

Regular Language: A Finite State Machine Accepting Iron Crafting Recipes

Formal Language Definition:

Alphabet (Σ):

$\Sigma = \{ \text{"iron "}, \text{"stick "}, \text{"rst "}, \text{"furnace "}, \text{"stone "}, \text{"sstone "}, \text{"inug "}, \text{"rsd "}, \text{"craft "}, \text{"drop "}, \text{"string "}, \text{"hook "}, \text{"spp "}, \text{"flint "}, \text{"chest "}, \text{"cobble "}, \text{"plank "}, \text{"iblock "}, \text{"_ "} \}$

★ These are the possible items that can appear in the crafting grid.

★ There **must** be a space after each Minecraft item, or else it is not a valid symbol of the alphabet

Conversion of Alphabet:

Iron: iron

Stick: stick

Redstone Torch: rst

Furnace: furnace

Smooth Stone: sstone

Iron Nuggets: inug

Redstone Dust: rsd

Crafting Table: craft

Dropper: drop

String: string

Tripwire Hook: hook

Stone Pressure Plate: spp

Flint: flint

Chest: chest

Cobblestone: cobble

Any planks: plank

Stone: stone

Iron block: iblock

Blank: _

Strings (w):

★ Each string w in L represents a 3x3 grid, formatted as a concatenation of 9 items:

$$w = s_1 s_2 s_3 s_4 s_5 s_6 s_7 s_8 s_9$$

where $s_i \in \Sigma$ for $i = 1, 2, 3, 4, 5, 6, 7, 8, 9$

Language Definition:

$L = \{ w \in \Sigma^9 \mid \text{The string represents a valid crafting recipe with iron} \}$

Semantics:

- ★ This Regular Language accepts a string of 9 symbols, each representing an item in the 3x3 grid of the Minecraft crafting table.
- ★ Each slot in the 3x3 grid is read left to right, top to bottom, starting in the top left corner with slot 1 and the bottom right corner with slot 9.
- ★ The arrangement of the symbols determines the recipe accepted by the crafting.
- ★ This machine specifically only accepts the correct crafting recipes for items containing iron in Minecraft 1.21. There are 35 possible strings accepted.
- ★ Each recipe must contain 9 symbols, with no slots within the grid being “NULL”, and at least one symbol must be “iron”.

Formal Regular Grammar

1st block:

St -> iron A | iblock B | stick C | plank D | _ E

2nd block:

A -> stick F | iron G | _ H

B -> iblock I

C -> iron J

D -> plank K | iron L

E -> _ M | inug N | iron O

3rd block:

F -> iron P

G -> iron Q | _ R

H -> iron S

I -> iblock T

J -> stick U

K -> plank V

L -> plank W

M -> _ X

N -> _ Y

O -> _ Z

4th block:

P -> iron A2

Q -> iron B2 | _ C2

R -> plank D2 | _ E2 | iron F2

S -> iron G2

T -> _ H2

U -> string I2

V -> cobble J2

W -> plank K2

X -> iron L2 | _ M2

Y -> _ N2

Z -> iron O2 | _ P2

5th block:

A2 -> rst Q2

B2 -> furnace R2 | iron S2 | craft T2 | _ U2

C2 -> stick V2 (iron pickaxe)

D2 -> plank W2 (smithing table)

E2 -> stick X2 (hoe)

F2 -> stick Y2 (axe) | iron Z2 (door)

G2 -> _ A3 (cauldron) | spp B3 (detector rail) | chest C3 (hopper) | iron D3 (chestplate) | stick E3 (rail)

H2 -> iron F3 (anvil)

I2 -> hook G3 (crossbow)

J2 -> iron H3 (piston)

K2 -> plank I3 (shield)

L2 -> iron J3 (helmet, pp, trpdr) | _ K3 (bucket, boots, minecart) | flint L3 (flint&steel)

