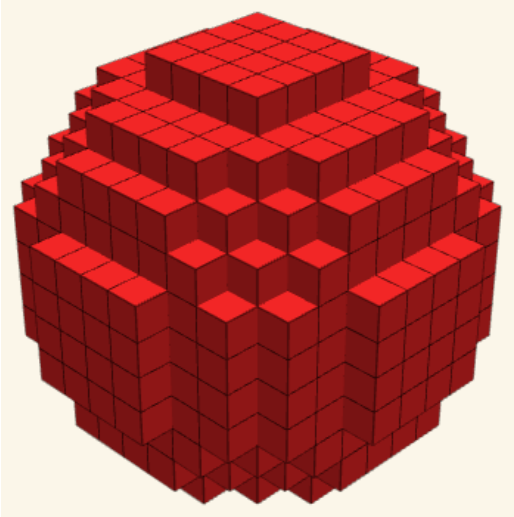
Pixel Round

11 —

, *Pixel Round*
11 .

,
: .



12, Pixel Round.

:

:

12.08.2022 № 732) ·

1.

( );

.

11. 10 .

(1, 3), -

(2), (4).

4 45 (180). (

90) §7.

Pixel Round — - ,

, - (PWA).

.

; -

.

(, Python); (

); (,).

; ; -

; ; .

15

Pixel Round;

`docs_math/Pixel_Round_Math_ru-RU.pdf`.

:

(-

), ,

. Pixel Round

, .

( )

C.

2.

— Minecraft Stardew Valley (*4A Games*, *Mundfish*).

: , , ,

ℝ?

, :

- - , .
, .
, .
- ,
. . . 1960–70- .
- . ,
(. §7) , (
).

: (
) .
— , — :
.
, .

3.

3.1

- ;
- ;
- .

3.2

- : , ,
.
- : ;
(, ,);
.
- : ; , ,
.

3.3

, :

—

, , ;
, ;
.

; ;
.

—

; Python
JavaScript; (—).

4.

4.1

- $\mathbb{R}^2$ $\mathbb{R}^3$; .
- : $x^2 + y^2 = r^2$.
- : $(x/r_x)^2 + (y/r_y)^2 = 1$.
- : , , .
- $\mathbb{R}^3$.
- : $V = \frac{4}{3}\pi r_x r_y r_z$.
- ( ).
- : 4- 2D, 6- 3D.

4.2

- .
- Pixel Round (, , , PNG).
- .

- .

5.

:

- .
- (9).
- ; , , (10).
- : , , .
- .

( ) -
10 (. §8.1).

6.

6.1

- Pixel Round ( );
- ;
- / BYOD ( ).

6.2

- (5), 2 ;
- , , 30 ;
- (#CC2020);
- (B);
- ( ).

6.3 Pixel Round

:

1. GitHub Pages . URL QR- , -
.
2. (`index.html` `file://`).
3. **PWA- :** , .

7.

.
.

7.1

- 1.2 (15 10);
- ;
- : , ( ).

7.2

- : $d_0 = 1 - R$ $F(x, y) = x^2 + y^2 - R^2$, $(1,\ R - \frac{1}{2})$.
- : πr^2 $r \to \infty$. — : $O(r^{2/3})$ (, 2003 .).
- : 20 Python.

7.3 (90-)

-
: 1+2 , 3+4 , .

7.4

- Pixel Round (, , *TrueConf*).
, .
(. ,).

8.

- :
— — — — . 45-
.

8.1 1 — “ ?”

;
; Pixel Round.

1.1 — 8

: “ — — ”.

:

1. : Super Mario,
, - Google.
2. : “ ? ,
?”
3. (1), (2).
4. . : “
— , ?”

1.2 — 12

: , .

: , .

:

1. , 11×11 .
2. : “ , , *10.* . .”
3. - .
4. : “ *?* , *?* *?*”
5. : . .

1.3 — 15

: ; .

( ) r:

$$x^2 + y^2 = r^2$$

$x^2 + y^2 < r^2$. r_x, r_y:

$$\left(\frac{x}{r_x}\right)^2 + \left(\frac{y}{r_y}\right)^2 = 1$$

, .

. Pixel Round :

- : $(i + \frac{1}{2}, j + \frac{1}{2})$?
- : 1965 , .
- : ?

. Pixel Round, 10, . : , .

