CG

Mandavi

PAGE No. 23

DATE / /

Assignment 1

Q1: Choose Correct Options / Fill in the blanks

a. iii -1/m and 1
b. E G A is Enhanced Graphics Adapter
c. iv. All quadrants
d. G U I is Graphical User Interface
e. iii Frame Buffer

Q2: Choose correct options / Fill in the blanks

a. Raster images are commonly called as

Ans: ii. Bit map

b. 4-bits are assigned to hold 16 colour values.

c. Pixel mask means

Ans: iii) A string containing 1 and 0.

d. In Raster Scan display, electronic beam is moved all over the screen one scan line at a time.

e. Which devices provides positional information to the graphics system?

Ans: c. Pointing Devices

Q3. State whether the following statements are true or false (Give reasons).

a. Bresanham's line drawing algorithm works on integer values only.

Ans: a) True. Bresenham's line algorithm is a line drawing algorithm that determines the points of an n-dimensional raster that should be selected in order to form a close approximation to a straight line between 2 points

b. Cartography is not one of the applications of Computer Graphics.

Ans: b) False. Cartography is drawing of maps.

c. Mid point circle algorithm follows 4-way symmetry to draw point

on circumference of circle.

Ans: a) True.

Q4. Name the following or define or design the following.

a. Resolution - It is the number of pixels contained on a display monitor, expressed in terms of the number of pixels on the horizontal axis and the number on the vertical axis.

b. Scan conversion - The process of representing continuous graphics objects as a collection of discrete pixels is known as scan conversion.

c. Aspect Ratio - The aspect ratio of an image is the ratio of its width to its height.

Q5. Answer the following questions in brief (20 to 30 words)

a. Write difference between Random and Raster Scan.

Ans:

Random Scan	Random Scan
• Directed towards the portions of the screen where a picture is to be rendered.	Swept across the screen and handles one row at a time and in downward direction.
• Resolution is good, as this produces even lines drawing.	Resolution is poor, since it generates meander lines which are organised as distinct point sets.
• Unable to display realistic shaded scenes.	effectively displays realistic scenes.
• Picture rendering is done with help of mathematical functions.	Picture rendering is done using pixels.

b. Define the following terms: Phosphorescence and Flourescence.

Ans: Phosphorescence – It is a process in which energy absorbed by a substance is released slowly in the form of light.

Fluorescence – It is a term used to describe the light given off by a phosphor after it has been exposed to a high-energy electron beam.

c. What do you mean by rasterization in Computer Graphics?

Ans: Rasterization is the task of taking an image described in a vector graphics format and converting it into a raster image.

Q6. Answer the following questions in brief (50 to 70 words)

a. Rasterize the line segment using DDA line drawing algorithm. The two endpoints coordinates of the line segment are P1(0, 0) and P2 (5, 2)

Ans: Consider one point of the line as (X_0, Y_0) and the second point of the line as (X_1, Y_1)

```
// calculate dx, dy
dx = x1 - x0 = 5-0=5
dy = y1 - y0 = 2-0=2
steps = abs(dx) > abs(dy) ? abs(dx) : abs(dy);
      = abs(dx)
      = 5
// calculate increment in x & y for each steps
Xinc = dx / (float) steps;
Yinc = dx / (float) steps;

Xinc = 5/5 = 1
Yinc = 2/2 = 1

// Put pixel for each steps
X = X0;
Y = Y0;
for (int i=0; i<=steps; i++)
{
    putpixel (round(X), round(Y), WHITE);
    X += Xinc;
    Y += Yinc;
}
X = 0+1 = 1
Y = 0+1 = 1
```

b) Derive and explain midpoint ellipse drawing algorithm.