M2 -> iron M3 (stonecutter, shears, nuggets)

N2 -> iron N3 (chain)

O2 -> rsd O3 (compass)

P2 -> stick P3 (shovel, hook) | iron Q3 (sword)

6th block:

Q2 -> iron C7 (activator rail)

R2 -> iron G7 (blast furnace)

S2 -> iron Q7 (iron block, bars)

T2 -> iron F7 (crafter)

U2 -> iron D7 (leggings)

V2 -> _ B7 (pickaxe)

W2 -> _ J7 (smithing table)

X2 -> _ B7 (hoe)

Y2 -> _ B7 (axe)

Z2 -> _ M7 (iron door)

A3 -> iron A7 (cauldron)

B3 -> iron E7 (detector rail)

C3 -> iron O7 (hopper)

D3 -> iron A7 (chestplate)

E3 -> iron D7 (rail)

F3 -> _ A7 (anvil)

G3 -> string B7 (crossbow)

H3 -> cobble I7 (piston)

I3 -> plank P7 (shield)
J3 -> _ R7 (trpdr, pp) | iron D7 (helmet)
K3 -> iron S7 (bucket, boots, minecart)
L3 -> _ K7 (flint&steel)
M3 -> _ T7 (stonecutter, shears, nuggets)
N3 -> _ N7 (chain)
O3 -> iron O7 (compass)
P3 -> _ U7 (hook, shovel)
Q3 -> _ B7 (sword)

7th block

A7 -> iron A8 (anvil, cauldron, chestplate)
B7 -> _ B8 (pickaxe, axe, hoe, sword, crossbow)
C7 -> iron C8 (activator rail)
D7 -> iron D8 (leggings, helmet, rail)
E7 -> iron E8 (detector rail)
F7 -> rsd F8 (crafter)
G7 -> sstone G8 (blast furnace)
I7 -> cobble I8 (piston)
J7 -> plank J8 (smithing table)
K7 -> _ K8 (flint&steel)
M7 -> iron L8 (door)
N7 -> _ M8 (chain)
O7 -> _ L8 (compass, hopper)
P7 -> _ J8 (shield)
Q7 -> iron A8 (block) | _ K8 (bars)
R7 -> iron L8 (trapdoor) | _ K8 (pp)
S7 -> _ L8 (bucket) | iron N8 (boots, minecart)
T7 -> stone H8 (stonecutter) | iron K8 (shears) | _ K8 (nuggets)
U7 -> _ O8 (hook, shovel)

8th block

A8 -> iron A9 (block, cauldron, chestplate, anvil)
B8 -> stick B9 (pickaxe, axe, hoe, sword, crossbow)
C8 -> stick A9 (activator rail)
D8 -> _ A9 (leggings, helmet, rail)
E8 -> rsd A9 (detector rail)
F8 -> drop C9 (crafter)
G8 -> sstone D9 (blast furnace)
H8 -> stone E9 (stonecutter)
I8 -> rsd F9 (piston)
J8 -> plank B9 (smithing table, shield)

K8 -> _ B9 (iron bars, pressure plate, flint&steel, iron nuggets, shears)

L8 -> iron B9 (door, bucket, compass, hopper, trapdoor)

M8 -> inug B9 (chain)

N8 -> _ A9 (boots) | iron A9 (minecart)

O8 -> plank B9 (hook) | stick B9 (shovel)

9th block (all terminating)

A9 -> iron (activator rail, block, leggings, cauldron, detector rail, chestplate, rail, anvil, helmet, boots, minecart)

B9 -> _ (iron bars, pickaxe, smithing table, hoe, axe, door, hopper, crossbow, shield, pressure plate, trapdoor, bucket, flint&steel, iron nuggets, shears, chain, compass, shovel, tripwire hook, sword)

C9 -> rsd (crafter)

D9 -> sstone (blast furnace)

E9 -> stone (stonecutter)

F9 -> cobble (piston)