岐阜工業高等専門学校　所研究室(Prime.8)
NIT, Gifu College

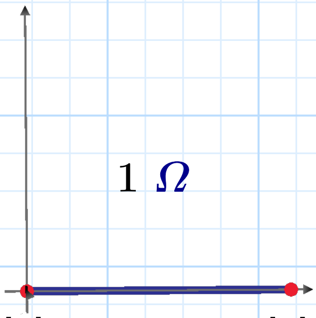
Puzzle-28. Make one ohm by 1Ω。

Each edge of node to node is one ohm. Find the resistance between red points.

```
f_xyz(i, j, h) := | C ← [0  0  0]
                  | for z ∈ 0 .. h
                  |   | C ← stack(C, [NaN  NaN  NaN])
                  |   | for y ∈ 0 .. j
                  |   |   | C ← stack(C, [NaN  NaN  NaN])
                  |   |   | for x ∈ 0 .. i
                  |   |   |   | C ← stack(C, [x  y  z])
                  | for y ∈ 0 .. j
                  |   | C ← stack(C, [NaN  NaN  NaN])
                  |   | for x ∈ 0 .. i
                  |   |   | C ← stack(C, [NaN  NaN  NaN])
                  |   |   | for z ∈ 0 .. h
                  |   |   |   | C ← stack(C, [x  y  z])
                  | for x ∈ 0 .. i
                  |   | C ← stack(C, [NaN  NaN  NaN])
                  |   | for z ∈ 0 .. h
                  |   |   | C ← stack(C, [NaN  NaN  NaN])
                  |   |   | for y ∈ 0 .. j
                  |   |   |   | C ← stack(C, [x  y  z])
                  | return C
```

1D

$Z:=1$　　$x:=1$　　$y:=0$　　$z:=0$

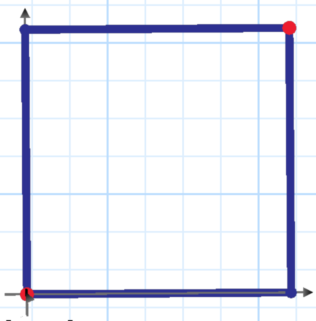


$1\ \Omega$

$[0]$　　$[1]$

2D

$Z:=1$　　$x:=1$　　$y:=1$　　$z:=0$

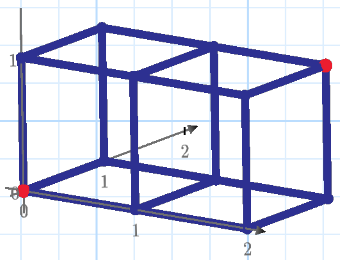


$[1\ \ 1]$　　$1\ \Omega$

$[0\ \ 0]$

3D

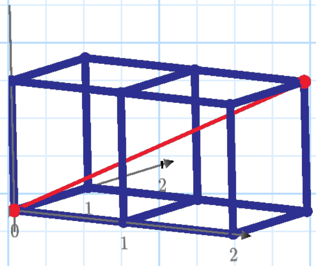
$x:=2$　　$y:=1$　　$z:=1$　　$Z:=2$



$[1\ \ 1\ \ 2]$　　$1\ \Omega$

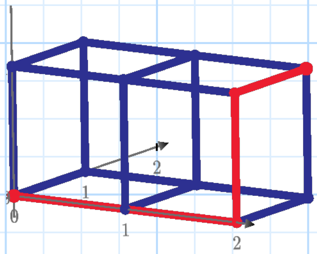
$[0\ \ 0\ \ 0]$

In this 3D 1*1*2 cube, the **inner distance** of node [0,0,0] to [1,1,2] is



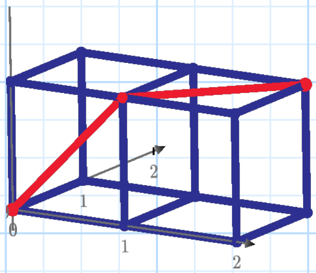
$$\sqrt{1^2+1^2+2^2} \rightarrow \sqrt{6}$$

In this 3D 1*1*2 cube, the **edge distance** of node [0,0,0] to [1,1,2] is



$$1+1+2 \rightarrow 4$$

In this 3D 1*1*2 cube, the **surface distance** of node [0,0,0] to [1,1,2] is



$$\sqrt{2^2+2^2} \rightarrow 2 \cdot \sqrt{2}$$

Puzzle 28. Where is the most far surface distance point from [0,0,0]? Find the point and the distance.

$$\sqrt{\left(\frac{9}{4}\right)^2+\left(\frac{7}{4}\right)^2} \rightarrow \frac{\sqrt{2} \cdot \sqrt{65}}{4} = 2.85$$