Ans: Midpoint ellipse Algorithm -

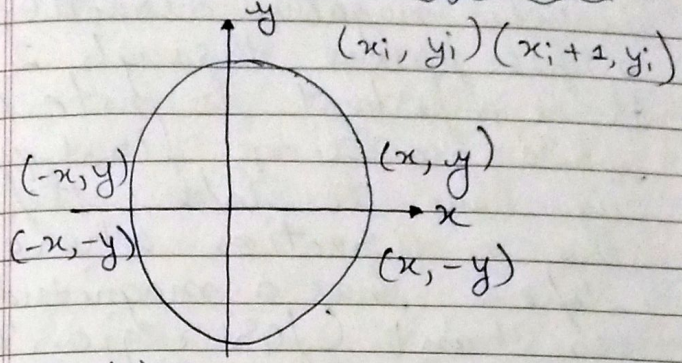


Fig (a) Four way symmetry of Ellipse

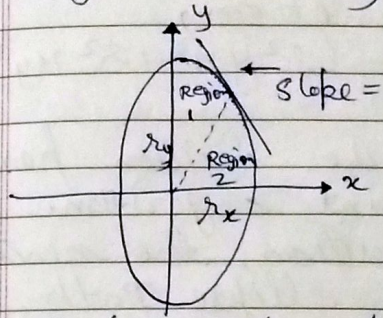


Fig (b) Ellipse processing regions

The midpoint ellipse drawing algorithm uses the four way symmetry of the ellipse to generate it. The figure (a) shows the 4-way symmetry of ellipse. This approach is similare to that used in displaying a raster circle. Here, the quadrant of the ellipse with $r_x < r_y$. As ellipse is drawn from 90 to 0 degrees, the x moves in

the Positive direction and y moves in the negative direction, and ellipse passes through 2 regions. It is important to note that while processing first quadrant we have to take steps in the y direction where the slope has a magnitude greater than 1 (for region 2). Like circle function, the ellipse function,

$f_{ellipse}(x, y) = (r_y^2 x^2 + r_x^2 y^2 - r_x^2 r_y^2)$

serves as the decision parameter in the midpoint algorithm. At each sampling position, the next pixel along the ellipse Path is selected according to the sign of the ellipse function evaluated at midpoint between the 2 candidate pixels $(x_i + 1, y_i)$ or $x_i + 1, y_i - 1$ for region 1 and $x_i, y_i - 1$ or $x_i + 1, y_i - 1$ for region 2. Starting at $(0, r_y)$ we have to take unit steps in the x direction until we reach the boundary between region 1 & 2. Then we have to switch to unit steps in the -y direction over the remainder of the curve in the first

quadrant. To check for boundary point between region 1 & 2 we have to test the value of the slope of the curve at each step. The slope of the ellipse at each step is given as $\frac{dy}{dx} = -\frac{2r_y^2 x}{2r_x^2 y}$

At the boundary point between region 1 & 2, $dy/dx = -1$ and

$2 r_y^2 x = 2 r_x^2 y$

$\therefore$, when $2 r_y^2 x \geq 2 r_x^2 y$

$r_y^2 x^2 + r_x^2 y^2 - r_x^2 r_y^2$

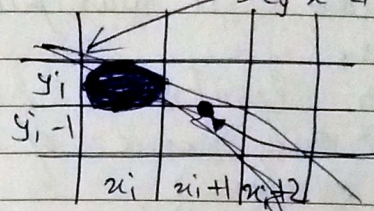


Fig (c)

we have to switch to unit steps in the y direction over the remainder of the curve in the first quadrant. the figure (c) shows the midpoint between the 2 candidate pixels at sampling position $x_i + 1$ in the first region. The next position along the ellipse path can be evaluated by decision parameter at this midpoint.

$d_{1i} = f_{ellipse}\left(x_i + 1, y_i - \frac{1}{2}\right)$

$= r_y^2 (x_i + 1)^2 + r_x^2 \left(y_i - \frac{1}{2}\right)^2 - r_x^2 r_y^2$

c. What is computer graphics? Discuss application areas in computer graphics.

Ans: Computer graphics is ~~the~~ an art of drawing pictures on computer screens with the help of programming. It involves computations, creation and manipulation of data. In other words, we can say that computer graphics is a rendering tool for generation and manipulation of images.

