

# Rubik's art

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## ► Table of Contents

- [Introduction](#)
- [Audience](#)
  - [Stakeholders from ALGOSUP](#)
  - [Members of Team 2 \(Team Leader\)](#)
  - [Members of Other Teams](#)
- [Deliverable](#)
- [Requirements](#)
- [Nice to have](#)
- [Priorities](#)
- [Non-Requirements / Out of scope](#)
- [Operating Requirements](#)
- [Assumptions](#)
- [Design Details](#)
  - [Fresco Dimensions](#)
  - [Cube Representation](#)
  - [Cube Arrangement](#)
  - [Protective Measures](#)
  - [Tasks division](#)
  - [Distribution of tasks and instructions](#)
  - [Software Architecture Diagram](#)
  - [Example of instructions](#)
  - [Fresco Support Construction Guide:](#)
    - [Tools Required:](#)
    - [Materials Needed:](#)
    - [Step-by-Step Construction:](#)
- [Maintenance and Upkeep](#)
  - [Technology Choice](#)
- [Ideas and Hypotheses](#)
  - [Unproven Hypotheses](#)
  - [Proven Hypotheses](#)
- [Challenges](#)
- [Possible Bugs](#)
  - [1. Misaligned Cubes:](#)
  - [2. Color Inconsistencies:](#)
  - [3. Structural Instability:](#)
  - [4. Dust Accumulation:](#)
  - [5. Cube Wear and Tear:](#)
- [Security Considerations](#)
- [Success Evaluation](#)
- [Conclusion](#)
- [Glossary](#)

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## Introduction

The Rubik's Art Fresco is a permanent artwork commissioned by ALGOSUP, consisting of Rubik's cubes arranged to form a [pixelated image](#) representing the institution. This technical specification outlines the detailed implementation plan for the creation, installation, and maintenance of the fresco.

## Audience

### Stakeholders from ALGOSUP

- **ALGOSUP Executives and Decision-makers:** They are the primary stakeholders, responsible for approving the project and ensuring it aligns with ALGOSUP's vision and branding.
- **ALGOSUP Marketing Team:** They are interested in the visual appeal and representation of the school. The fresco will serve as a marketing tool, attracting potential students and parents.
- **ALGOSUP Students:** The fresco will be a part of their daily environment, potentially impacting their perception of the school and its values.

### Members of Team 2 (Team Leader)

- **Construction Team Leader:** Responsible for overseeing the construction process, ensuring each team completes their assigned sections accurately and efficiently.
- **Cube Handling Team Members:** Responsible for physically handling the Rubik's cubes, placing them in their designated positions according to the provided plans.
- **Documentation Team Members:** Responsible for recording cube rotations, capturing the construction process on film, and maintaining comprehensive documentation for future reference.

### Members of Other Teams

- **Project Managers:** They will be responsible for ensuring that their teams complete their assigned sections accurately and efficiently.
- **Cube Handling Team Members:** Responsible for physically handling the Rubik's cubes, placing them in their designated positions according to the provided plans.
- **Documentation Team Members:** Responsible for recording cube rotations, capturing the construction process on film, and maintaining comprehensive documentation for future reference.

## Deliverable

The deliverable for this project is a visually striking and meticulously constructed fresco created entirely from Rubik's cubes. The fresco will serve as a permanent feature within ALGOSUP, displayed in what is currently the library and visible from both the interior and exterior of the building. The project must be delivered by October 26.

## Requirements

- A minimum of 2000 and a maximum of 3000 Rubik's cubes to be used.
- Each Rubik's cube represents a 3x3 [pixel matrix](#) of colors: Green, Yellow, Red, Orange, Blue, and White.
- The construction process should be divided into multiple sections, assigned to different teams.
- The construction process should be recorded and documented for future reference.

- The final image should closely resemble the original [prototype](#).

## Nice to have

- Integration of [Augmented Reality \(AR\)](#) elements with the fresco could provide an innovative and engaging dimension. AR technology could enable viewers to interact with the artwork, potentially revealing additional information or dynamic visual effects. This would not only enhance the viewer experience but also showcase ALGOSUP as a forward-thinking institution embracing cutting-edge technology.
- Implementation of a specialized software program to demonstrate Rubik's cube movements. Introducing a specialized software program that visually demonstrates the possible movements of Rubik's cubes would greatly enhance team comprehension and precision during the construction process.

## Priorities

- Ensure structural stability and integrity of the fresco.
- Adhere to the specified cube count range (2000-3000 Rubik's cubes).
- Maintain visual appeal and accuracy of representation.
- Divide construction process into manageable sections.
- Be visible from outside the building.

## Non-Requirements / Out of scope

- Use of a robot for [cube manipulation](#) will not be pursued due to logistical constraints and time considerations. Indeed, the communication system with the robot is new to us and learning to use it would take too much time and the incorporation of its usage in parallel to the other teams is too much of a burden.

## Operating Requirements

Adequate lighting to be able to see the fresco from the outside. Do not place objects in front of the fresco to block the view.

## Assumptions

- The provided Rubik's cubes will be of standard size and quality, without significant defects.
- The provided image overlay will accurately represent the desired final result.
- The needed material will be provided by the client on time.

## Design Details

### Fresco Dimensions

- Area of  $\approx 9.3$  square meters
- Rectangular shape to maximize visibility (184.8cm x 504cm)

### Cube Representation

- Each Rubik's cube represents a 3x3 pixel matrix.

- Colors: Green, Yellow, Red, Orange, Blue, White.

## Cube Arrangement

- The design will be composed of 2970 Rubik's cubes. (90x33)
- Cubes will be precisely rotated and positioned to create the desired artistic composition.
- The dimensions of a cube are 5.6 x 5.6 x 5.6 cm.