1.4 — 10

: “ . *10,*
: , $(i+0{,}5,\ j+0{,}5)$
≤ 5 .”
Pixel Round 10.
.
(2): “ : , “ ” ?”

( )

1.4 8 14. .

8.2 2 — “ , ”

.

2.1 — 5

. : “ ,
.”

2.2 — 10

. (i, j)

$$d_x = \frac{i + \frac{1}{2} - c_x}{r_x}, \qquad d_y = \frac{j + \frac{1}{2} - c_y}{r_y}$$

, $d_x^2 + d_y^2 \le 1$.
. $c_x = c_y = 5,\ r_x = r_y = 5,$ $(2, 1)$.
$d_x = -0{,}5,\ d_y = -0{,}7,$ $d_x^2 + d_y^2 = 0{,}74 \le 1$. .
. $(0, 0)$. (: $1{,}62 > 1,$.)

2.3 — 15

. 1965 , IBM.
. : ,
.
$(x = 0,\ y = R)$ $d_0 = 1 - R$, 0–45°:

$$\begin{cases} d < 0: & : (x{+}1,\ y),\ d \mathrel{+}= 2x + 3 \\ d \geq 0: & : (x{+}1,\ y{-}1),\ d \mathrel{+}= 2(x - y) + 5 \end{cases}$$

. $R = 5$, x, y, d.
.

: 1965 — -6 (,).
.
1970- .

. d ,
. Pixel_Round_Math_ru-RU.pdf, §5.

2.4 — 8

(i, j) , :

$$n_x = \text{clamp}(c_x,\ i,\ i{+}1), \qquad n_y = \text{clamp}(c_y,\ j,\ j{+}1)$$

, $\left(\frac{n_x - c_x}{r_x}\right)^2 + \left(\frac{n_y - c_y}{r_y}\right)^2 \leq 0{,}94.$
0,94, 1? 1 “ ”
. . ,
, — , .

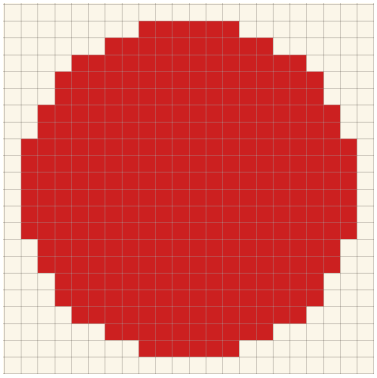
2.5 — 7

. Pixel Round:

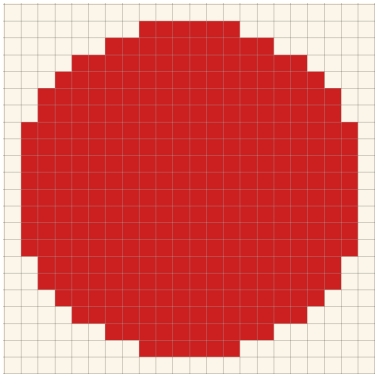
1. 16, .
2. . .
3. $\pi r^2 = 64\pi \approx 201{,}06$.
4. : $\frac{|S - S|}{S} \times 100\%$.
5. .

: 1%; ;

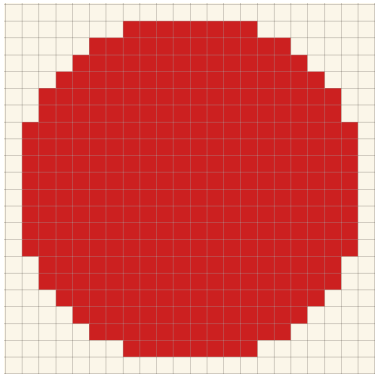
. .



(a)



(b)



(c)

. 1: 20 . , .

8.3 3 — “ : ”

; ;

.

3.1 — 2D 3D 15

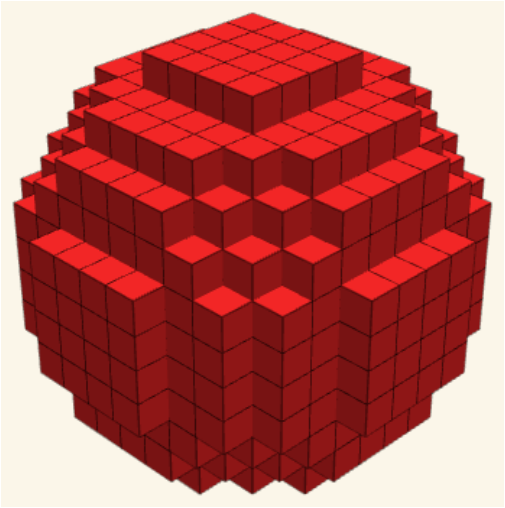
z. :

$$\left(\frac{x}{r_x}\right)^2 + \left(\frac{y}{r_y}\right)^2 + \left(\frac{z}{r_z}\right)^2 = 1$$