Computer graphics has numerous applications, some of which are listed below:

- Computer graphics user interface (GUIs) - A graphic, mouse-oriented paradigm which allows the user to interact with a computer.
- Computer presentation graphics - "A picture is worth a thousand words"
- Cartography - Drawing maps
- Weather Maps - Real-time mapping, symbolic representations
- Satellite Imaging - Geodesic Images
- Photo Enhancement - Sharpening blurred photos.

Q7) Think and Answer

a. What is Antialiasing? Is it useful for Computer Graphics?

Ans. Antialising is a technique used in computer graphics to remove the aliasing effect. The aliasing effect is the appearance of "jagged edges" or "jaggies" in a rasterized image. Yes it is useful for computer graphics

b) Calculate pixel positions along a straight line between A(20, 20) and B(10, 12) using Bresenham's line drawing method.

Ans: Taking $(x_0, y_0) = (10, 12)$ and $(x_n, y_n) = (20, 20)$

$dx = x_n - x_0 = 20 - 10 = 10$

$dy = y_n - y_0 = 20 - 12 = 8$

$p_k = 2dy - dx = 2 \times 8 - 10 = 6$

As $p_k > 0$,

1) $p_{k+1} = p_k + 2dy - 2dx$
$= 6 + 2 \times 8 - 2 \times 10$
$= 2$
$x_{k+1} = x_k + 1 = 10 + 1 = 11$
$y_{k+1} = y_k + 1 = 12 + 1 = 13$

2) $p_{k+1} = p_k + 2dy - 2dx = 2 + 2 \times 8 - 2 \times 10 = -2$
$x_{k+1} = x_k + 1 = 11 + 1 = 12$
$y_{k+1} = y_k + 1 = 13 + 1 = 14$

3) As $p_k < 0$
$p_{k+1} = p_k + 2dy = -2 + 2(8) = 14$
$x_{k+1} = x_k + 1 = 12 + 1 = 13$
$y_{k+1} = y_k = 14$

4) As $p_k > 0$
$p_{k+1} = p_k + 2dy - 2dx = 14 + 2(8) - 2(10) = 10$
$x_{k+1} = x_k + 1 = 13 + 1 = 14$
$y_{k+1} = y_k + 1 = 14 + 1 = 15$

p_k	p_{k+1}	x_{k+1}	y_{k+1}
		10	12
6	2	11	13
2	−2	12	14
−2	14	13	14
14	10	14	15
10	6	15	16
6	2	16	17
2	−2	17	18
−2	14	18	18
14	10	19	19
10	6	20	20

5) As $p_k > 0$
$p_{k+1} = p_k + 2dy - 2dx = 10 + 2 \times 8 - 2 \times 10 = 6$
$x_{k+1} = x_k + 1 = 14 + 1 = 15$
$y_{k+1} = y_k + 1 = 15 + 1 = 16$

6) As $p_k > 0$
$p_{k+1} = p_k + 2dy - 2dx = 6 + 2(8) - 2(10) = 2$
$x_{k+1} = x_k + 1 = 15 + 1 = 16$
$y_{k+1} = y_k + 1 = 16 + 1 = 17$