## Protective Measures

- The mounting structure will be designed to minimize stress on the cubes.
- Periodic inspections will be conducted to ensure the structural integrity and stability of the fresco.
- a sheet affixed to the wall stating that it is forbidden to touch or remove cubes from the fresco

## Tasks division

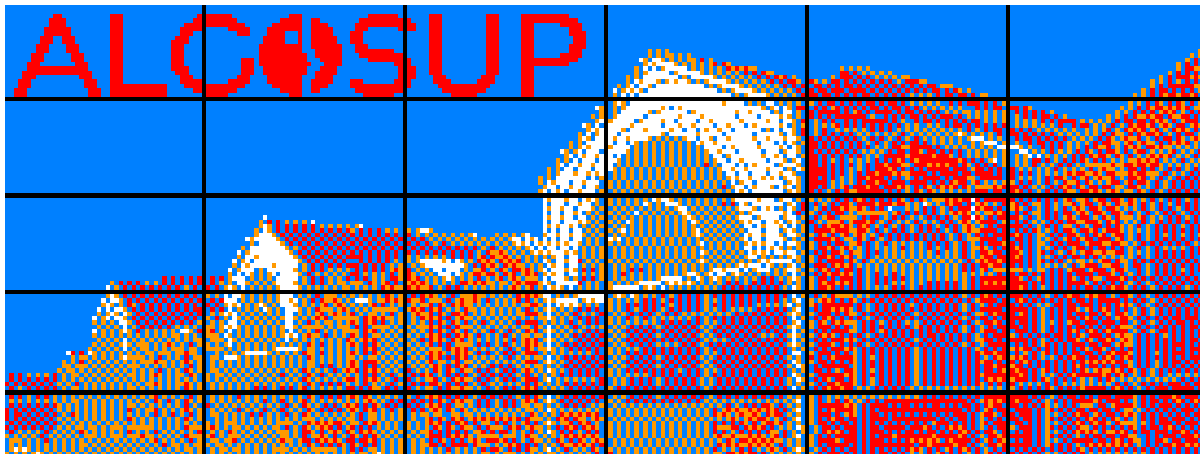
ALGOSUP's students are divided in 8 project teams. When the final image will be chosen by the client, each team will have to collaborate to realize the final fresco. Even so, each one will have to work on their own under the control of the chosen team.

If chosen, Team 2 will primarily handle the organization and execution of the construction process.

Tasks will be divided into small, manageable blocks for easy distribution.

As you visible on the image below, we divided our fresco in 30 sections:

- 24 sections of 90 rubik's cube (15 wide x 6 height)
- 6 sections of 45 rubik's cube (15 wide x 3 height) at the bottom



Each team will be assigned specific sections to construct. This division of labor into 30 sections will enable us to tailor the workload to each team's pace.

Furthermore, each team will receive a detailed plan outlining their specific responsibilities, including the placement of Rubik's cubes within their assigned section. This plan will serve as a guide, ensuring accurate execution. Each team must deliver its sections to the library and return them in the same layout as on the plan, to make it easier for Team 2 to build the whole fresco when they need it.

## Distribution of tasks and instructions

The tasks will automatically be distributed by a software since the different work-hours of each team would make manual coordination hard. The software will be written with Google's AppsScript tool, controlling a Google Spreadsheets to keep track of the data.

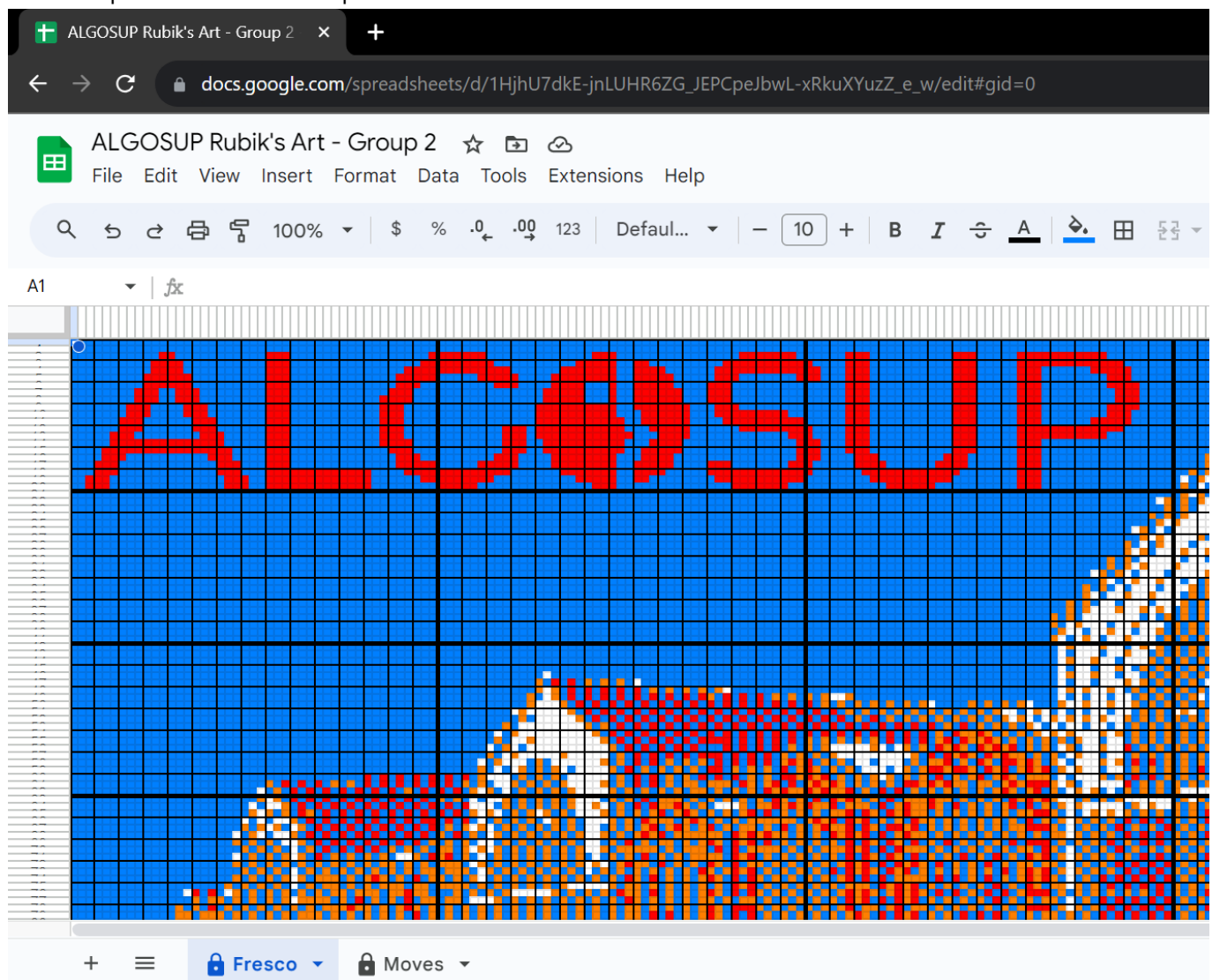
The sheets will be divided as follows:

- Fresco: The image representation, divided in the different sections and cubes
- Moves: List of the initial position of the cubes and the rotations to be made, along with an indicator to keep track of the state (to be done, started, done, ...) and the identifier of the cube (where the cube goes in the fresco)

The original data will be provided automatically by a script written in Python.

The Google Spreadsheet is [here](#) and the code used will be published on our Github repository [here](#).

