How does a Computer Work?

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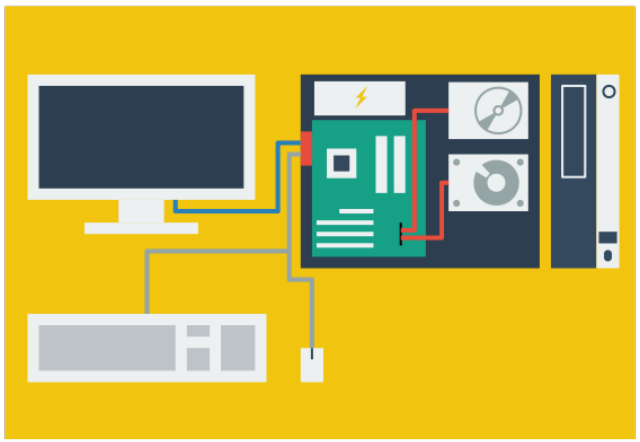
Everything you need to know about hardware, compilers, and formal languages to get started in Python

Hardware vs Software

Hardware vs Software



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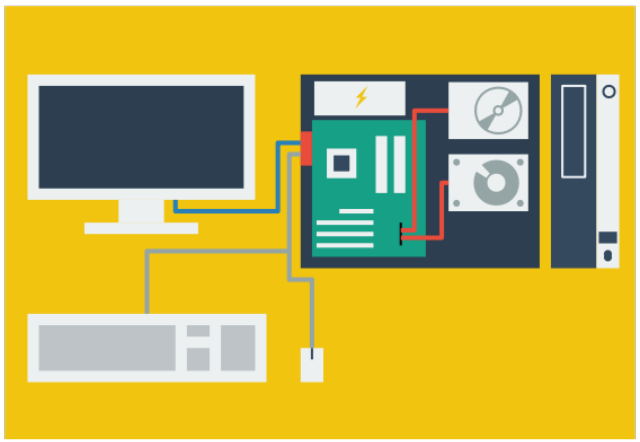

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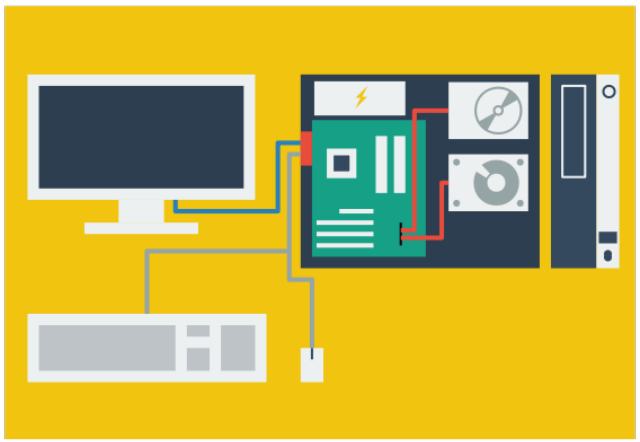

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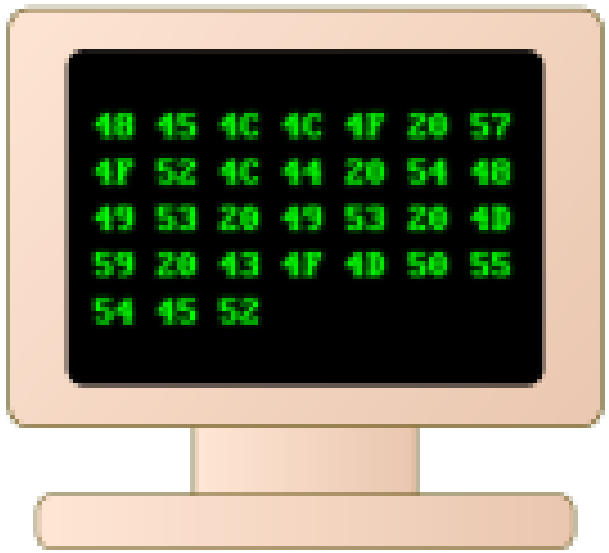

Hardware Examples

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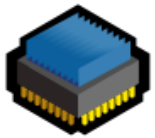

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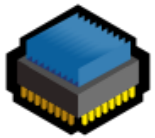

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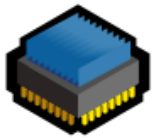

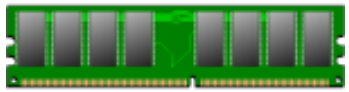

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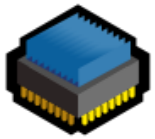

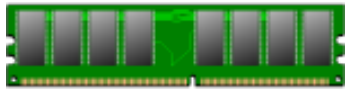

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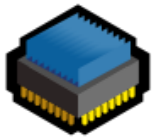

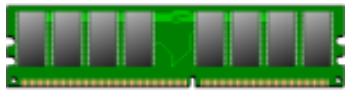

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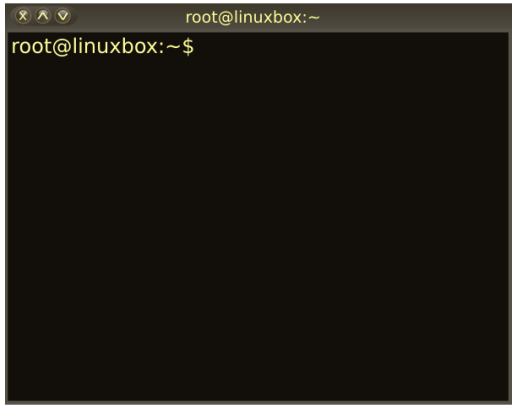