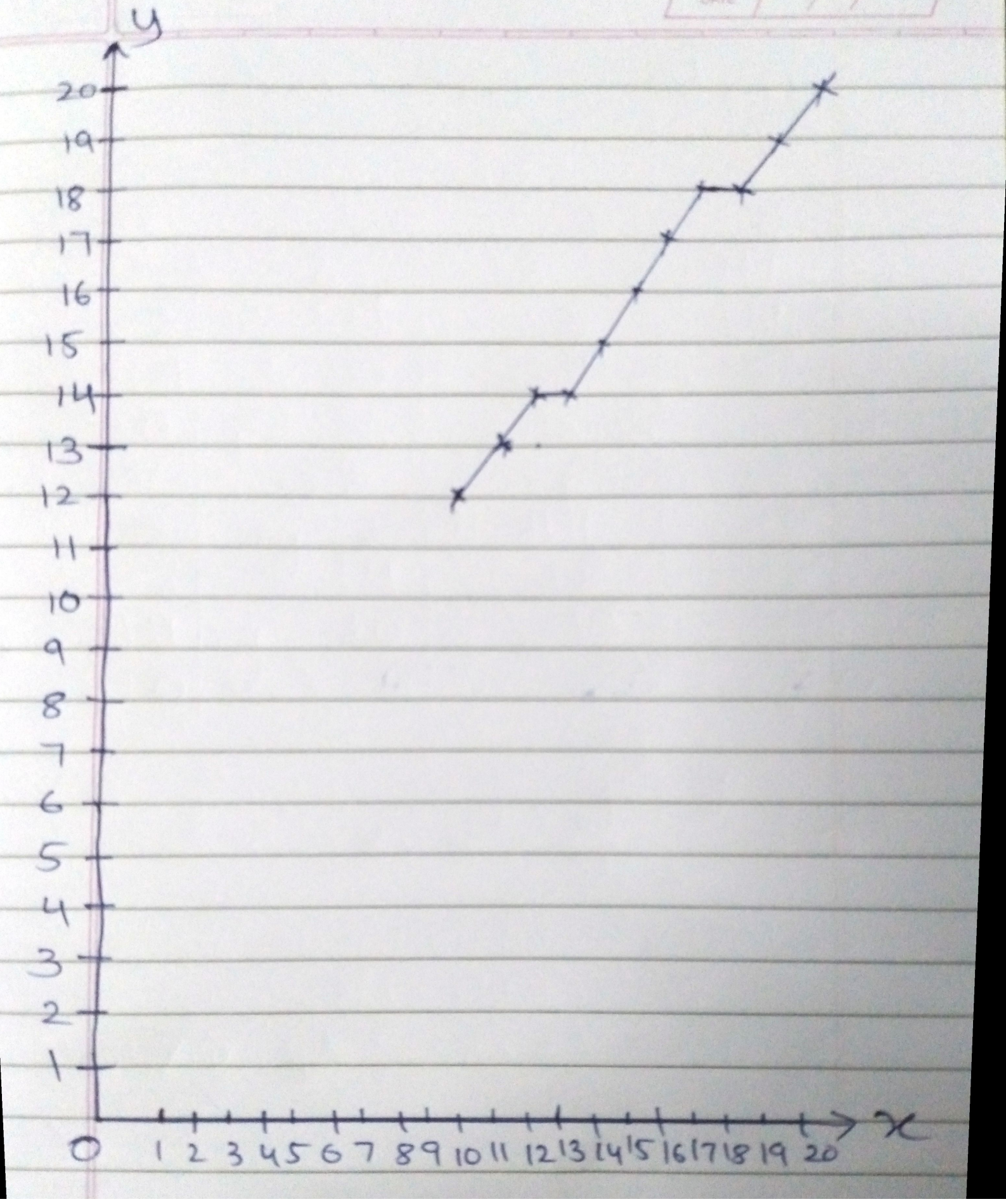
7) As $p_k > 0$
$p_{k+1} = p_k + 2dy - 2dx = 2 + 2(8) - 2(10) = -2$
$x_{k+1} = x_k + 1 = 16 + 1 = 17$
$y_{k+1} = y_k + 1 = 17 + 1 = 18$

8) As $p_k < 0$

$p_{k+1} = p_k + 2dy = -2 + 2(8) = 14$
$x_{k+1} = x_k + 1 = 17 + 1 = 18$.
$y_{k+1} = y_k = 18$

9) As $p_k > 0$
$p_{k+1} = p_k + 2dy - 2dx = 14 + 2(8) - 2(10)$
$= 10$
$x_{k+1} = x_k + 1 = 18 + 1 = 19$
$y_{k+1} = y_k + 1 = 18 + 1 = 19$

10) $p_{k+1} = p_k + 2dy - 2dx = 10 + 2(8) - 2(10)$
$= 6$
$x_{k+1} = x_k + 1 = 19 + 1 = 20$
$y_{k+1} = y_k + 1 = 19 + 1 = 20$.


y
20
19
18
17
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O
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
x

Q8 My Ideas

a. Given radius r=12 and center coordinates (50, 50), compute the coordinates of points lying on the circle using mid point circle algorithm.