Here is a preview of what the spreadsheet will look like:



ALGOSUP Rubik's Art - Group 2

docs.google.com/spreadsheets/d/1HjhU7dkE-jnLUHR6ZG\_JEPCpeJbwL-xRkuXYuzZ\_e\_w/edit#gid=1367194382

ALGOSUP Rubik's Art - Group 2

File Edit View Insert Format Data Tools Extensions Help

100% 123 Default... 10 B I A

A1 | Coords

	A	B	C	D	E
1	Coords	Status	Front	Up	Moves
2	A1	0	green	orange	R U B D' R' F' U
3	B1	0	green	white	R' B' U B2 L B' U
4	C1	0	green	orange	L' B R' L U2
5	D1	1	white	blue	U' D R' F L' R
6	E1	1	green	orange	F' U F2 R' F' L
7	F1	0	white	blue	U' D R' F L' R
8	G1	2	green	orange	U2 R' U' D2 R' L
9	H1	2	white	blue	U2 B' U' D2 B' F
10	I1	0	green	orange	U2 R' U' D2 R' L
11	J1	0	white	blue	U2 B' U' D2 B' F
12	K1	0	green	orange	U2 R' U' D2 R' L
13	L1	2	white	blue	U2 B' U' D2 B' F
14	M1	2	green	orange	U2 L D' F R' B D
15	N1	0	white	blue	U' D R' F L' R
16	O1	0	white	blue	D' U B' R' D2 L
17	P1	1	green	orange	L' D' R' D B L
18	Q1	0	green	orange	L' D' U F R' F' B
19	R1	0	green	orange	L D2 U2 L'
20	S1	0	white	blue	B' F U

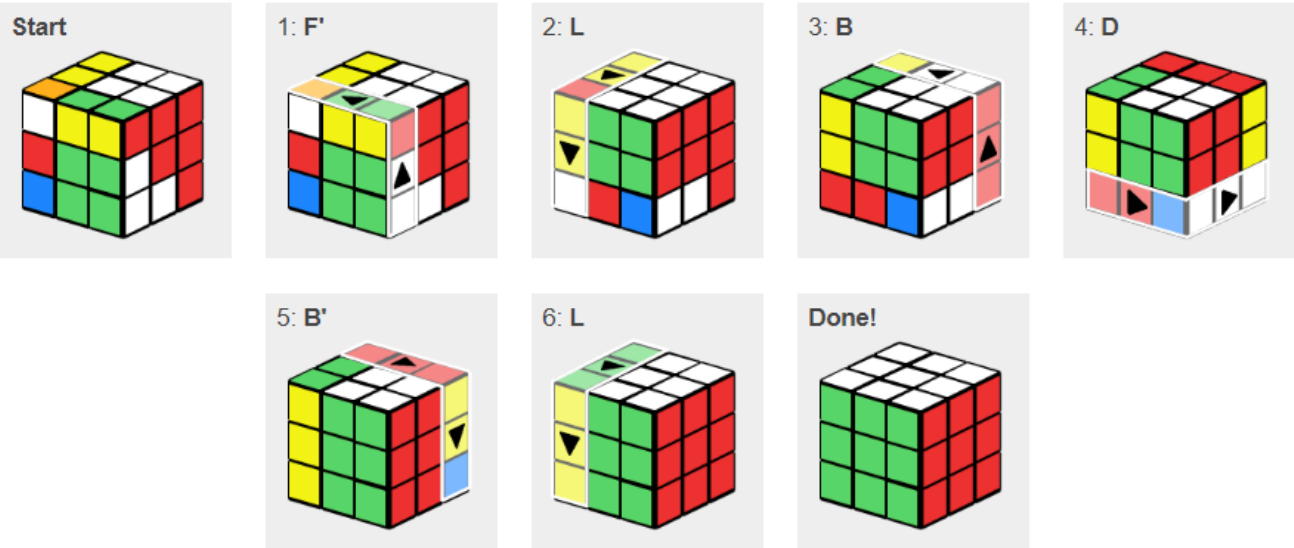
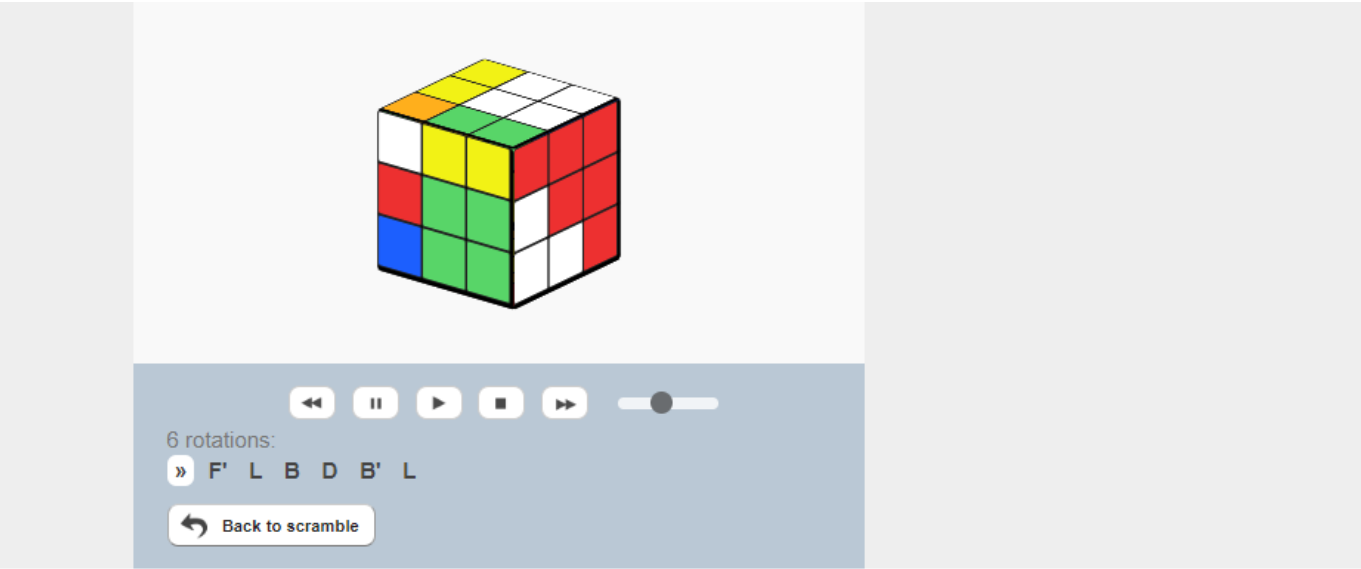
+ ≡

Fresco

Moves

Additionally, to guarantee precise execution, we will employ a specialized software program that visually illustrates the various movements of the Rubik's cubes. The different workers will only have to read the instructions shown on their screen.