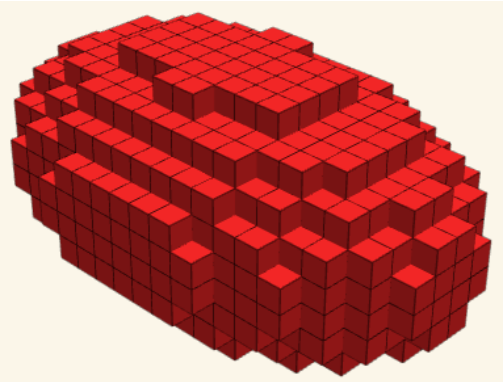
$r_x = r_y = r_z = r$ $x^2 + y^2 + z^2 = r^2$.
. (*volume element*). ,
:

$$a_x^2 + a_y^2 + a_z^2 \le 1, \quad a_\xi = \frac{\xi + \frac{1}{2} - c_\xi}{r_\xi}$$

. Pixel Round 3D, , ,
(*Classic*, *Smooth*, *Blocks*).



(a) $D = 12$ ($r_x = r_y = r_z = 6$).



(b) $W = 20, H = 10, D = 12$.

. 2: 3D- . — , .

3.2 — 15

— :

$$V = \frac{4}{3}\pi r_x r_y r_z$$

$r_x = r_y = r_z = r$ $V = \frac{4}{3}\pi r^3$.
(13 14).
:

1. 12 ($r = 6$): $V = \frac{4}{3}\pi \cdot 216 \approx 904{,}78$.
2. Pixel Round $D = 12$ . .
3. .

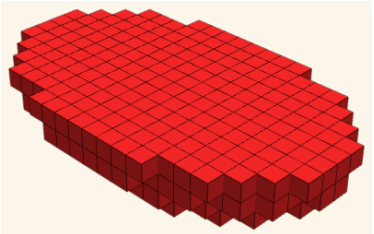
: V $/V$ $\to 1$ $D \to \infty$. D —
: .
.

3.3 — 8

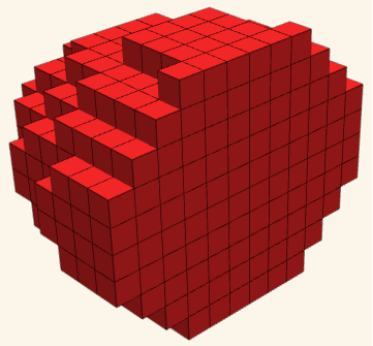
Pixel Round . — ,
:

X: $x \geq cut \Rightarrow$
Y: $y \geq cut \Rightarrow$
: $x + y \geq cut \Rightarrow$

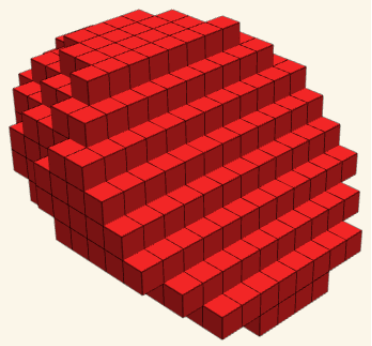
. Y 50%, X 50%.
50% — 45° xy.
: “ 0 $D_x + D_y$, D_x?
?”



(a) Y 50% ($y \geq 5$)



(b) X 50% ($x \geq 10$)



(c) ($x + y \geq 15$)

. 3: $(W = 20, H = 10, D = 12)$, 50% .
.

3.4 — - 7

XX .

:

- — “ ” (1915)
  .
- — 1920- .
- — “ III ” .

: “ .

. *Pixel Round,*

- , — , “ ”

. , *?”*

.

8.4 4 — “ : ”

; .

4.1 — 5

: “ ,

, *Pixel Round* (, ,).

, , , — .

, : *?* *?*

?”

: , .

4.2 — 30

:

- Pixel Round;
- , , ;
- (B, 5).

:

1. .
2. Pixel Round, PNG.
3. ( ).
4. .

