semester 2

Application Project Math

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Math

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Distance between two points: Projection of a Three-Dimensional Figure

Introduction

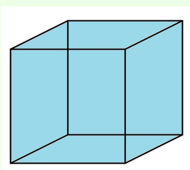
Throughout this project we will use the formulas seen in class to calculate the distance between two points given the coordinates, in order to locate the vertices of a three-dimensional cube and project said figure from a perspective where the figure and its depth can be appreciated.
Likewise, we will apply some formulas from other topics previously seen, such as the Pythagorean Theorem and Trigonometric Ratios, in order to complete the development of the project.

Goal

Find an applicable formula to calculate the distance between two points given their coordinates in order to project a three-dimensional cube from a plane. Go from a 3D figure to a 2D one.

Theoretical framework

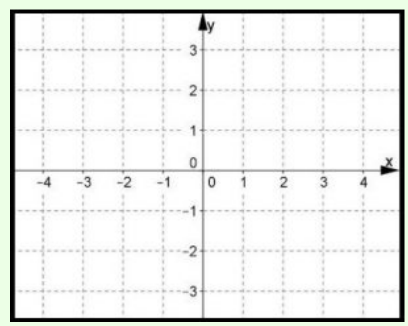
Cube:in a body (polyhedron) formed by six mutually congruent square faces.



Dimension:aspect of a body that is associated with the way its volume, size, and/or width changes when it is enlarged or scaled proportionally.

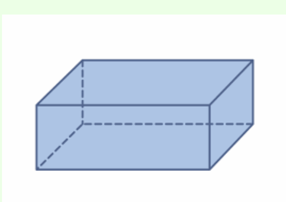
Projection: It is the image obtained from a body to be reflected in a plane from the point of view of the observer. It is obtained on a surface by lines that They start from the same point.

Cartesian plane:two mutually perpendicular number lines (X-axis and Y-axis) that connect at a point.



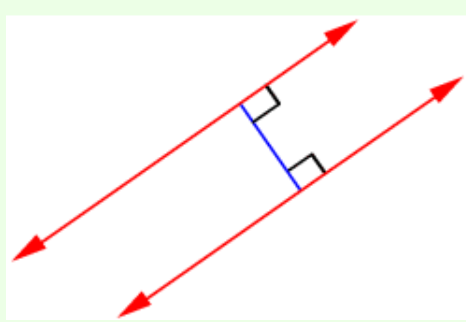
Depth:the distance between a reference point and its background.

Perspective: It is the science that allows an element to be represented in three dimensions on a flat surface to identify its height, width and depth.



Distance: It is the distance traveled from one point to another.

Coordinate:lines used to determine the position of a point.



Hypothesis

Using a plane in which to project the points we will find that if the projections are placed perpendicular to the plane we will have a cube in three dimensions.

Project development

This project had a very interesting process as our formula went through three iterations; Originally our formula meant that basically all the vertices were projected perpendicularly to the painting, this because there was no separation between the perspective and the painting. We did an experiment looking at the cube from one of its diagonals so that we could see all the vertices and we finished our formula; However, with further experimentation we realized that if you looked at the cube head-on you would only see four of the vertices and there would be no depth, which is where we were forced to change our formula to our second iteration.

In this perspective, the perspective was separated and is very similar to the current formula, however, when making the explanatory images of this document, we noticed that our procedure could be summarized quite a bit (more than half) and thus the formula we currently have was given.