Here is a screenshot from the website (the moves will have to be reversed):

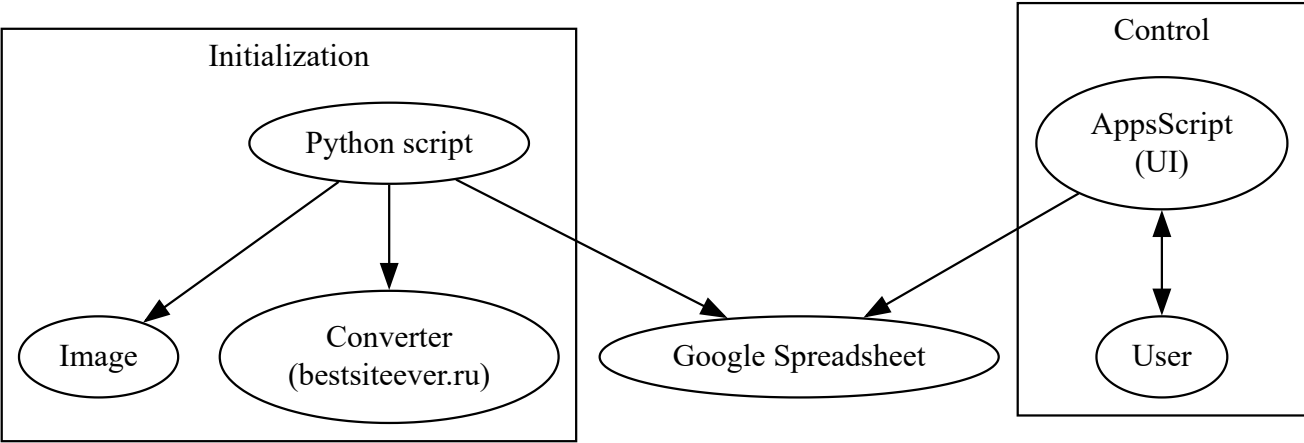


Since each group will work on one portion of the fresco at a time, the software will ask which section the user is working on before selecting a cube from this section that has not yet been processed.

The added bonus of using such tools comes if the client wants to change the design. Indeed, simply changing the input image will automatically change the moves and instructions.

Note: If another team is selected, the softwares will happily be shared as they won't be of use otherwise and might even increase the overall construction speed.

Software Architecture Diagram



Example of instructions

Let us take the example of the cube **S1**. **S** means the cube is on the 19th column (from the left) and **1** the first row (bottom).

To properly execute the move order, the cube will first have to properly be rotated. In this case, the front face is the white one and the top face is the blue one.

Finally, the rotations can be executed. They are provided in the following format:

Letter	Face
F	Front
B	Back
L	Left
R	Right
U	Up
D	Down

By default, each face should be rotated by **90° clockwise** when the face is on the front. Modifiers can be added to change the rotation:

- **'**: Rotate 90° **counter-clockwise**
- **2** or **²**: Rotate by 180° (half-turn)

In our case, the sequence is **B' F U**. This means the movements are as follows:

1. Back face counter-clockwise (this means an orange line will appear at the back of the top face)
2. Front clockwise (there is now only a blue strip on to the face)
3. Up/top face clockwise (the front face has the top going blue-red-blue and the rest is white)

Then the cube will have to be placed on the correct position on the section.

Repeat with a new sequence.



## Fresco Support Construction Guide:

Simultaneously, our team will focus on designing, developing, and building the support structure for the fresco. Here is a step-by-step guide to construct the frame for the fresco:

### Tools Required:

1. **Measuring Tape:** To ensure accurate measurements.
2. **Electric Drill:** For creating holes.
3. **Screwdriver:** To fasten screws securely.
4. **Level:** To ensure the frame is straight and level.
5. **Pencil:** For marking measurements on wood.
6. **Safety Gear:** Including gloves and safety glasses.

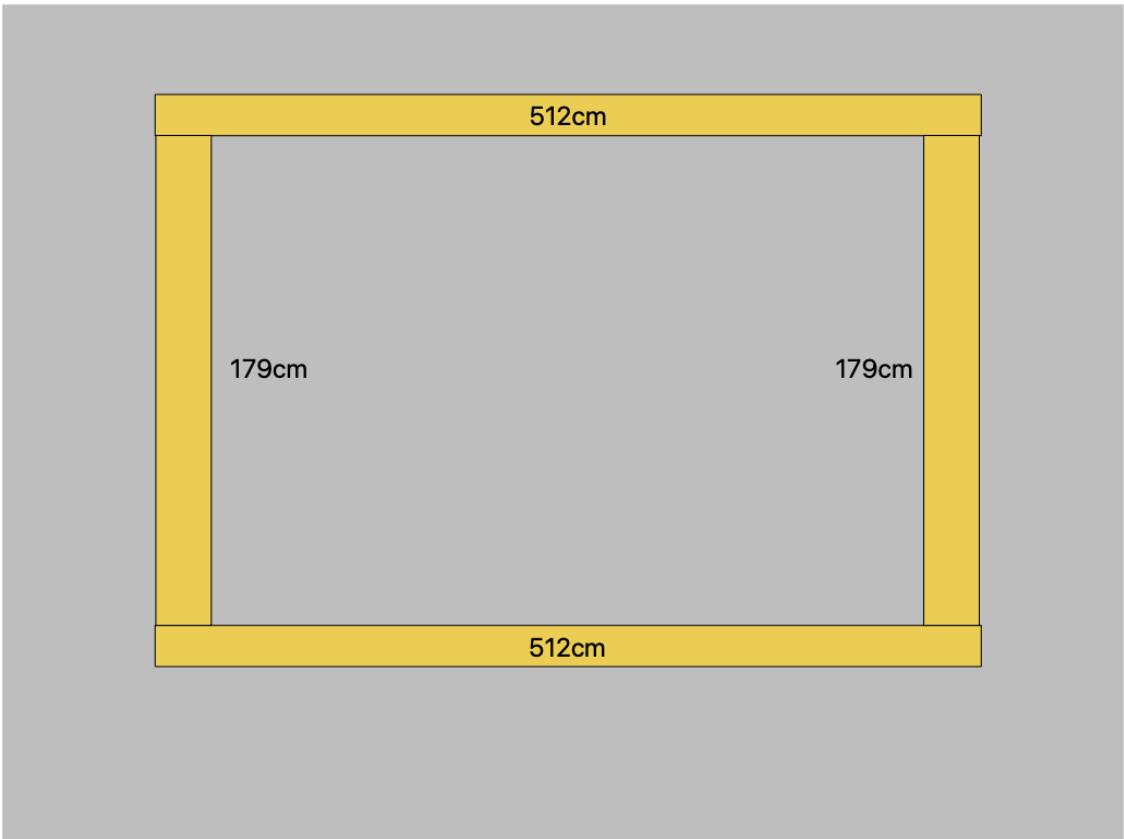
### Materials Needed:

- 2 Wood Planks (3cm Thickness, 512cm x 6cm)
- 2 Wood Planks (3cm Thickness, 179cm x 6cm)
- 9 Iron Brackets
- Multiple Screws

### Step-by-Step Construction:

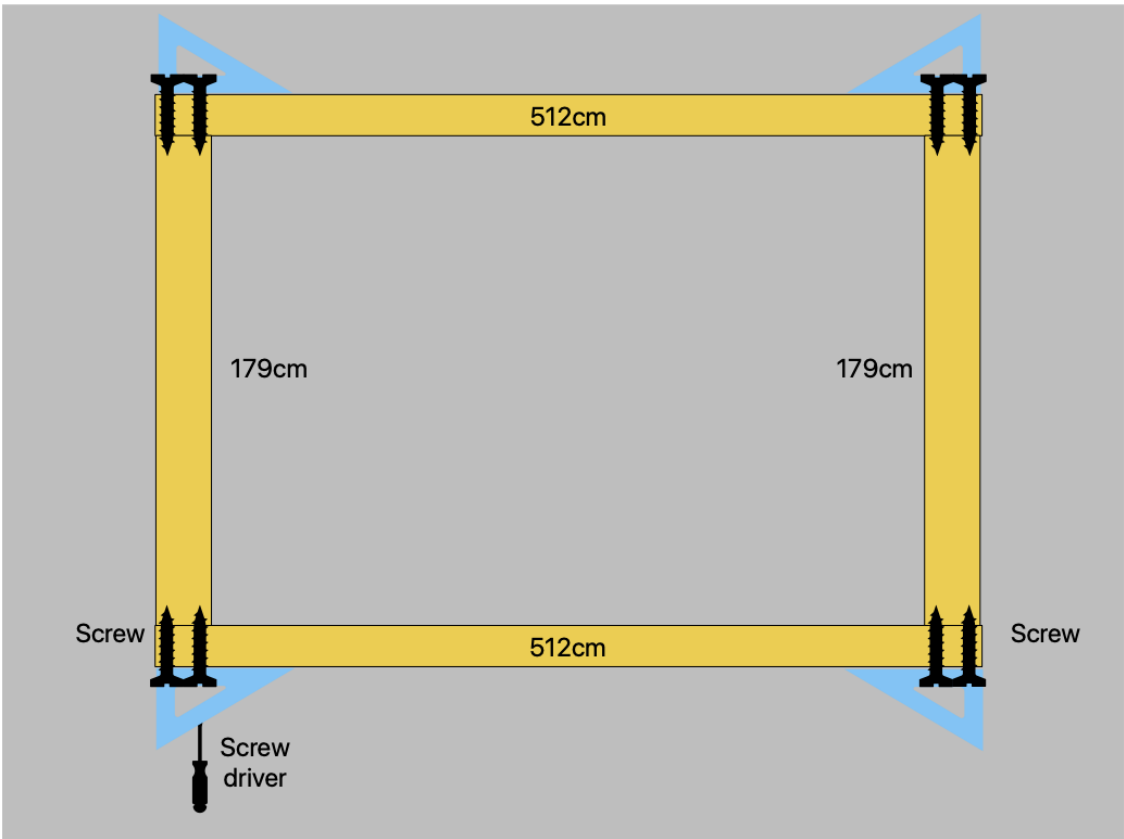
#### 1. Assemble the Frame:

- Take the two longer planks (512cm) and position them parallel to each other on a flat surface. These will serve as the top and bottom of the frame.
- Place the two shorter planks (179cm) parallel to each other between the longer planks to form a rectangular frame.



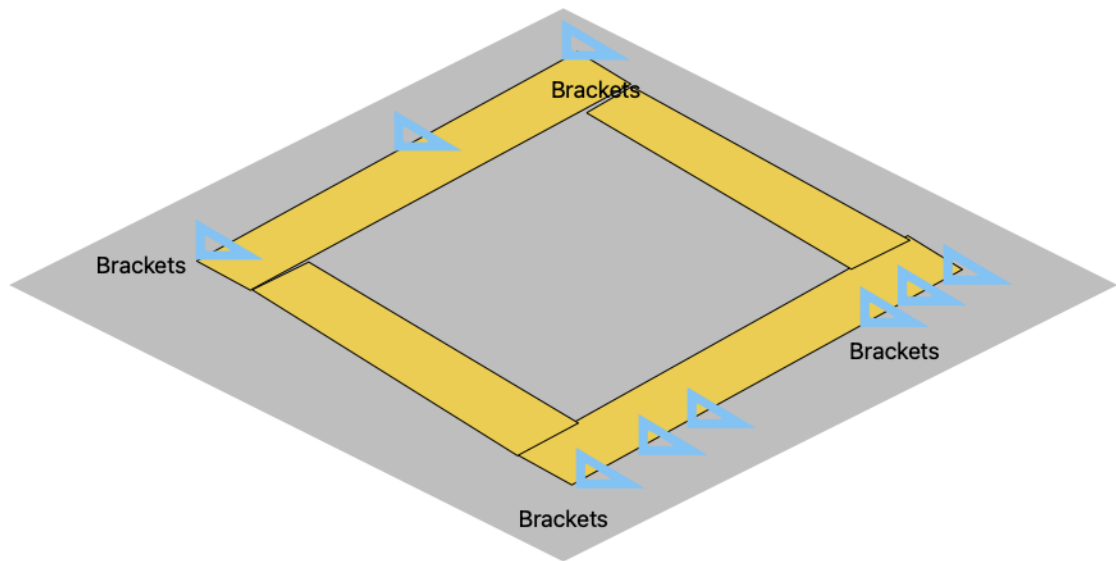
2. **Attach Iron Brackets:**

- Place the iron brackets at the corners of the top and bottom planks. Use the electric drill to create pilot holes for the screws, then fix the brackets securely.