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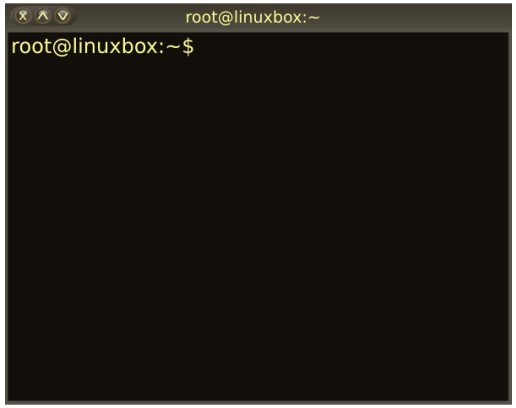

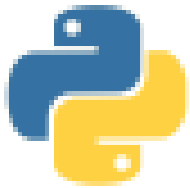

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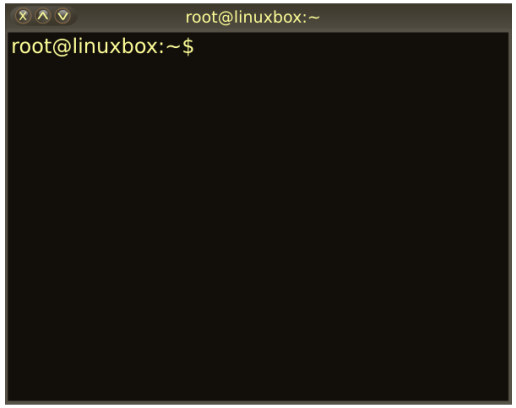

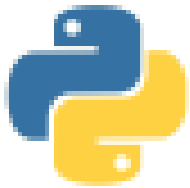

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Software Examples

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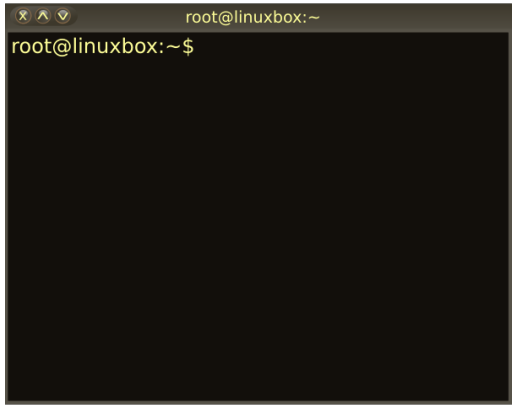

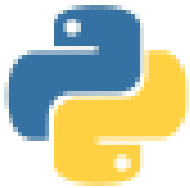

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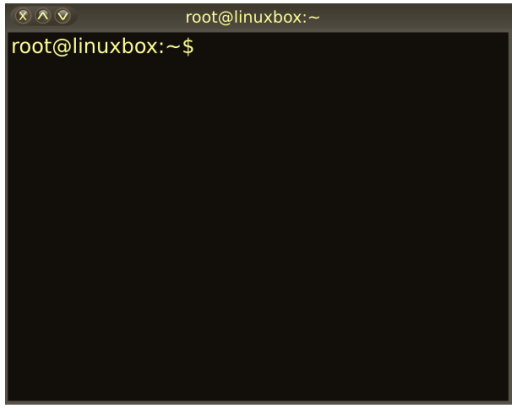

Application Software:

Concept Check!

For each of the following, which are examples of hardware and which are examples of software?

- Your computer's CPU
- Your favorite videogame
- The google chrome browser
- Your computer webcam
- Your graphics card (GPU)
- Google sheets
- Your gaming headset
- Microsoft Windows 10
- Your first Python program
- Thumb drive containing your 1st Python program

Solutions!

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- Your first Python program **software (application)**
- Thumb drive w/ Python prog **hardware (memory/storage)**

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- Letters/Words – store binary codes that can be looked-up in ASCII table

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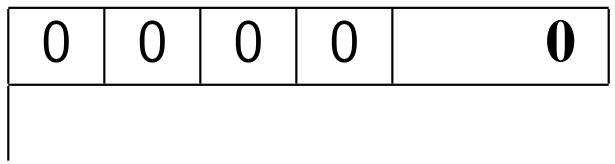

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$\vdots$

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You can find ASCII tables on *Wikipedia*, or other websites:

100 0001	101	65	41	A
100 0010	102	66	42	B
100 0011	103	67	43	C
100 0100	104	68	44	D
100 0101	105	69	45	E
100 0110	106	70	46	F

image cred: Wikipedia

How a Computer Works

Instruction Set:

Code	Instruction
00000001 A B	Add $A + B \rightarrow A$
00000010 A B	Divide $A/B \rightarrow A$
⋮	⋮
01011011 A	Print $A \rightarrow$ Terminal
⋮	⋮
10100100 A C	Save $A \rightarrow C$ (on hd)

Memory:

Address	Contents
00000000	01101011
00000001	11001100
00000010	10001000
00000011	10101110
⋮	⋮
11111111	00100000

Assembly Language

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Program:

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INPUT   A
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https://www.intel.com/content/dam/www/public/us/en/documents/manuals/64-ia-32-architectures-software-developer-instruction-set-reference-manual-325383.pdf

Concept Check!