— — — — — — Formula and Variables ——————

Values we have:

Perspective:**Px, Py, Pz**

Frame:**CD**(Distance from P to the center of the frame). **cx**: Angle of the frame in X. **Cy:**Frame angle in Y

Three-Dimensional Vertex:**Vx, Vy, Vz**

— — — — — — X-coordinate ——————

Differences:**Dx, Dy, Dz (P - V)**

Opening angle in X:**$Ax = Tan^{-1}(Dz/Dx) - Cx$**

Result X:**$Rx = Tan(Ax) * Cd$**

— — — — — — Y-coordinate ——————

Hypotenuse/Three-Dimensional Distance from V to P:**$Hy = \sqrt{Dx^2 + Dz^2 + Dy^2}$**

Opening angle in Y:**$Ay = (Tan^{-1}(Dy/Hx))*-1 - Cy$**

Result Y:**$Ry = Tan(Ay) * Cy$**

Bi-dimensional Vertex (Final Result)= **(Rx, Ry)**

Procedure (explanation):

If you read this God save you.

In the "Formulas" section we have three things; The pers view (P) which we want, the Information d and our three-dimensional vertex

The perspective can be exp which you are seeing since converting a 3D object to you need to know from which case we can see the right perspective rendered as black converge.

The black square to the left of Frame (C), which is the distance from it to us as your head can be rotated upwards, and the frames in X and Y for v are the angles of Cx and Cy.

For the vertex, you choose the shape that you want to convert into X, Y and Z coordinates... procedure with each vertex.

