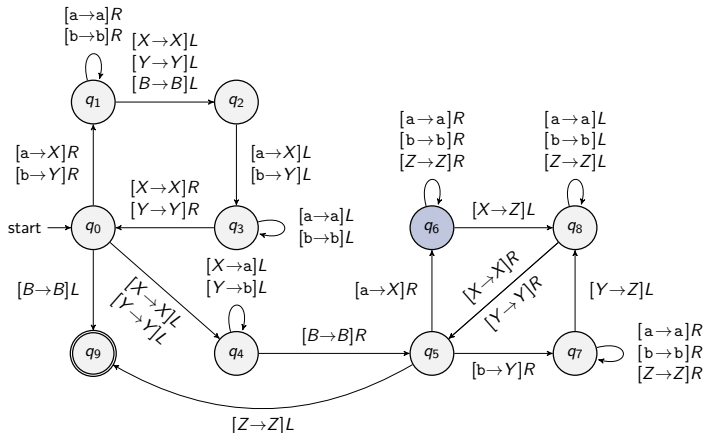


Replace a (or b) with X (or Y) in the first half.

Construct a **Turing machine** that **accepts** the language:

$$L(M) = \{ww \mid w \in \{a, b\}^*\}$$

...	B	X	b	b	X	Y	Y	B	...
-----	---	---	---	---	---	---	---	---	-----

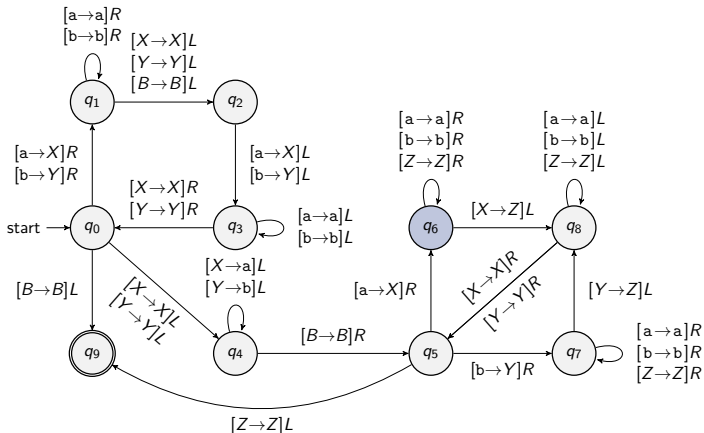


Find and Replace X (or Y) with Z in the second half.

Construct a **Turing machine** that **accepts** the language:

$$L(M) = \{ww \mid w \in \{a, b\}^*\}$$

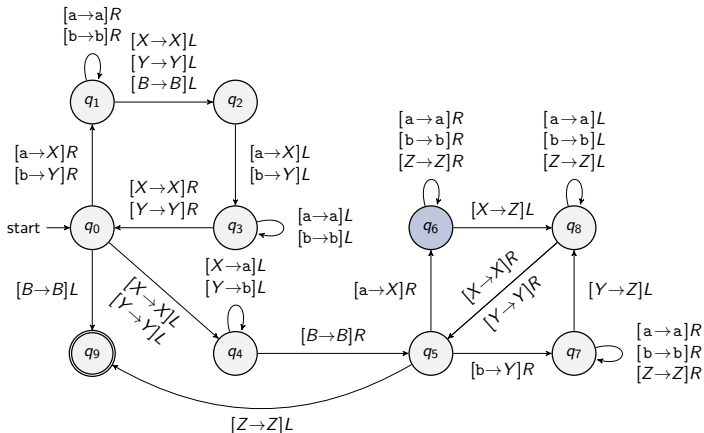
...	B	X	b	b	X	Y	Y	B	...
-----	---	---	---	---	---	---	---	---	-----