Assume that

- `INPUT_I A`: reads an integer input from the keyboard, and stores it in memory address `A`
- `ADD_I A B` adds 2 integers stored in `A` and `B` and stores the result by overwriting `A`
- `PRINT_I A` decodes the contents of the memory address `A` as an integer and prints it to the screen

What does the following snippet of assembly code do?
(Assume `B` contains the binary encoding for the integer 2)

```
INPUT_I   A
ADD_I     A B
PRINT_I   A
```

Solution!

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INPUT_I   A
```
← reads a number from keyboard

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INPUT_I   A      ← reads a number from keyboard
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The code reads an integer from the keyboard, adds 2, and prints the answer

High-Level Languages

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computer languages:

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computer languages:	*compiler / interpreter* $\rightarrow$

High-Level Languages

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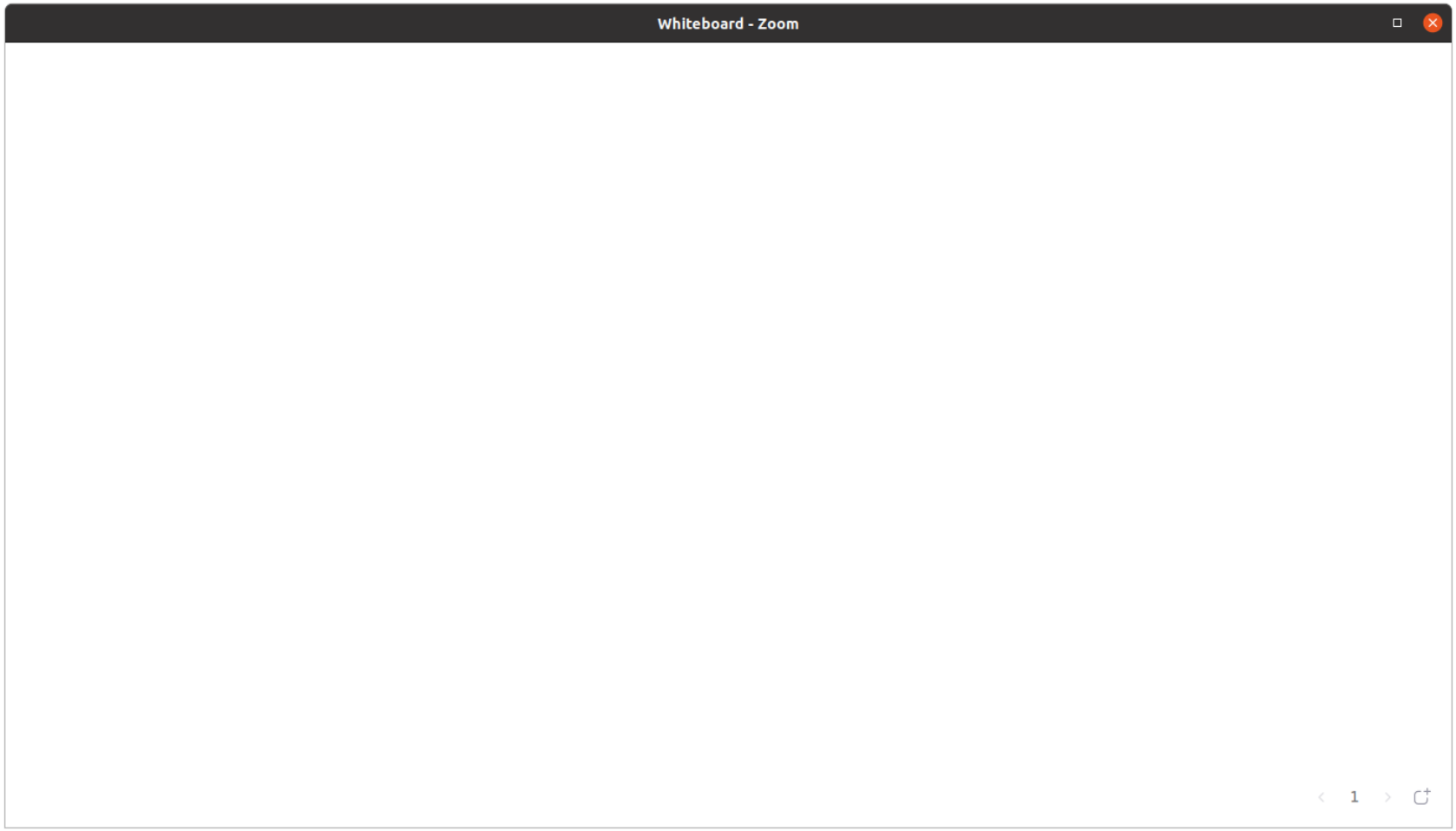
Examples:

- Assembly instructions
- Python code
- Mathematical logic

A Programmer's Joke



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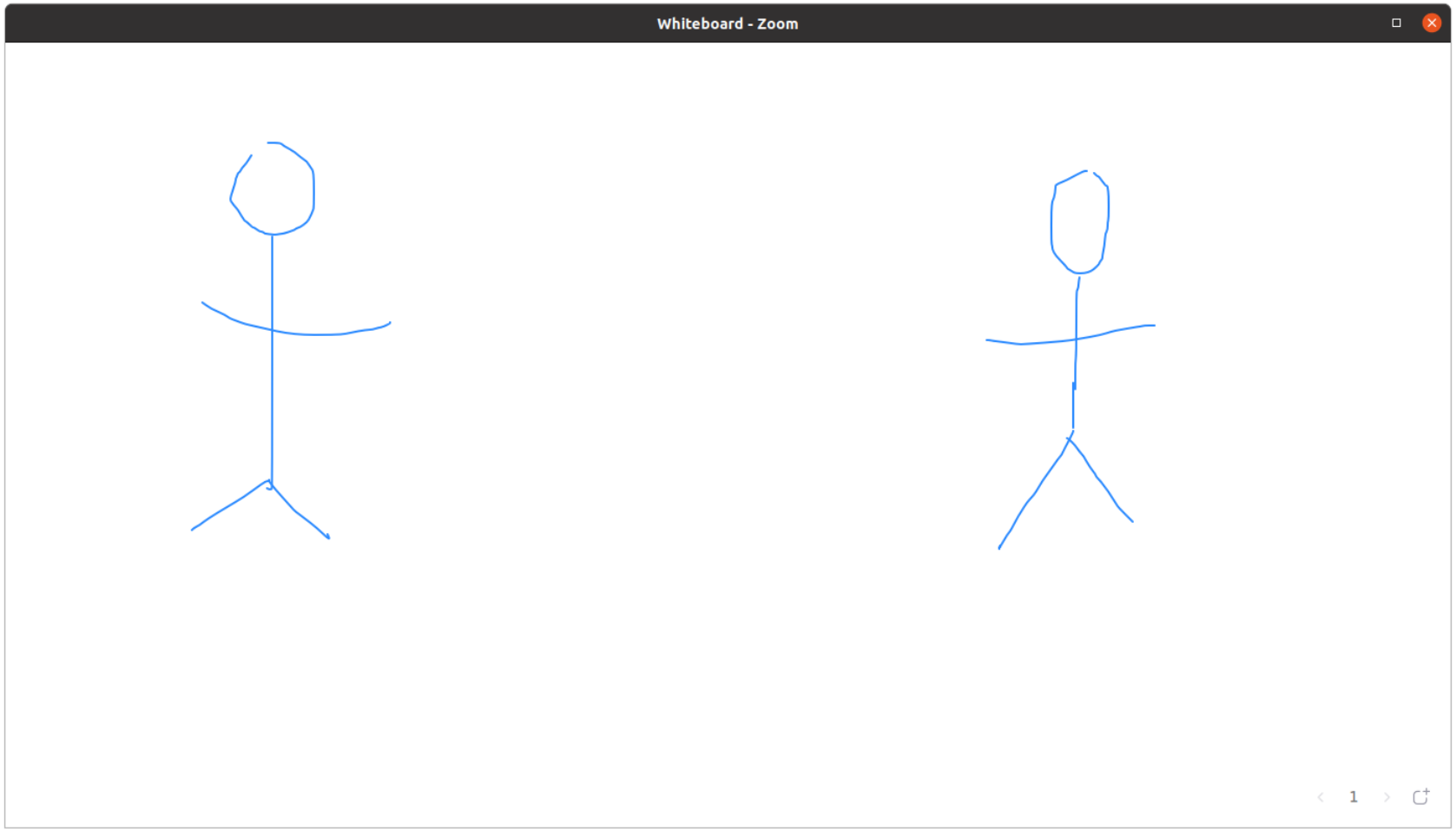