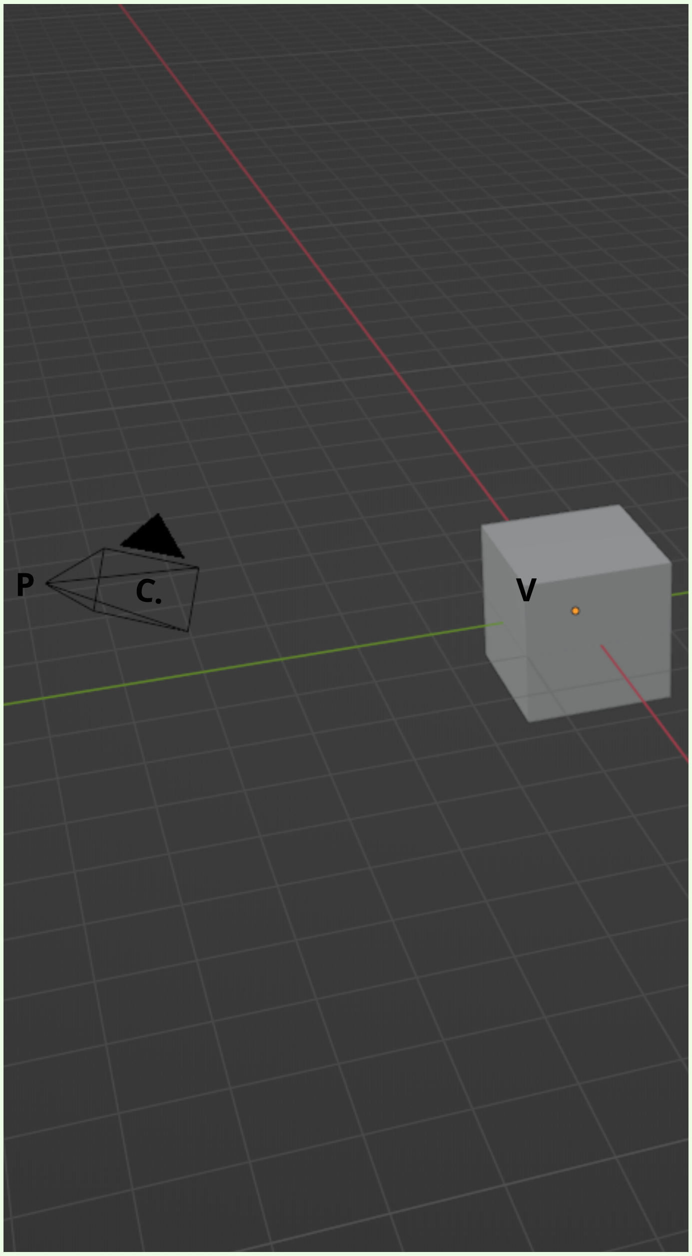


Image 1

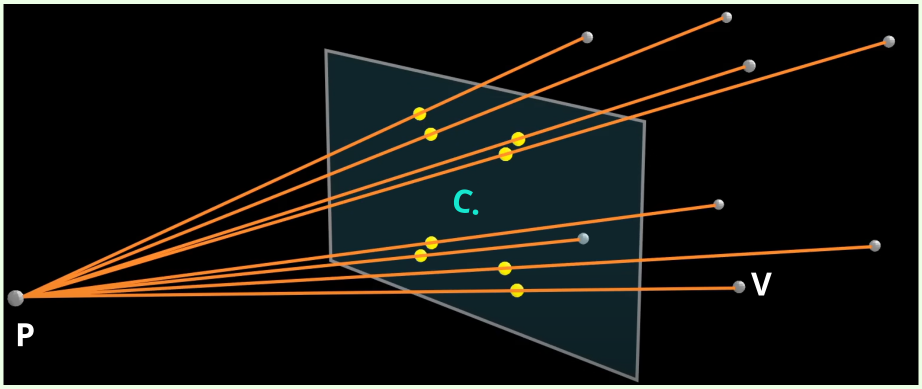


Image 2

In image 2 we can see what we have to do. What we need is to project a line from P to each of the vertices, where this line makes contact with C is that it is our result in two dimensions.

But... How do we get that point? To understand how we do this we first have to simplify how we see it; We are going to remove a dimension from everything when seen from above (images 3 and 4):4

In this view there is no AND neither in the plane nor in our box, in other words we are removing a dimension from the space and one dimension from our box.
What we are looking for is the distance from the center of the box (the purple point) to the intersection that has the purple line (**C.**) with the green (**Hx**). First let's find the horizontal distance (**rx**).
To do this, let's first understand that our perspective is the black point located in the lower left corner marked **P**, the intermittent gray line out of the center of this at 45 ° is where the perspective is looking, the other two intermittent lines are simply illustrative to visualize the connection between**P** and our chart (**C.**).**CD**is our previously mentioned distance between**P**and the purple dot in the center of**c.** Changing this distance helps the way you see depth; Naps seeing a face from the front and there was no distance (**CD**= 0) instead of seeing the eight vertices you would see only 4 since the other four would be at the same point as the ones we are seeing.