Construct a **Turing machine** that **accepts** the language:

$$L(M) = \{ww \mid w \in \{a, b\}^*\}$$

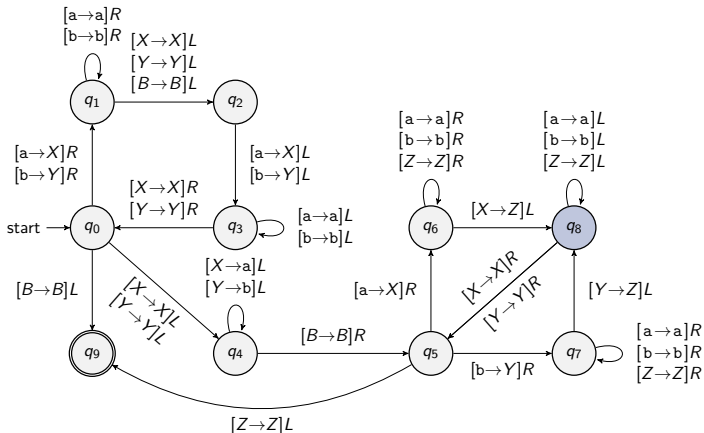
...	B	X	b	b	X	Y	Y	B	...
-----	---	---	---	---	---	---	---	---	-----



Construct a **Turing machine** that **accepts** the language:

$$L(M) = \{ww \mid w \in \{a, b\}^*\}$$

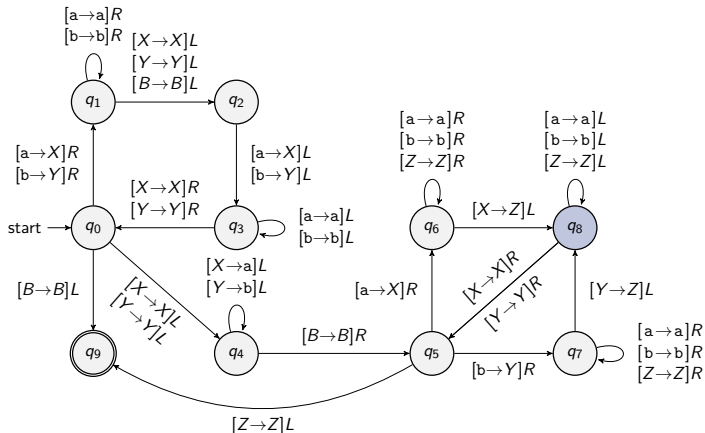
...	B	X	b	b	Z	Y	Y	B	...
-----	---	---	---	---	---	---	---	---	-----



Construct a **Turing machine** that **accepts** the language:

$$L(M) = \{ww \mid w \in \{a, b\}^*\}$$

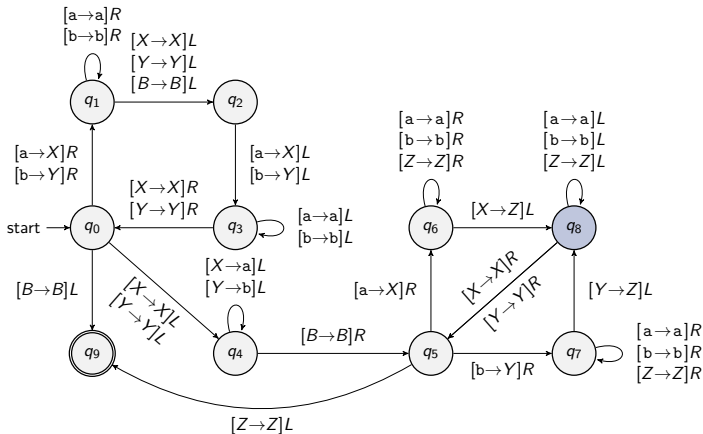
...	B	X	b	b	Z	Y	Y	B	...
-----	---	---	---	---	---	---	---	---	-----