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

$x^2+y^2-r^2=0$

$x^2+y^2-144=0$

$x=0$, $y=r=12$ and $d=1-r=1-12$

$=-11$

Plot (0, 12)

Iteration 1:

As $d<0$, update d as

$d=d+2x+3$

$d=-11+2(0)+3=-8$

Increment x, $x+=1$

$x=0+1=1$

No change in y, $y=12$

Plot (1, 12)

Iteration 2:

As $d<0$, update d as

$d=d+2x+3$

$d=-8+2(1)+3$

$d=-3$

Increment x, $x=x+1$

$x=1+1=2$

No change in y, $y=12$

Plot (2, 12)

Iteration 3:

As $d<0$, update d as

$d=d+2x+3$

$d=-3+2(2)+3$

$=4$

Increment x, $x=x+1$

$x=2+1$

$=3$

No change in y, $y=12$

Plot (3, 12)

Iteration 4:

As $d>0$, update d as

$d=d+2(x-y)+5$

$d=4+2(3-12)+5$

$=4-18+5=-9$

Increment x, $x=x+1=3+1=4$

Decrement y, $y=12-1=11$

Plot (4, 11)

Iteration 5:

As $d<0$, update d as

$d=d+2x+3$

$=-9+2(4)+3$

$=2$

Increment x, $x+=1=4+1=5$

No change in y, y=11
Plot (5, 11)

Iteration 6:
As d>0, update d as
d = ~~d+2x+3~~ d+2(x-y)+5
= 2+2(5-11)+5
= -5
Increment x, x = x+1
= 5+1=6
Decrement y, y = 11-1=10
Plot (6, 10)

Iteration 7:
As d<0, update d as
d = d+2x+3
= -5+2(6)+10 = 17
Increment x, x = x+1 = 6+1=7
No change in y, y = 10
Plot (7, 10)

Iteration 8:
As d>0, update d as
d = d+2(x-y)+5
= 17+2(7-10)+5
= 16
Increment x, x = x+1 = 7+1=8
Decrement y, y = 10-1=9
Plot (8, 9)

Iteration 9:

As d>0, update d as
d = d+2(x-y)+5
= 16+2(8-9)+5
= 19
Increment x, x = x+1
= 8+1=9
Decrement y, y = 9-1=8
Plot (9, 8)
Check whether x<y, that is 9<8, which is false. Hence algorithm stops here.

b) Plot the points for midpoint ellipse with $r_x = 8$, and $r_y = 6$ for region 1.

Ans: Initial point for region 1 $(0, r_y)$
$= (0, 6)$
$2r_y^2 x = 0$ (with increment value $2r_y^2 = 2(6)^2 = 72$)
$2r_x^2 y = 2r_x^2 r_y = 2(8)^2(6)$ with increment value $-2r_x^2 = -2(8)^2 = -128$)
The initial decision parameter for region 1 $p_{1_0} = r_y^2 - r_x^2 r_y + \frac{1}{4} r_x^2$

$= (6)^2 - (8)^2(6) + \frac{1}{4}(8)^2$

$= -12$

PAGE No. 23
DATE / /

k	p_k	(x_{k+1}, y_{k+1})	$2r_y^2 x_{k+1}$	$2r_x^2 y_{k+1}$
0	-92	(1, 6)	72	768
1	30.2	(2, 6)	144	768
2	13	(3, 5)	216	640
3	-22.2	(4, 5)	288	640
4	-51	(5, 4)	360	512
5	-77.7	(6, 3)	432	384