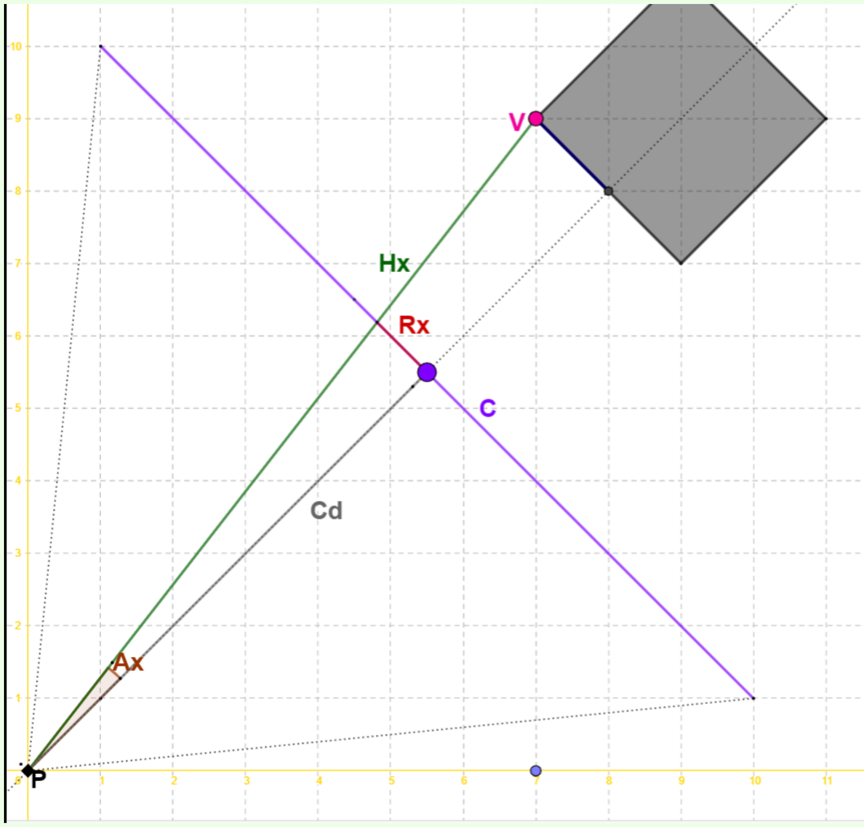


Image 3

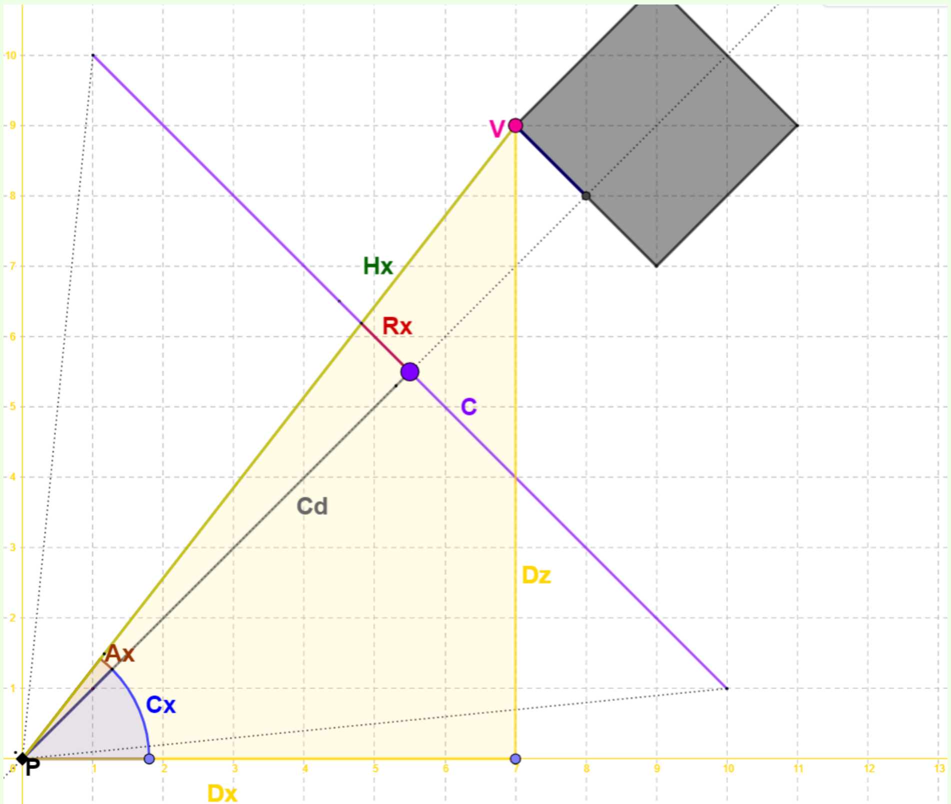


Image 4

that we understood better the Let's do math.
All we have to do is uir our angle**ax.** we see in image 4 we can
a**triangle**straight with the lines between**P**Y**v, and**in X sanding tangent we can get the lower left
cx).
you tangent^{-1}of**dz**/**Dx**and you **cx**, which in this example is 45° which is the perspective angle. The formula went like this:

an^{-1}(dz/Dx) -cx

do the angle**ax**we can solve for Rx being the opposite leg of this using tangent:

rx= so(ax) *CD

Once we get the distances of **rx** of each vertex, we will use those points to be able to return to see the problem in three dimensions.