Construct a **Turing machine** that **accepts** the language:

$$L(M) = \{ww \mid w \in \{a, b\}^*\}$$

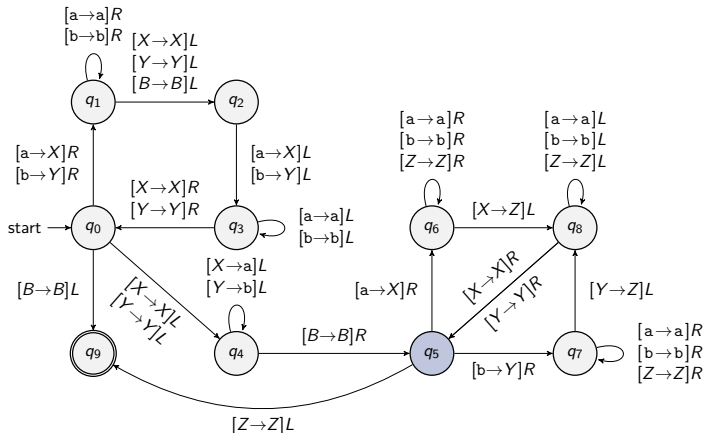
...	B	X	b	b	Z	Y	Y	B	...
-----	---	---	---	---	---	---	---	---	-----



Construct a **Turing machine** that **accepts** the language:

$$L(M) = \{ww \mid w \in \{a, b\}^*\}$$

...	B	X	b	b	Z	Y	Y	B	...
-----	---	---	---	---	---	---	---	---	-----

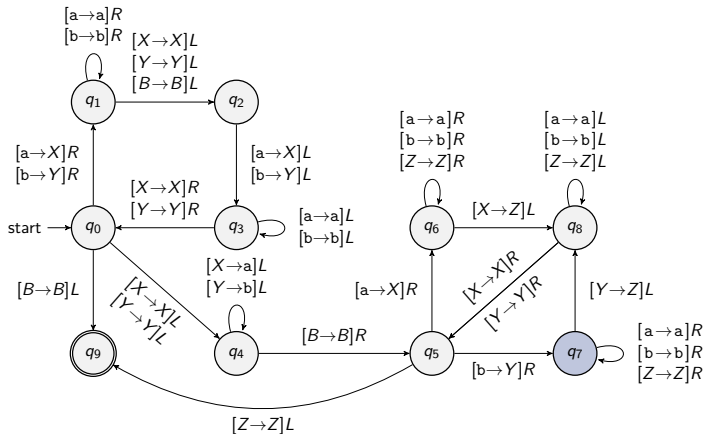


Repeat until no input symbols in the first half.

Construct a **Turing machine** that **accepts** the language:

$$L(M) = \{ww \mid w \in \{a, b\}^*\}$$

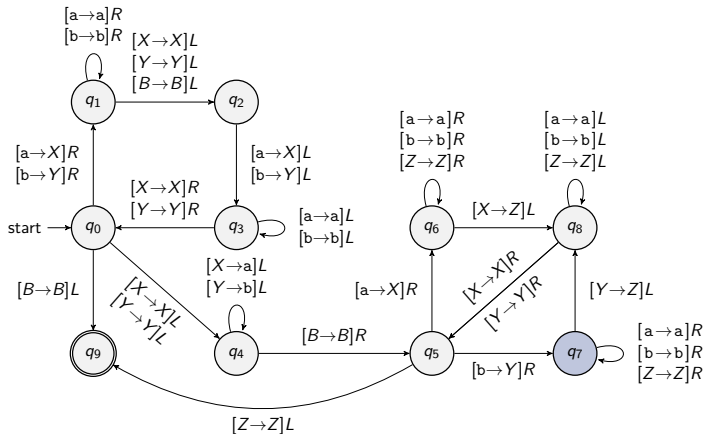
...	B	X	Y	b	Z	Y	Y	B	...
-----	---	---	---	---	---	---	---	---	-----



Construct a **Turing machine** that **accepts** the language:

$$L(M) = \{ww \mid w \in \{a, b\}^*\}$$

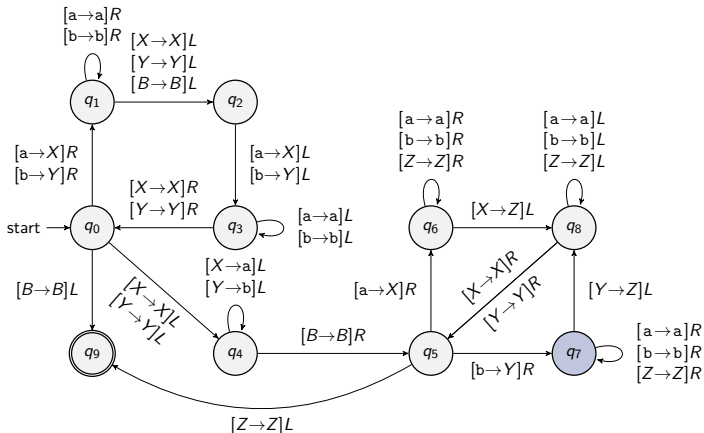
...	B	X	Y	b	Z	Y	Y	B	...
-----	---	---	---	---	---	---	---	---	-----