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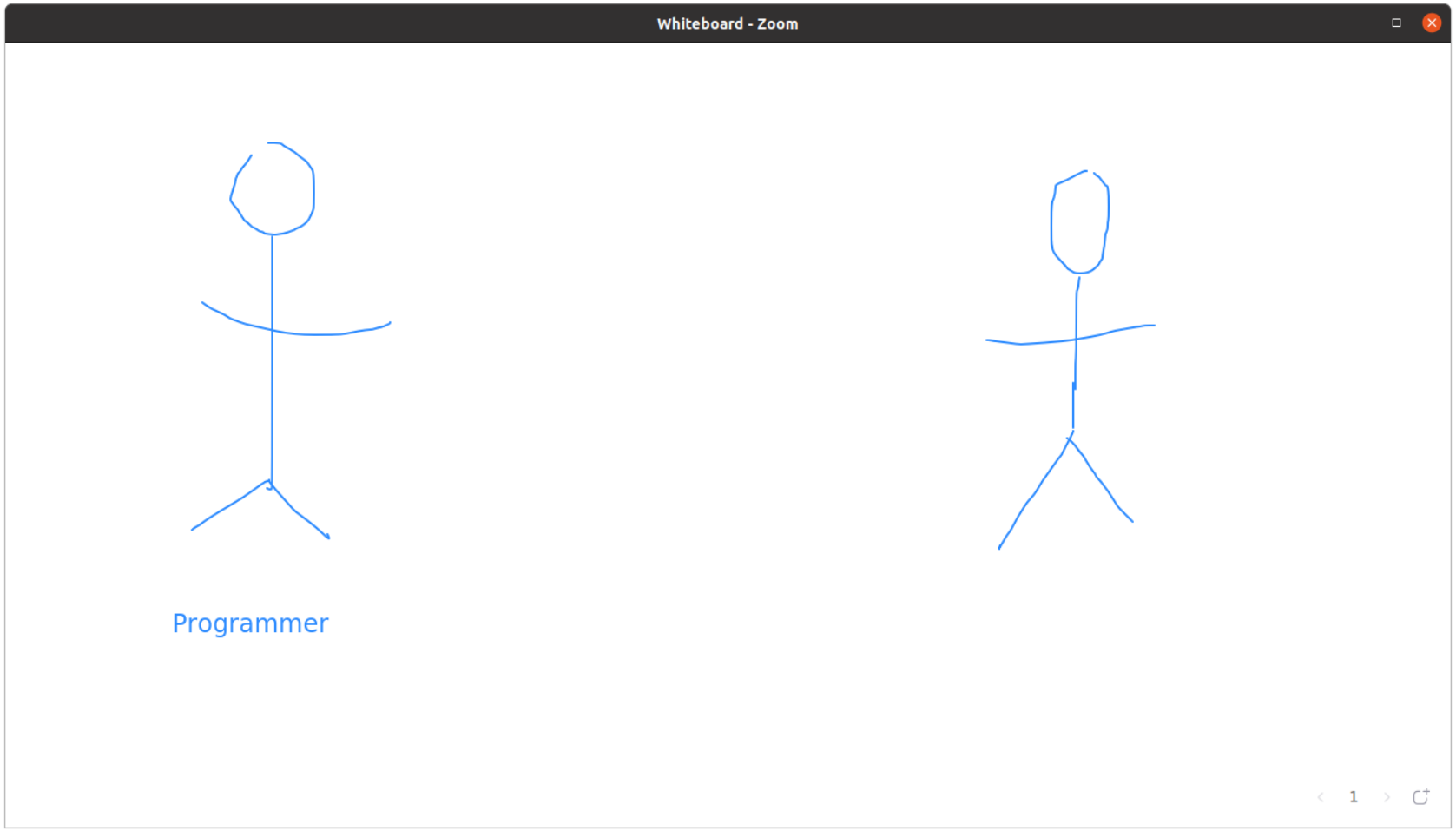

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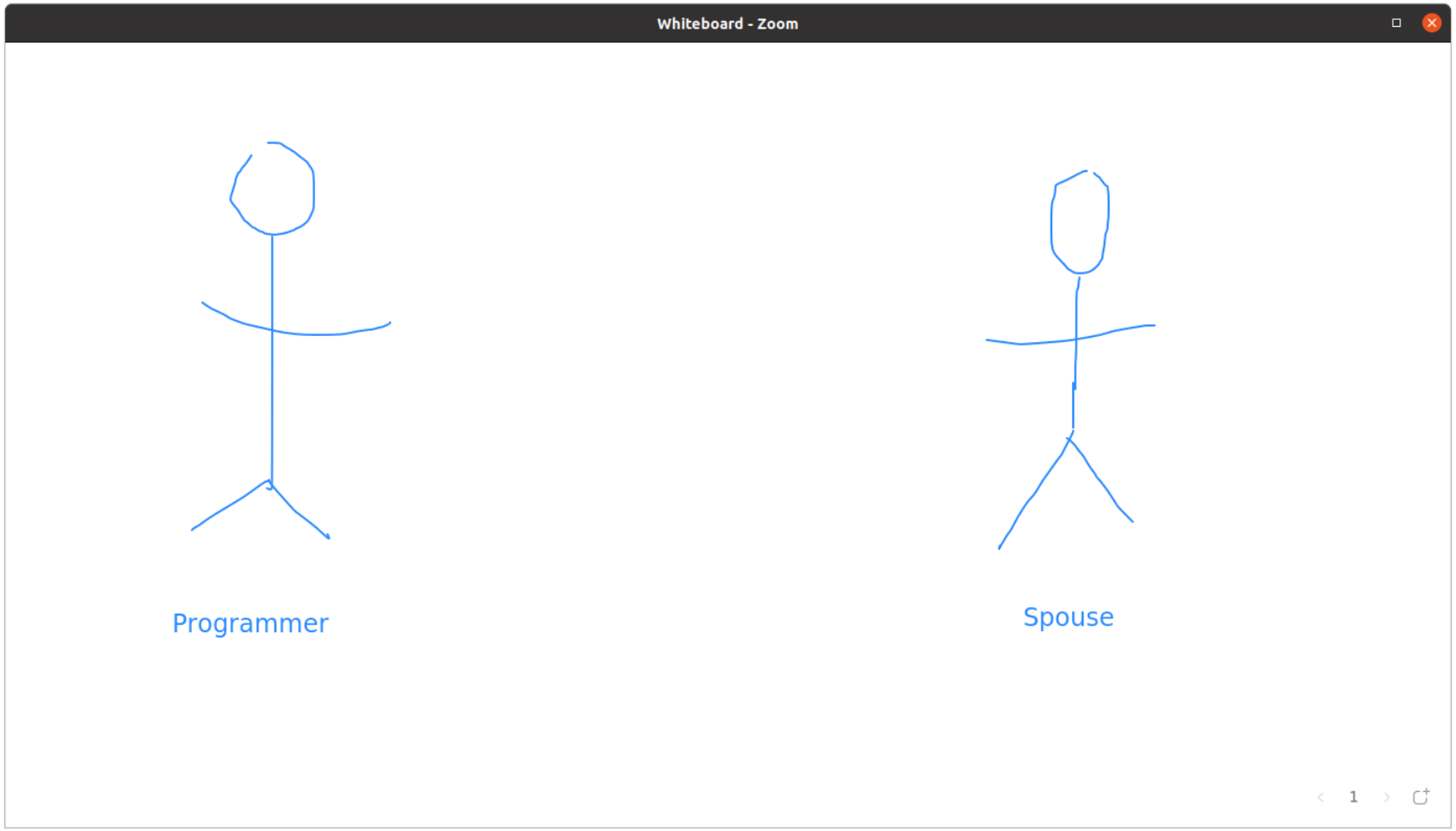

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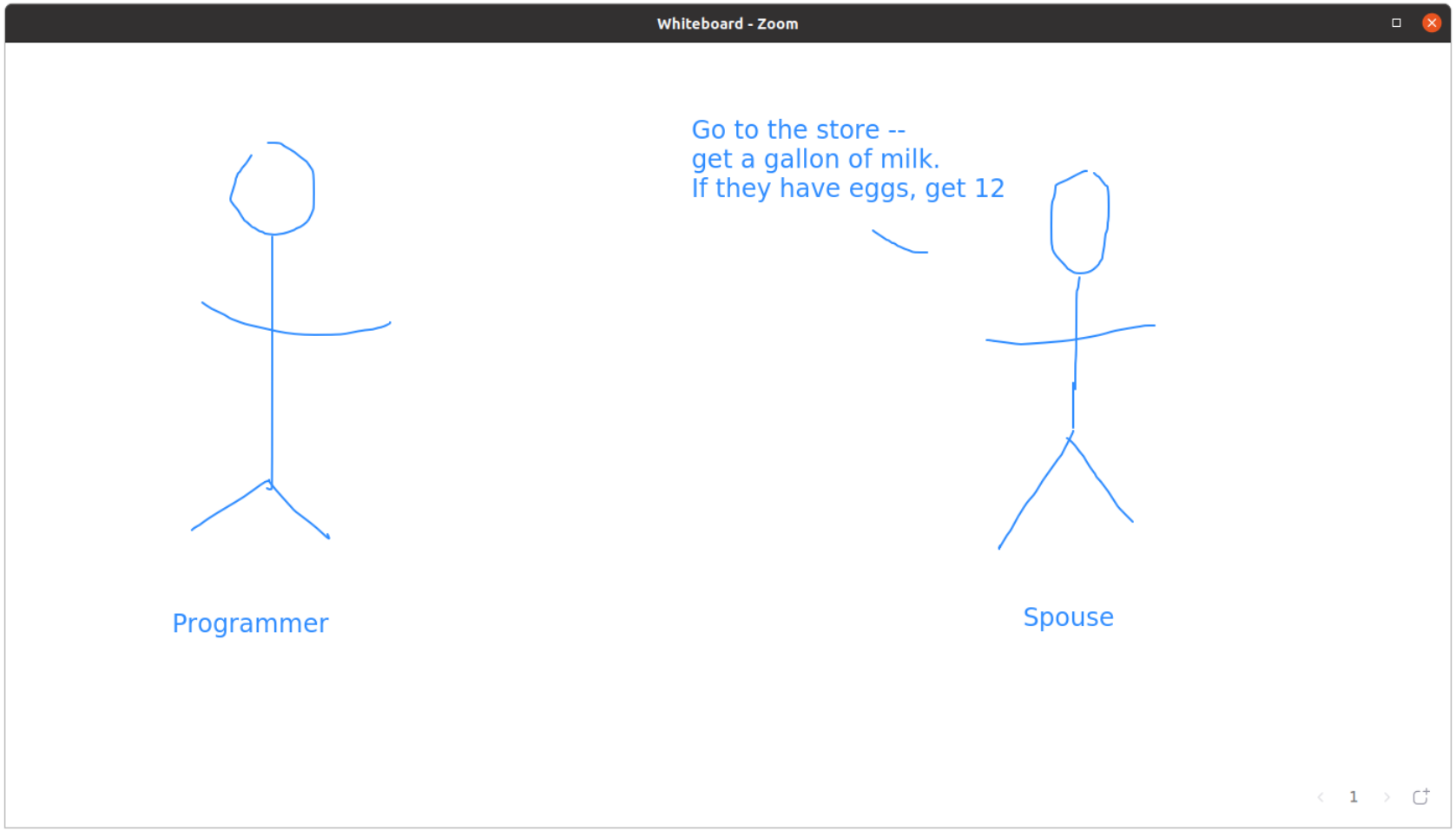

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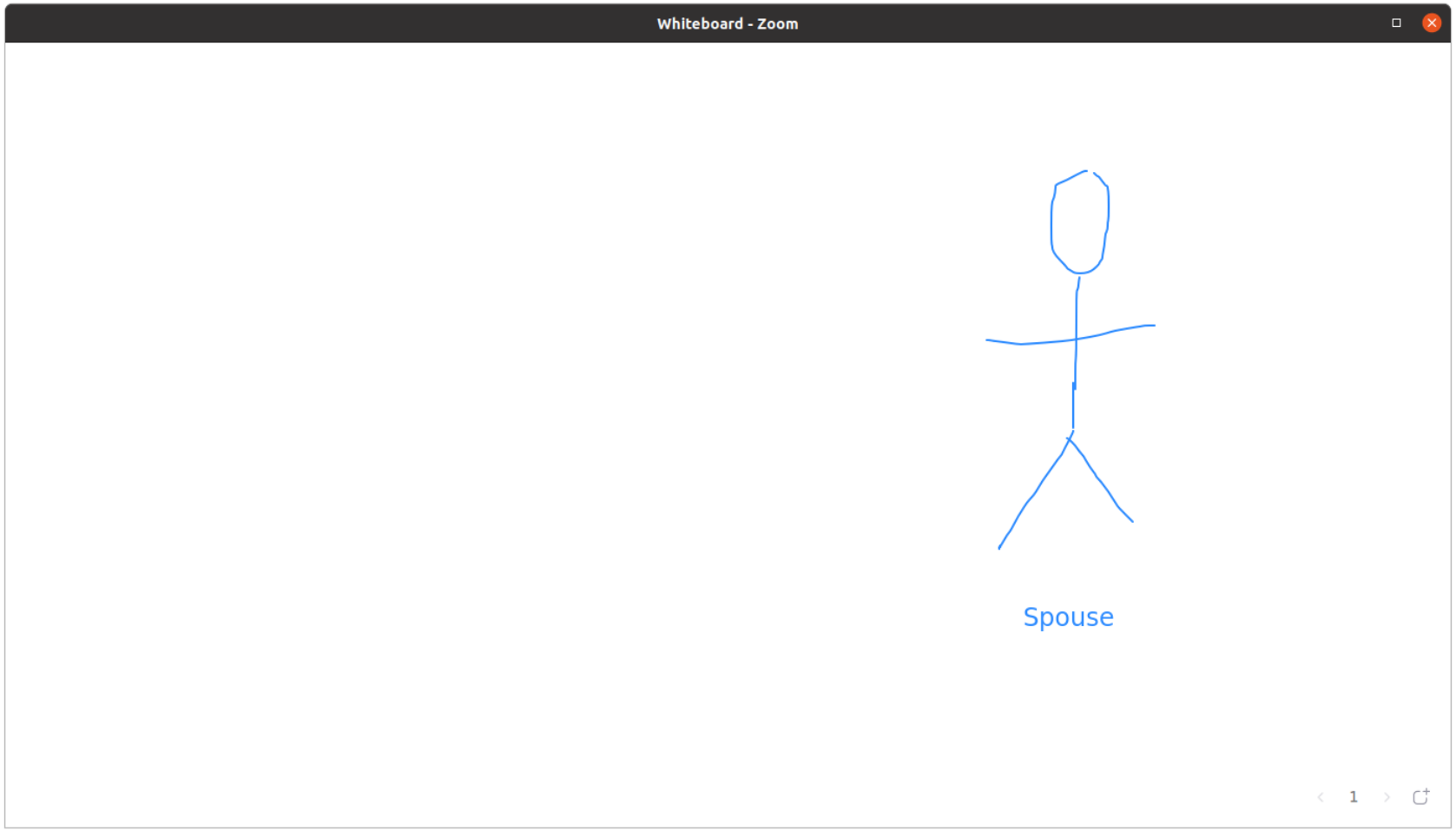