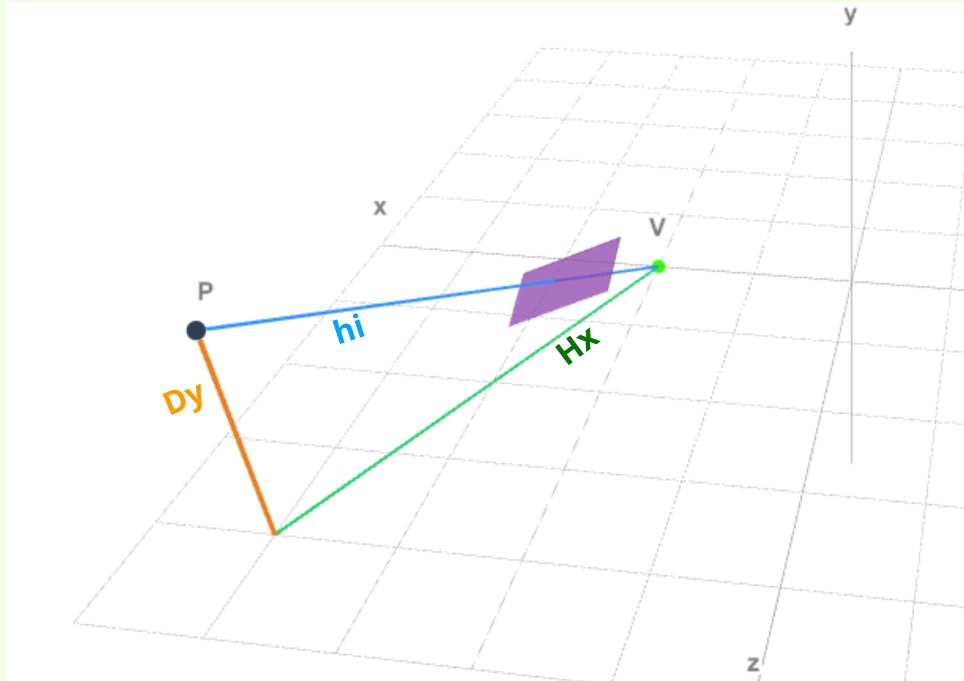


Image 5A

We will form another right triangle, taking the previously used **Hx** as our adjacent leg, and the difference of V and P in Y (**Dy**). To get this distance we will use the distance between two points formula (also known as Pythagoras) with a slight change. The formula to get **Hx** it is:
$\sqrt{Dx^2 + Dz^2}$

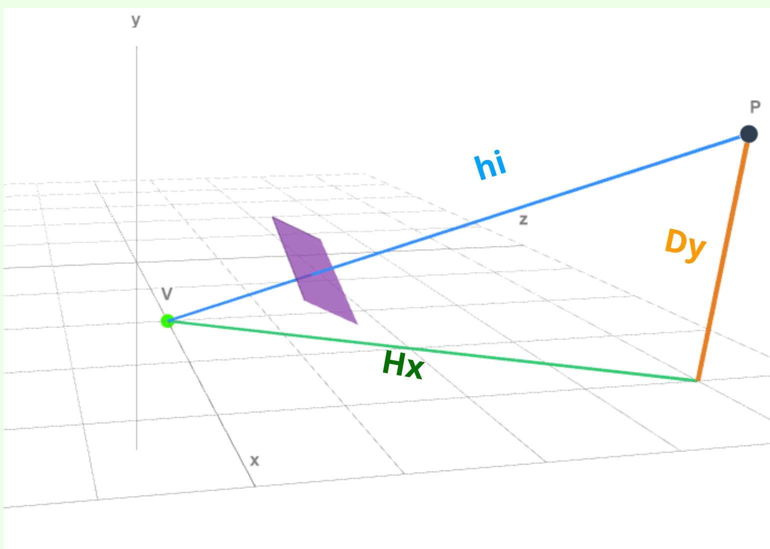


Image 5B

To calculate the hypotenuse we have the same Pythagoras formula. To do ordamos the exercise seen in class where we need to take the distance of two vertices in l of a box; so like in that We will make another Pythagoras to get the usa with Y: **hi**$=\sqrt{Hx^2 + Dy^2}$.
The formulas can be simplified to a **Y**$= \sqrt{Dx^2 + Dz^2 + Dy^2}$