Construct a **Turing machine** that **accepts** the language:

$$L(M) = \{ww \mid w \in \{a, b\}^*\}$$

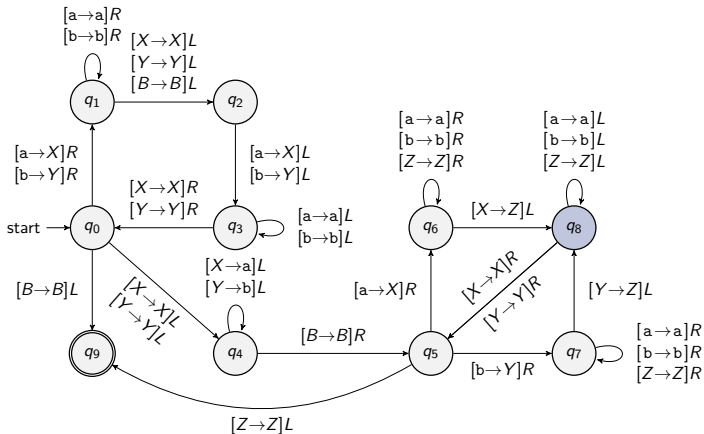
...	B	X	Y	b	Z	Y	Y	B	...
-----	---	---	---	---	---	---	---	---	-----



Construct a **Turing machine** that **accepts** the language:

$$L(M) = \{ww \mid w \in \{a, b\}^*\}$$

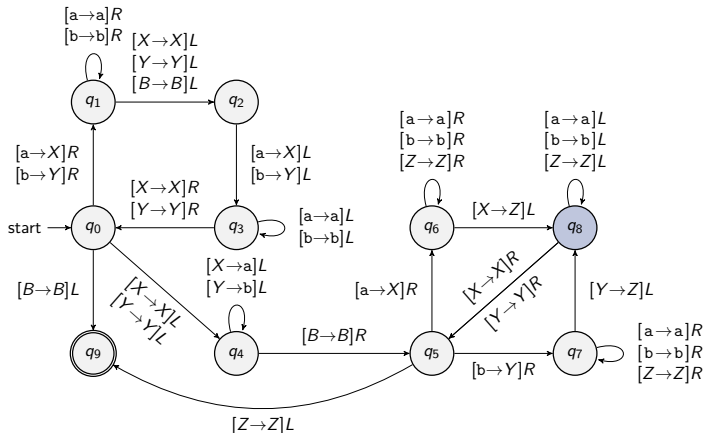
...	B	X	Y	b	Z	Z	Y	B	...
-----	---	---	---	---	---	---	---	---	-----



Construct a **Turing machine** that **accepts** the language:

$$L(M) = \{ww \mid w \in \{a, b\}^*\}$$

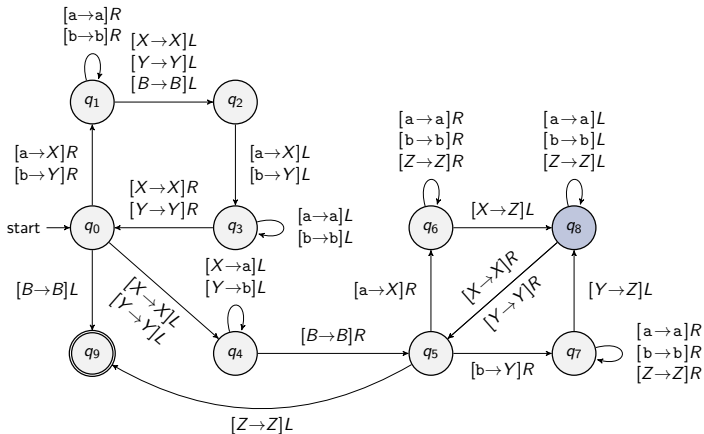
...	B	X	Y	b	Z	Z	Y	B	...
-----	---	---	---	---	---	---	---	---	-----