: — “ *?*

?”

4.3 — 10

2 .

:

- ;
- ( ) ;
- 3D- — .

(3): — “ ; — ”.

.

9.

, .

.

9.1

1, 1.2. , ,

.

9.2

: , 1.4, 2.2, 2.5 3.2.

9.3

:

1. (B), 5 , 4.
2. (4.2) .

9.4

(4–5)	(3) / (2)
; ; - - . . Pixel Round ; 2D 3D; ; . 2D. - ; - (, , , .). ; ; . .	

9.5

- : 40%.
- : 50%.
- : 10%.

10.

10.1

. 2.3 , Python. (16 25) — .

10.2

. Pixel Round , . : .

10.3

Pixel Round . 12- ($2^{1/12} \approx 1{,}0595$). .

10.4

1965 — -6 , .
: , ,
. 11 .

11.

- . . . , № 6, 1971.
- . . . .: , 1967 [. 1976].
- . . . .: , 1946.
- . . 12.08.2022 № 732. .: 2022.
- . . . .: , 1989.
- . . .: , 1959 [. 1945].
- . . . .: , 2007.
- . . . .: , 2007.
- . ., ...: , 1996.
- Bresenham J. E. Algorithm for computer control of a digital plotter. *IBM Systems Journal*, vol. 4, no. 1, pp. 25–30, 1965.
- Pitteway M. L. V. Algorithm for drawing ellipses or hyperbolae with a digital plotter. *The Computer Journal*, vol. 10, no. 3, pp. 282–289, 1967.
- Pixel Round — : `docs_math/Pixel_Round_Math_ru-RU.pdf`.

A. Pixel Round

1.3 .

: 15 .

A.1 2D

1. Pixel Round. , .
2. **2D /** .
3. *Size* 10.
4. . : “ 10, 5, …, ”.
5. : / / . 30 .

A.2

1. . .
2. $W = 16$, $H = 8$.
3. : “ — $(x/8)^2 + (y/4)^2 = 1$. x 8, y — 4?”

A.3 3D

1. **3D /** , $D = 12$.
2. .
3. : .
4. : $W = 20, H = 10, D = 10$.
5. *Cut* Y, 50%.
6. . .

A.4

1. .

2. PNG.

3. — .

B.

. . Pixel Round, .
.

1 —

. $r = 7$. ,
, . .

a) $(3, 4)$: $(25 < 49)$.
b) $(5, 5)$: $(50 > 49)$.
c) $(0, 7)$: .
d) $(-7, 0)$: .

2 —

. $(5, 5)$ 5. $(1, 3)$:
?

: $(1{,}5;\ 3{,}5)$. : $\sqrt{14{,}5} \approx 3{,}81 < 5$. .

3 —

. Pixel Round 20 . .
πr^2. . . .

: $S = 100\pi \approx 314{,}16$. : $< 2\%$. : 5–8%.

4 —

. $r_x = 4$, $r_y = 6$, $r_z = 3$.

a) .
b) Y, 50% , .
c) y.

: ( ) $V = 96\pi \approx 301{,}59$. ( ) $\approx 150{,}80$. ( ) $y < cut$, $cut = 6$.

5 —

. :

(1) .
(2) : ? ? , ?
(3) 3D- ? , .

C.

,

. ; .

C.1

1	Pixel Round (1.3) $D = 10$ (A2).
2	(2.5) $D = 16$; .
3	3D- (3.1, 3.2) $(z = 0, 1, 2, ...)$ . .
4	Pixel Round (4.2) - . (4.3) .

C.2 ( )

- A3 30×30, .
- 4 A4 (5).
- $D = 16$, Pixel Round, .

C.3

- .

, :

- - (, - № 239, № 131 , № 2): . §7.
- : , .
- : , .

D.

- — , . Pixel Round — .
- — , 1965 (IBM) , (,). — .
- **Canvas ( )** — HTML- , .
- — $F(x, y) = 0$, . : $(x/r_x)^2 + (y/r_y)^2 - 1 = 0$.
- — *picture element.* ; 1×1.
- **PWA — Progressive Web App** — - , - . Pixel Round PWA.
- — (2D) (3D).
- — C: C . — $r_x = r_y$.
- **12-** — 12 . : $\sqrt[12]{2} \approx 1{,}0595$. .
- — *volume element.* : $1 \times 1 \times 1$.
- **WebGL** — . Pixel Round *three.js*.

— —