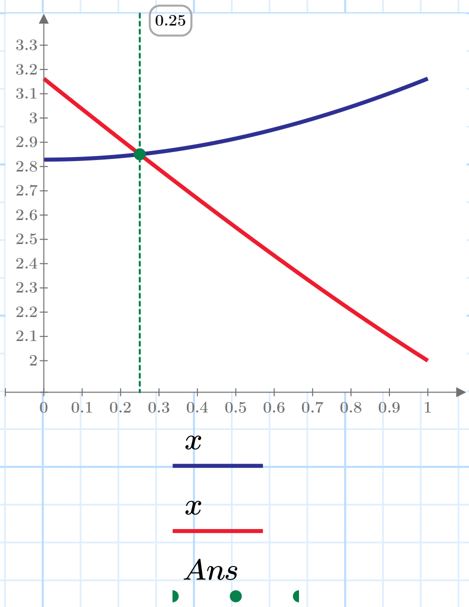
clear (x) $\qquad x:=0,0.01..1$

$L(x):=\sqrt{(2+x)^2+(2-x)^2}$

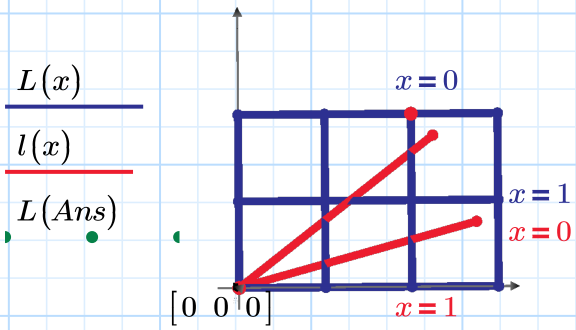
$l(x):=\sqrt{(2+(1-x))^2+(1-x)^2}$

$Ans:=\sqrt{(2+x)^2+(2-x)^2}=\sqrt{(2+(1-x))^2+(1-x)^2}\xrightarrow{solve}\frac{1}{4}$

2D $\qquad x:=3 \quad y:=2 \quad z:=0 \quad Z:=3$



Deployment Diagram



$L(Ans)\xrightarrow{simplify}\frac{\sqrt{130}}{4}=2.85$ $\qquad l(Ans)\xrightarrow{simplify}\frac{\sqrt{130}}{4}=2.85$

1*1*nの場合

clear (x,n)

$x(n):=x^2+(n+x)^2=(1+x)^2+(n+1-x)^2\xrightarrow{solve,x}\frac{n+1}{2\cdot n}$

$Lx(n):=\sqrt{\left(\frac{n+1}{2\cdot n}\right)^2+\left(n+\frac{n+1}{2\cdot n}\right)^2}$

$x(1)\to 1 \qquad x(2)\to\frac{3}{4} \qquad \lim_{n\to\infty} x(n)\to\frac{1}{2}$

$Lx(1)\to\sqrt{5} \qquad Lx(2)\to\frac{\sqrt{2}\cdot\sqrt{65}}{4} \qquad \lim_{n\to\infty} Lx(n)\to\infty$

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clear (x) $\quad x:=0,0.01..1$

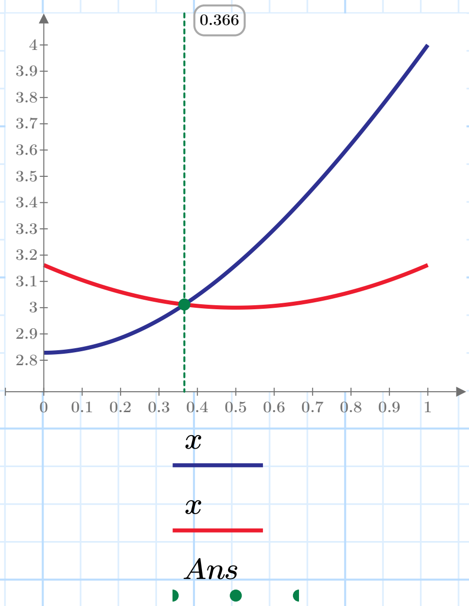
$$L(x):=\sqrt{(2+2\cdot x)^2+(2-2\cdot x)^2}$$

$$l(x):=\sqrt{(2+(1-x)+x)^2+(1-2\cdot x)^2}$$

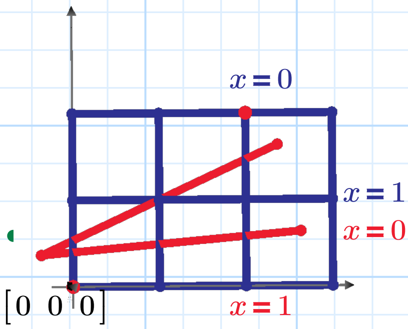
$$Ans:=\sqrt{(2+2\cdot x)^2+(2-2\cdot x)^2}=\sqrt{(2+(1-x)+x)^2+(1-2\cdot x)^2}\xrightarrow[solve]{assume,\,x>0}\frac{\sqrt{3}-1}{2}$$

2D

$x:=3 \quad y:=2 \quad z:=0 \quad Z:=3$



Deployment Diagram



$$L(Ans)\xrightarrow{simplify}\sqrt{-(4\cdot\sqrt{3})+16}=3.0119424 \qquad l(Ans)\xrightarrow{simplify}\sqrt{-(4\cdot\sqrt{3})+16}=3.0119424$$

1*1*nの場合

clear (x,n)

$$x(n):=(1-2\cdot x)^2+(n+1)^2=(2-2\cdot x)^2+(n+2\cdot x)^2\xrightarrow{solve,\,x}\begin{bmatrix}\frac{-\sqrt{4\cdot n^2-4}+(2-2\cdot n)}{4}\\ \frac{\sqrt{4\cdot n^2-4}+(2-2\cdot n)}{4}\end{bmatrix} \quad x($$

$$Lx(n):=\sqrt{(1-2\cdot x(n))^2+(n+1)^2}$$

$$x(1)\rightarrow 0 \qquad x(2)\rightarrow\frac{\sqrt{3}-1}{2} \qquad \lim_{n\to\infty} x(n)\rightarrow\frac{1}{2}$$

$$Lx(1)\rightarrow\sqrt{5} \qquad Lx(2)\rightarrow\sqrt{(-\sqrt{3}+2)^2+9}=3.012 \qquad \lim_{n\to\infty} Lx(n)\rightarrow\infty$$