Construct a **Turing machine** that **accepts** the language:

$$L(M) = \{ww \mid w \in \{a, b\}^*\}$$

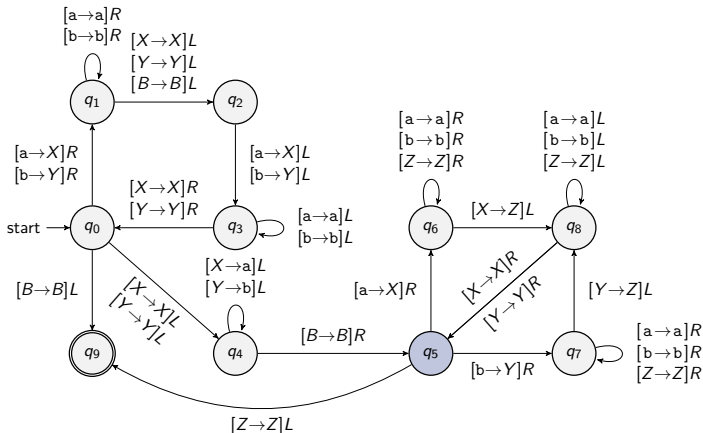
...	B	X	Y	b	Z	Z	Y	B	...
-----	---	---	---	---	---	---	---	---	-----



Construct a **Turing machine** that **accepts** the language:

$$L(M) = \{ww \mid w \in \{a, b\}^*\}$$

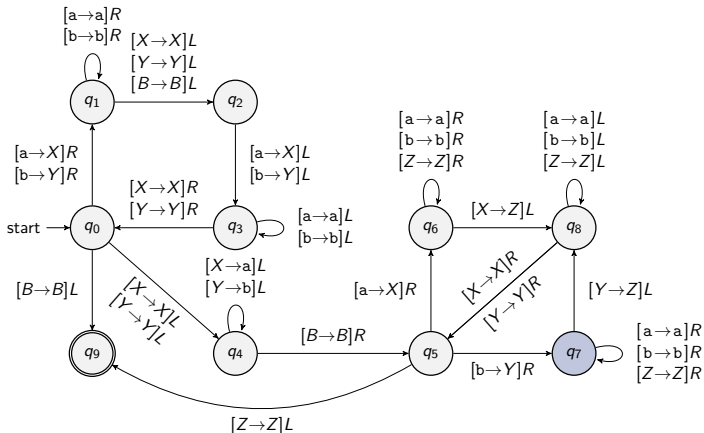
...	B	X	Y	b	Z	Z	Y	B	...
-----	---	---	---	---	---	---	---	---	-----



Construct a **Turing machine** that **accepts** the language:

$$L(M) = \{ww \mid w \in \{a, b\}^*\}$$

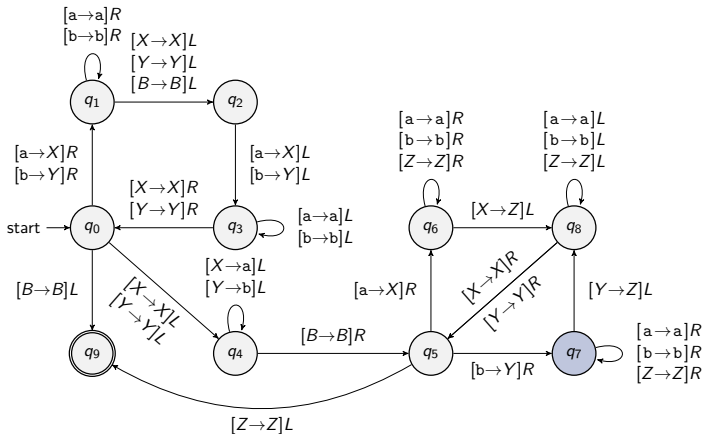
...	B	X	Y	Y	Z	Z	Y	B	...
-----	---	---	---	---	---	---	---	---	-----