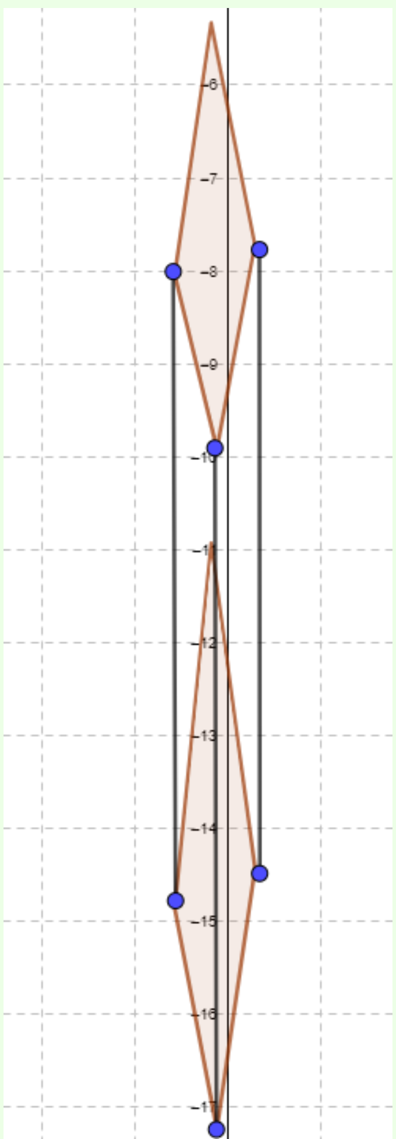
triangle measurements, now we can the opening angle, with the following formula: **Ouch= (So¯¹(Dy/Hx))*-1 - Cy**
To finish, let's take the Y coordinate from the table: **Ry= Tan(Ay) * Cy**

Execution:

Given a cube with a smaller vertex (XYZ plus close to 0) located at [1,0,2], with dimensions of [3,4,3] and given P at [10,10,10], given Cd= 2, Cx=45, Cy= -45.

Calculates the projection of the vertices on a two-dimensional plane.

V[X,Y,Z]	[Dx, Dy, Dz]	ax	rx	hi	Oh	ry	R[Ry, Rx]
[1,0,2]	[9,10,8]	- 3,366	-0.11	15,652	12.42	- 9.91	[-9.91,-0.11]
[1,0,5]	[9,10,5]	- 15,945	-2.28	14,352	10,133	- 8.04	[-8.04,-2.28]
[4,0,2]	[6,10,8]	8.1232	- 1,857	14,142	9,735	- 7,720	[-7.72,-1.857]
[4,0,5]	[6,10,5]	- 5,194	- 2,090	12,688	6,757	- 5,331	[5,526;-2,092]
[1,4,2]	[9,6,8]	- 3,394	- 2,059	13,453	20,964	- 17,241	[-17.24,-2.05]
[1,4,5]	[9,6,5]	- 15,969	- 2,286	11.91	18,274	- 14,859	[-14.85,-2.28]
[4,4,2]	[6,6,8]	8,123	- 1,857	11,661	17,774	- 14,425	[-14.425,-1.85]
[4,4,5]	[6,6,5]	- 5,194	- 2,091	9,848	13,649	- 10,927	[-10.92,-2.09]



Results:

As we can see these vertices passed to a Plane in Geogebra we can see that we are left with a picture that is very squashed due to the distance from which we are seeing it

Conclusion:

With the data obtained we were able to conclude that our hypothesis was not correct since, as I mentioned in the development of the project, the formula went through iterations; Originally it seemed that it worked, however as we experimented we realized that the lines have to have a different angle than 90 with respect to the face, otherwise when you see the cube from the front you cannot see its depth.

Bibliographies:

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