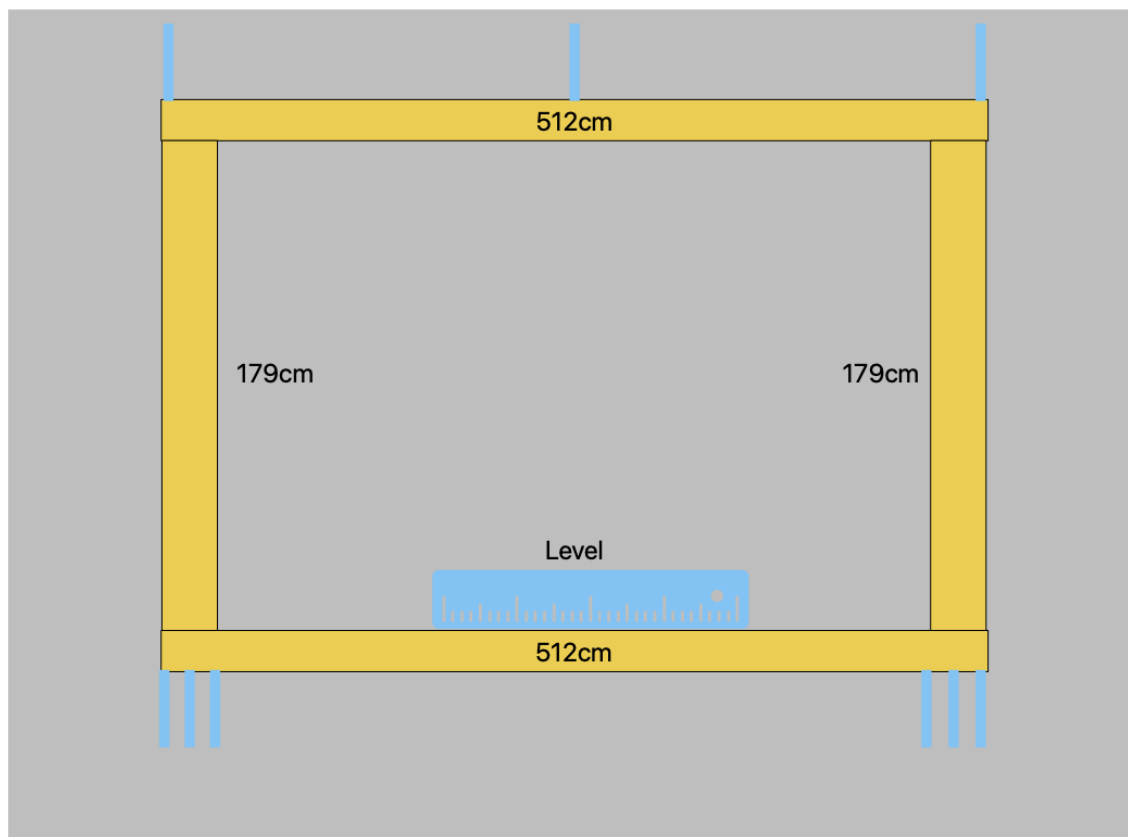
### 3. Strengthen the Plank:

- To provide additional support, add extra iron brackets all along the bottom plank.



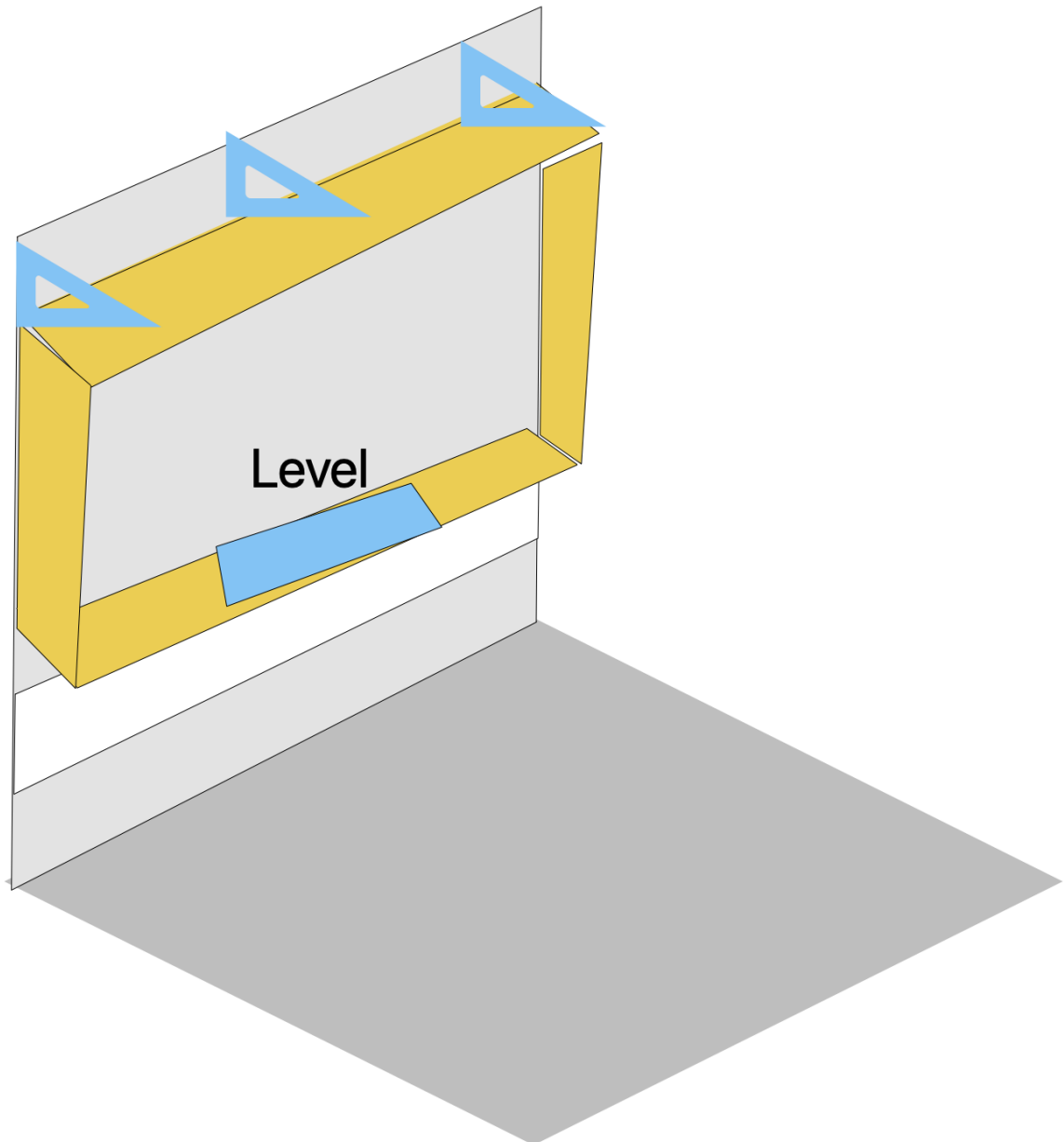
### 4. Check for Level:

- Use the level to ensure the frame is straight and level. Make any necessary adjustments before proceeding.



### 5. Preparation for Mounting:

- Position the frame at the designated location on the wall, ensuring it is aligned above the sockets.