Construct a **Turing machine** that **accepts** the language:

$$L(M) = \{ww \mid w \in \{a, b\}^*\}$$

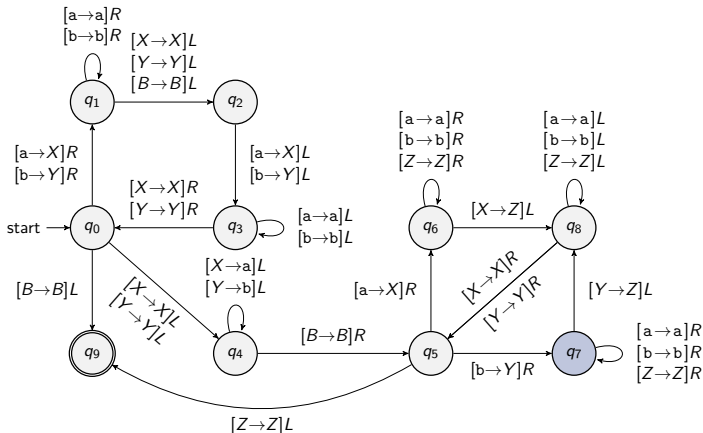
...	B	X	Y	Y	Z	Z	Y	B	...
-----	---	---	---	---	---	---	---	---	-----



Construct a **Turing machine** that **accepts** the language:

$$L(M) = \{ww \mid w \in \{a, b\}^*\}$$

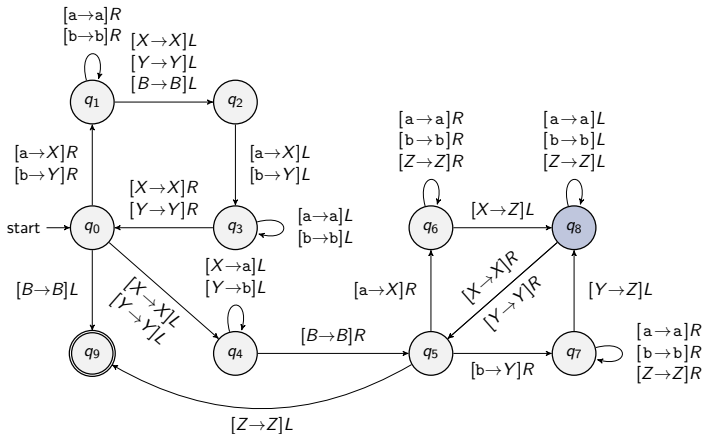
...	B	X	Y	Y	Z	Z	Y	B	...
-----	---	---	---	---	---	---	---	---	-----



Construct a **Turing machine** that **accepts** the language:

$$L(M) = \{ww \mid w \in \{a, b\}^*\}$$

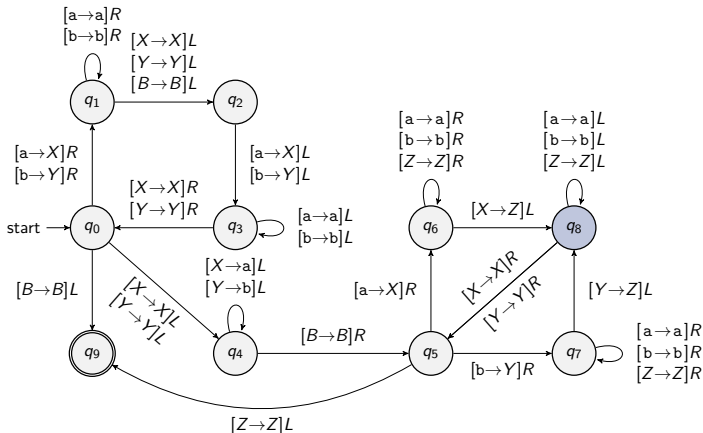
...	B	X	Y	Y	Z	Z	Z	B	...
-----	---	---	---	---	---	---	---	---	-----