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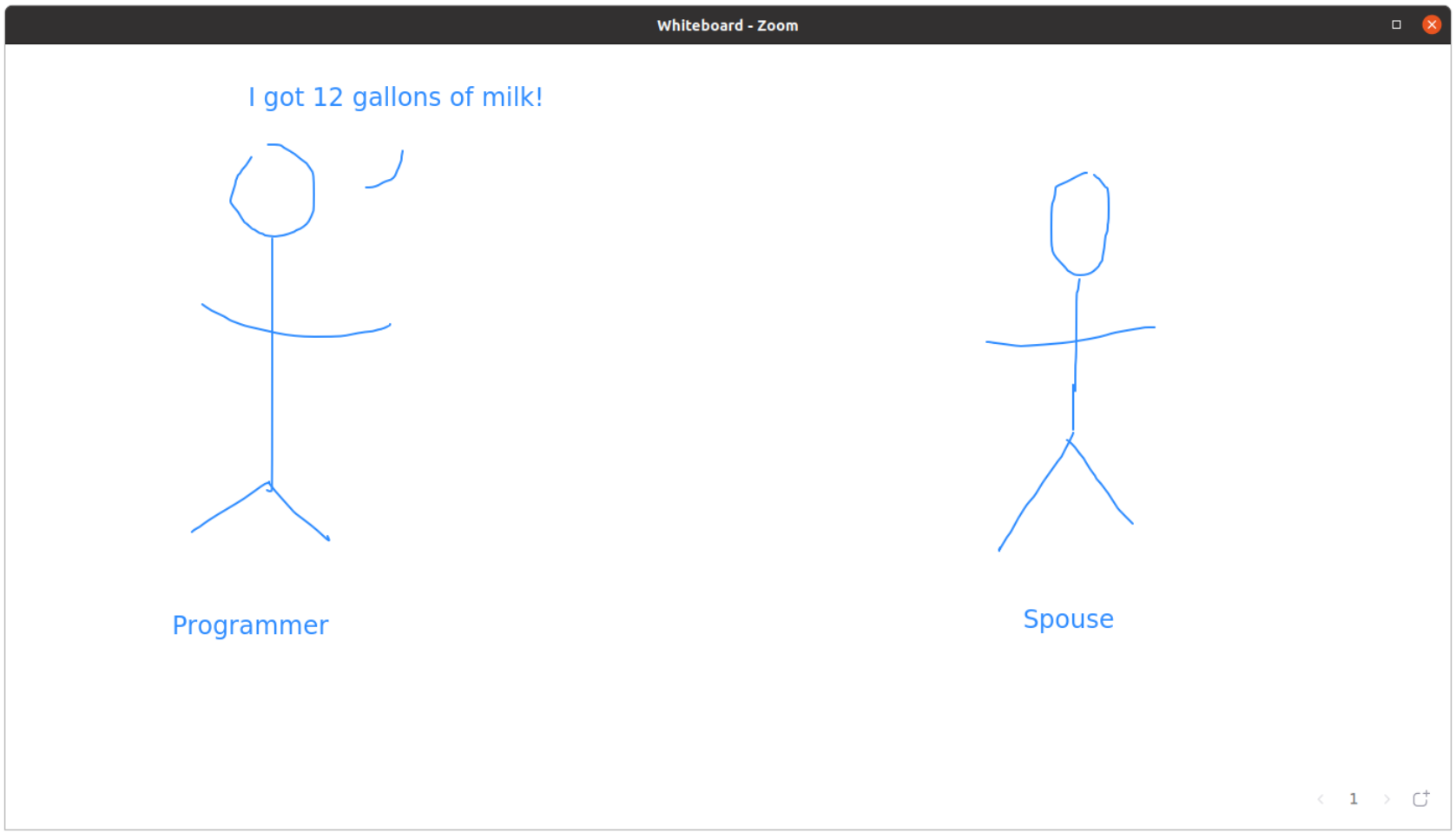

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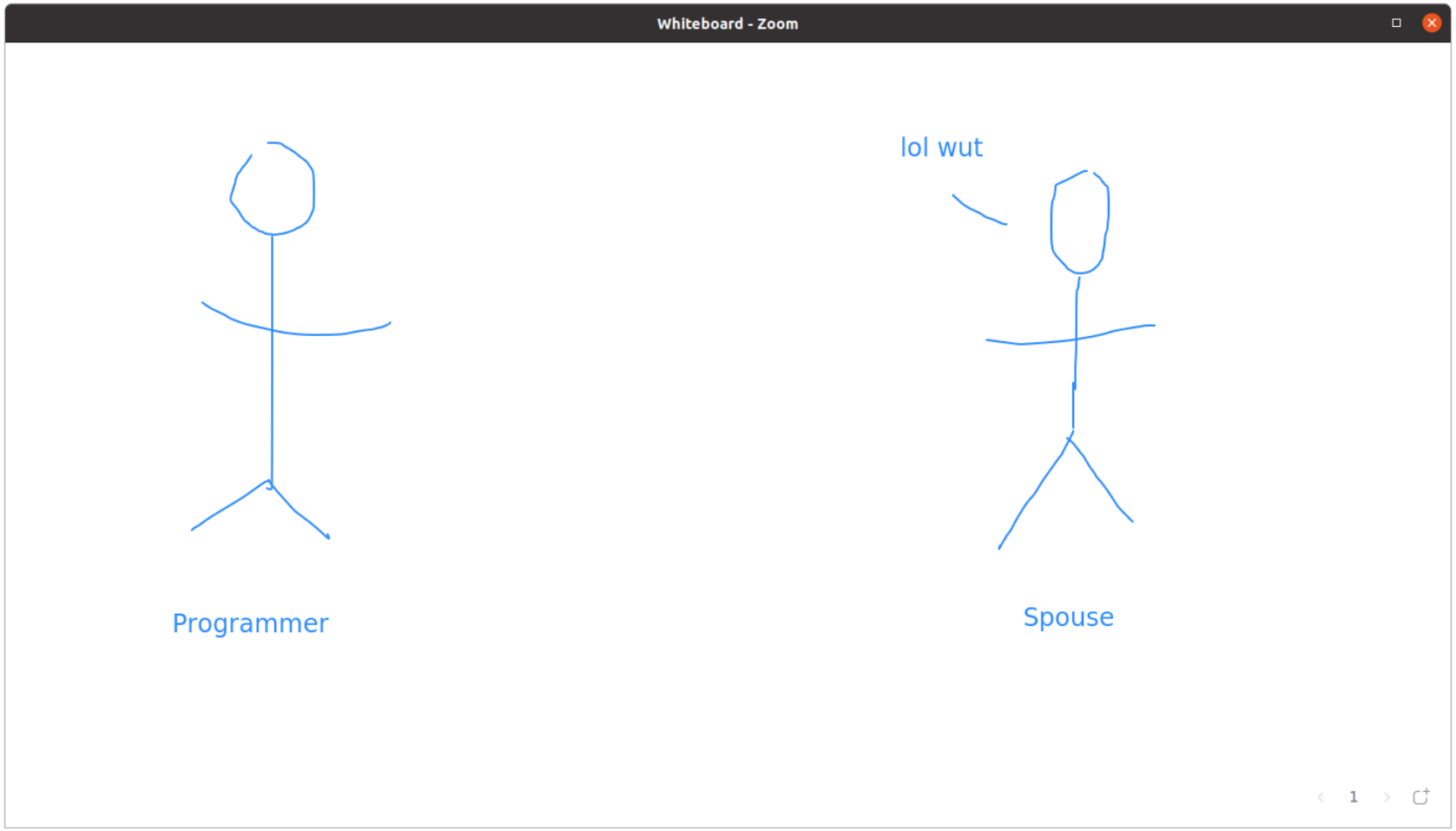

A Programmer's Joke

"Get a gallon of milk. If they have eggs, get 12."

Concept Check!

Which of the following would you write in a formal language?

- An email
- A computer program
- A research paper
- A mathematical proof
- A computer science textbook

Solutions!

Which of the following would you write in a formal language?

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- A computer program **Yes**
- A research paper **No**
- A mathematical proof **Yes**

Solutions!

Which of the following would you write in a formal language?

- An email **No**
- A computer program **Yes**
- A research paper **No**
- A mathematical proof **Yes**
- A computer science textbook **No**