#### 6. **Secure the Frame:**

- Use appropriate screws and the electric drill to securely fasten the frame to the wall. Ensure it is firmly anchored.

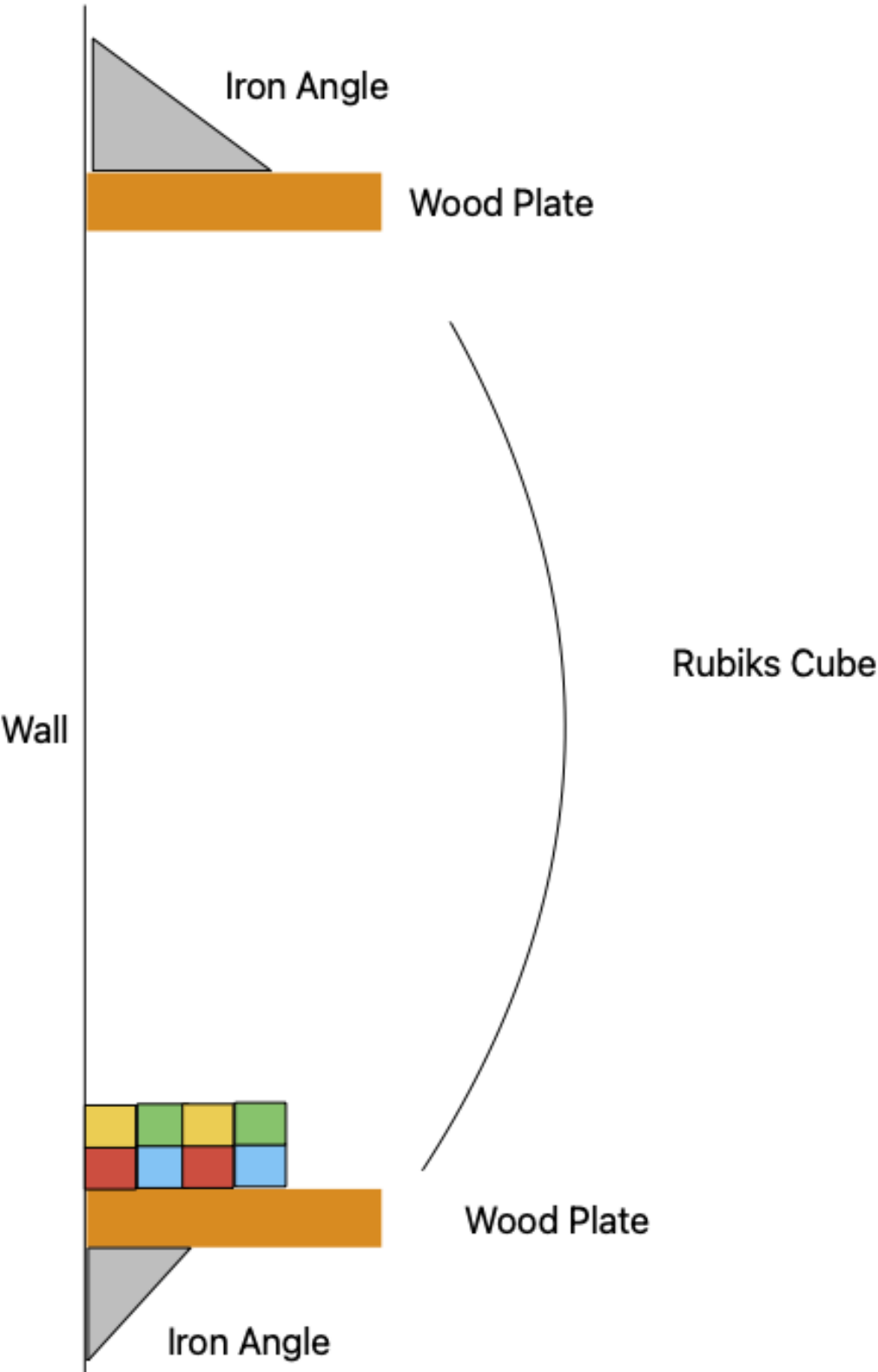
#### 7. **Final Checks:**

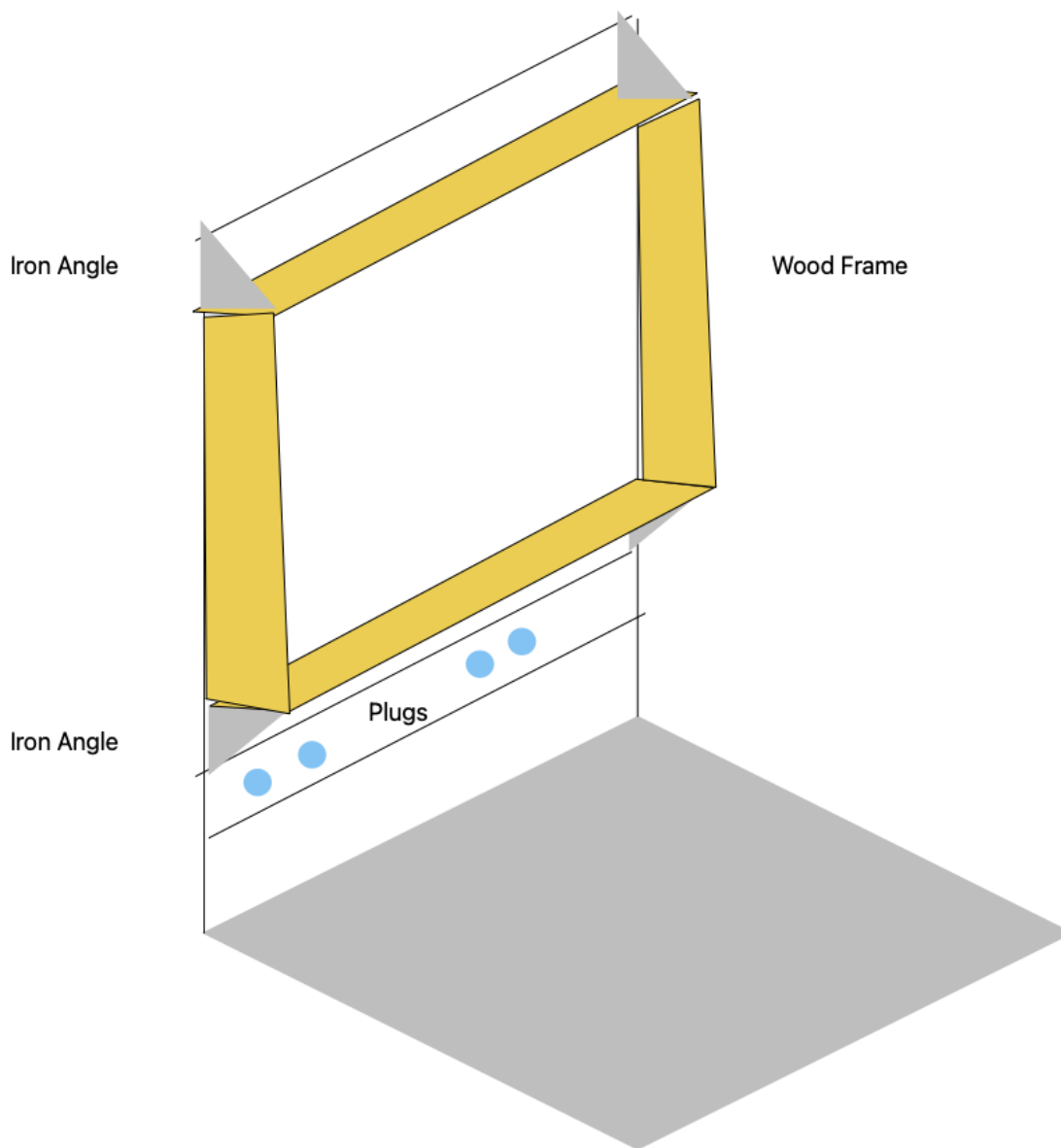
- Double-check the frame for stability and alignment. Make any final adjustments as needed.