Construct a **Turing machine** that **accepts** the language:

$$L(M) = \{ww \mid w \in \{a, b\}^*\}$$

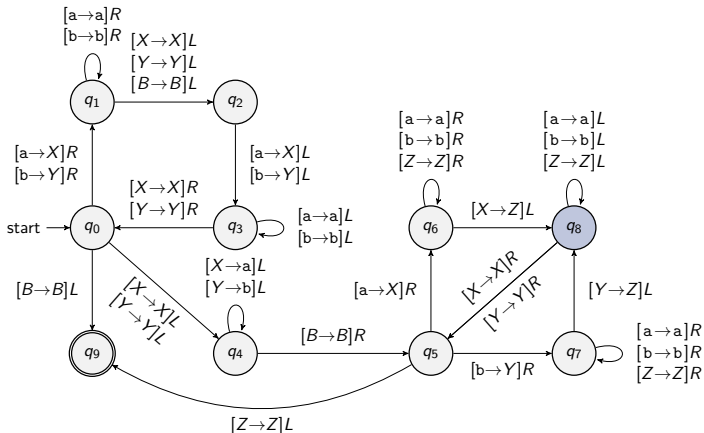
...	B	X	Y	Y	Z	Z	Z	B	...
-----	---	---	---	---	---	---	---	---	-----



Construct a **Turing machine** that **accepts** the language:

$$L(M) = \{ww \mid w \in \{a, b\}^*\}$$

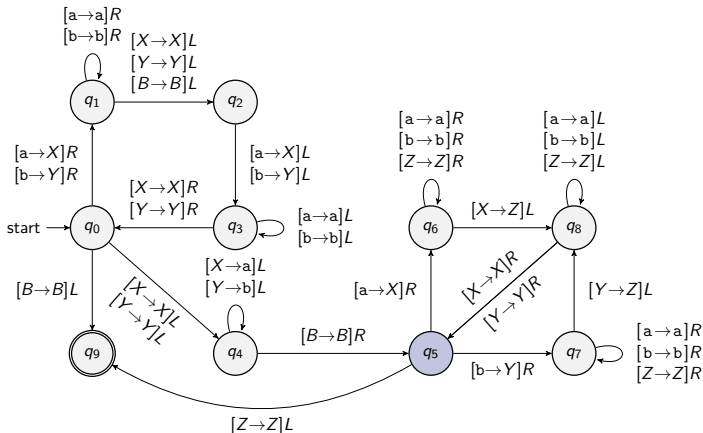
...	B	X	Y	Y	Z	Z	Z	B	...
-----	---	---	---	---	---	---	---	---	-----



Construct a **Turing machine** that **accepts** the language:

$$L(M) = \{ww \mid w \in \{a, b\}^*\}$$

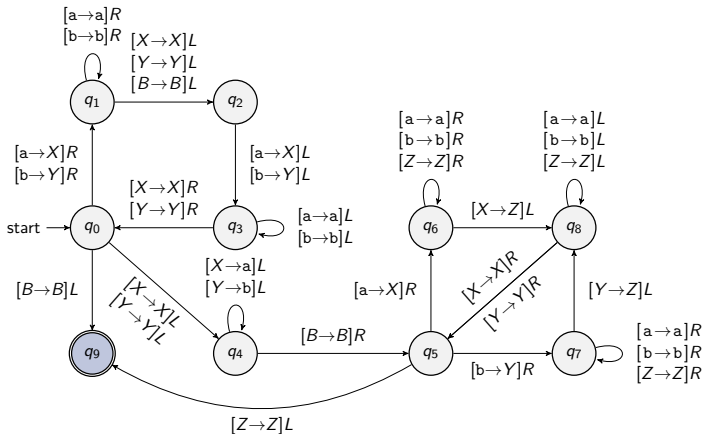
...	B	X	Y	Y	Z	Z	Z	B	...
-----	---	---	---	---	---	---	---	---	-----



Construct a **Turing machine** that **accepts** the language:

$$L(M) = \{ww \mid w \in \{a, b\}^*\}$$

...	B	X	Y	Y	Z	Z	Z	B	...
-----	---	---	---	---	---	---	---	---	-----



Accept!