#### 8. **Safety Measures:**

- Ensure all screws are tightly fastened, and there are no loose components. This will guarantee the stability and security of the frame.

Here are some images to illustrate :





## Maintenance and Upkeep

- Regular cleaning (each monday) to remove dust and maintain the visual appeal of the fresco.
- Routine inspections (each monday) to identify any missing or damaged cubes, with prompt replacement.
- Any necessary repairs or replacements will be performed promptly to ensure the longevity of the artwork.

## Technology Choice

Python and AppsScript will be used to program the software. The reason for this choice is based on the fact that we will be using a Google Spreadsheet to keep track of the work, its [API](#) being accessible in Python which will be used as an alternative to Google's AppsScript which does not allows for collection of data from other websites.

## Ideas and Hypotheses

## Unproven Hypotheses

- The division of labor into 36 sections will optimize the construction process for different teams.
- The use of a specialized software program will facilitate the construction process and improve the accuracy of the final result.

## Proven Hypotheses

In our case, Python is the best-suited programming language to develop the software. It's the one the team knows best, and the one best suited to our needs.

## Challenges

- Ensuring the structural integrity and stability of the fresco.
- Balancing artistic expression with technical constraints, and ensuring the final piece effectively represents ALGOSUP's identity.
- Adapt the fresco to the environment and make it well visible and understandable from the outside.

## Possible Bugs

### 1. Misaligned Cubes:

**Description:** There is a risk of cubes being slightly misaligned during the construction process, leading to a deviation from the intended image.

**Symptoms:** Visual discrepancies where adjacent cubes do not align perfectly, resulting in a jagged or uneven appearance in the image.

**Mitigation:** Conduct regular quality checks during the construction process, using precise measurements and alignment tools to ensure cubes are accurately positioned.

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### 2. Color Inconsistencies:

**Description:** Due to variations in cube manufacturing, there is a possibility of slight color discrepancies between cubes of the same designated color.

**Symptoms:** Visual differences in shade or hue between adjacent cubes of the same color, affecting the overall uniformity of the image.

**Mitigation:** Thoroughly inspect and sort cubes by color before construction, aiming to match shades as closely as possible. Utilize cubes with the most consistent coloration for prominent areas.

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### 3. Structural Instability:

**Description:** Inadequate support or fastening of the cubes may lead to sections of the fresco being unstable or prone to dislodging.

**Symptoms:** Observable movement or wobbling of cubes, especially in areas where they are not securely fastened to the support structure.

**Mitigation:** Ensure the support structure is robust and securely fastened before building the fresco in itself. Add new iron angles if the planks struggle to support the fresco. Conduct regular inspections to identify and address any structural issues.

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#### 4. Dust Accumulation:

**Description:** Over time, dust and particles may accumulate on the surface of the fresco, potentially obscuring the image and diminishing its visual impact.

**Symptoms:** Gradual loss of clarity and vibrancy in the image due to a layer of dust settling on the cube surfaces.

**Mitigation:** Implement a regular cleaning schedule using [non-abrasive materials](#) to gently remove dust. Consider using a protective cover or plexiglass panel to minimize dust accumulation.

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#### 5. Cube Wear and Tear:

**Description:** Continuous handling of the Rubik's cubes during construction may lead to minor scratches or wear on the cube surfaces.

**Symptoms:** Surface imperfections or small scratches on the cubes, particularly in areas that have undergone frequent manipulation.

**Mitigation:** Prioritize the use of damaged cubes for areas where imperfections are less noticeable. Conduct thorough inspections of cubes before placement.

### Security Considerations

The mounting structure will be designed to minimize stress on the cubes and prevent accidental displacement.

### Success Evaluation

The success of the project will be determined by the feedback provided by the daily workers of the B3, as well as the degree of similarity between the final image and the original prototype. This evaluation will serve as a crucial indicator of the project's overall success and alignment with the intended vision.

The success of the project will be determined by the feedback provided by the daily workers of the B3 and bystanders, as well as the degree of similarity between the final image and the original prototype. This evaluation will serve as a crucial indicator of the project's overall success and alignment with the intended vision.

### Conclusion

By adhering to these technical specifications, we aim to create a Rubik's Art Fresco that not only meets ALGOSUP's vision but also stands as a durable and visually captivating representation of the institution's identity.

### Glossary



**Augmented Reality (AR)**

A technology that overlays digital information (such as images, sounds, or 3D models) onto the real world through a device like a smartphone or AR headset.

**API (Application Programming Interface)**

A set of rules and protocols that allows different software applications to communicate and interact with each other.

**Pixelated Image**

An image that has been intentionally blurred or distorted to the point where individual pixels are visible, often used for artistic or privacy purposes.

**Acrylic Panel**

A transparent sheet made of synthetic polymer material, commonly used to protect surfaces or provide a clear barrier. It is also known by many brand names such as Plexiglas or Heselite.

**Cube Manipulation**

The act of rotating and positioning Rubik's cubes to achieve a desired configuration or pattern.

**Prototype**

A preliminary version or model of a product or project used for testing and evaluation.

**Pixel Matrix**

A grid of individual pixels used to represent an image, where each pixel corresponds to a single point of color.

**Non-abrasive Materials**

Substances that do not cause damage or wear when used on surfaces.