Computergrafik SS 2016
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Vorlesung vom 11.04.2016

noch Kapitel 3:
2D-Grundlagen

VectorLine

```
int x1,y1,x2,y2,x,y,dx,dy;
double r, step;

dy = y2-y1;
dx = x2-x1;

step = 1.0/Math.sqrt(dx*dx+dy*dy);
for (r=0.0; r <= 1; r=r+step) {
  x = (int)(x1+r*dx+0.5);
  y = (int)(y1+r*dy+0.5);
  setPixel(x,y);
}
```

StraightLine

von links nach rechts

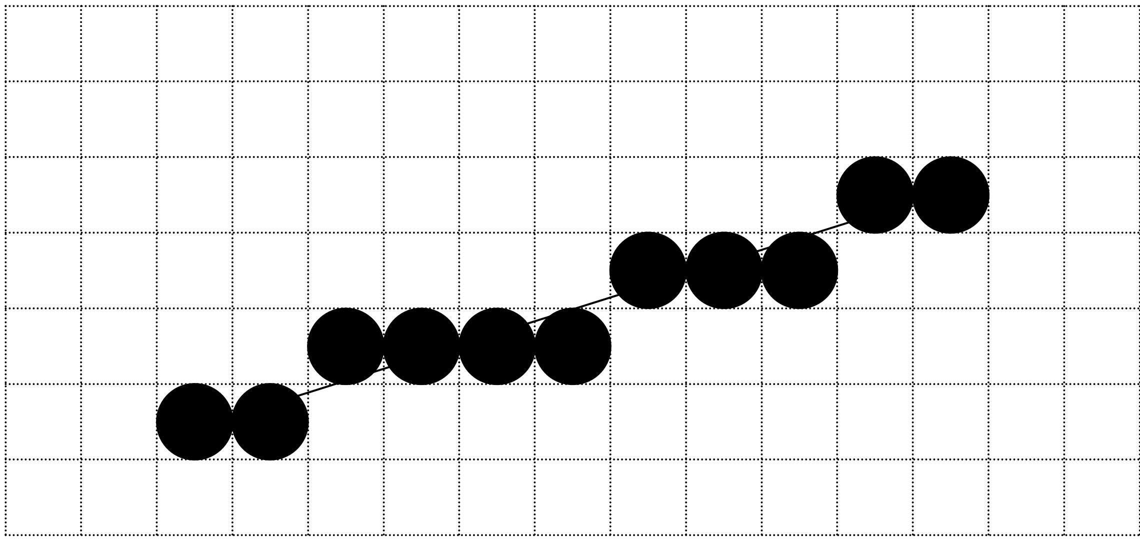
```
s = (double)(y2-y1)/(double)(x2-x1);
c = (double)(x2*y1-x1*y2)/(double)(x2-x1);

for (x=x1; x <= x2; x++) {
  y = (int)(s*x+c+0.5);
  setPixel(x,y);
}
```

Bresenham

Steigung $s = \Delta y / \Delta x$

Fehler $error = y_{ideal} - y_{real}$



BresenhamLine, die 1.

```
dy = y2-y1; dx = x2-x1;
s = (double)dy/(double)dx;
error = 0.0;
x = x1;
y = y1;
while (x <= x2){
  setPixel(x,y);
  x++;
  error = error + s;
  if (error > 0.5) {
    y++;
    error = error – 1.0;
  }
}
```

BresenhamLine, die 2.

```
dy = y2-y1; dx = x2-x1;
s = (double)dy/(double)dx; delta = 2*dy
error = 0.0;
x = x1;
y = y1;
while (x <= x2){
  setPixel(x,y);
  x++;
  error = error + s;          delta
  if (error > 0.5) {          dx
    y++;
    error = error - 1.0;      2*dx
  }
}
```

multipliziere Steigung mit 2dx

BresenhamLine, die 3.

```
dy = y2-y1; dx = x2-x1;
s = (double)dy/(double)dx;
error = 0.0;
x = x1;
y = y1;
while (x <= x2){
  setPixel(x,y);
  x++;
  error = error + s;
  if (error > 0.5) {
    y++;
    error = error - 1.0;
  }
}
```

delta = 2*dy -dx

schritt = -2*dx

delta

~~dx~~ 0

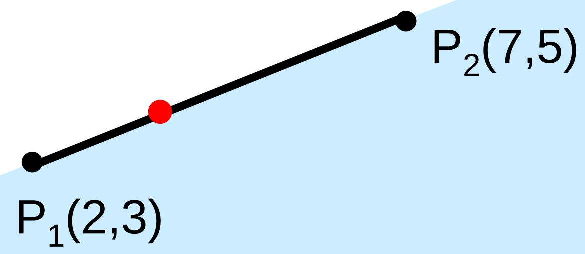
~~2*dx~~

+ schritt

Verschiebe error um dx nach unten. Führe Variable schritt ein

Punkt versus Gerade

$$\begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} 2 \\ 3 \end{pmatrix} + r \cdot \begin{pmatrix} 7-2 \\ 5-3 \end{pmatrix} \qquad \vec{u} = \vec{p_1} + r \cdot \vec{v}$$



$$\begin{aligned} x &= 2 + 5r \\ y &= 3 + 2r \\ 2x &= 4 + 10r \\ 5y &= 15 + 10r \\ -2x + 5y &= 11 \\ -2x + 5y - 11 &= 0 \end{aligned}$$

$F(x,y)$ $=$ 0 falls P auf der Geraden

$>$ 0 falls P links von der Geraden

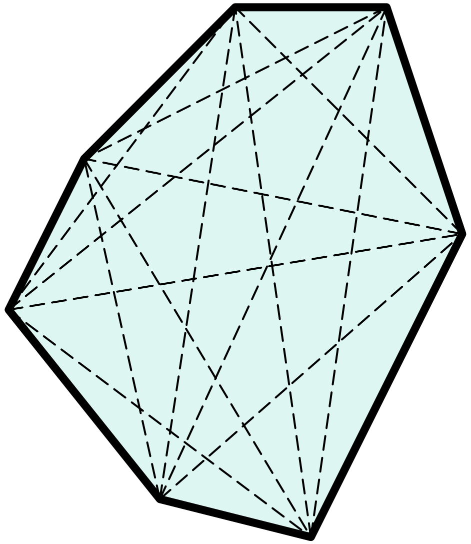
$<$ 0 falls P rechts von der Geraden

$$\begin{pmatrix} x \\ y \end{pmatrix} \cdot \begin{pmatrix} -2 \\ 5 \end{pmatrix} - 11 = 0$$

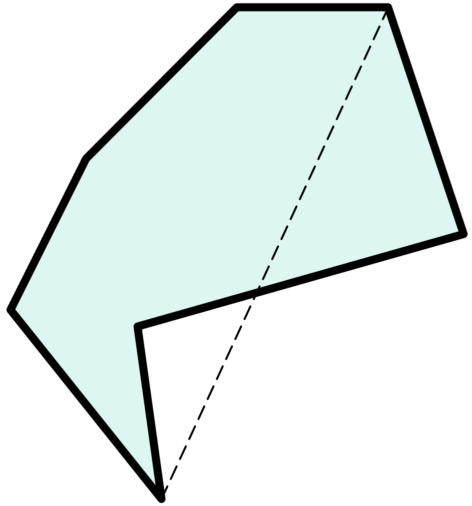
Skalarprodukt

Was hat dieser Vektor mit der ursprünglichen Gerade zu tun ?

Polygon

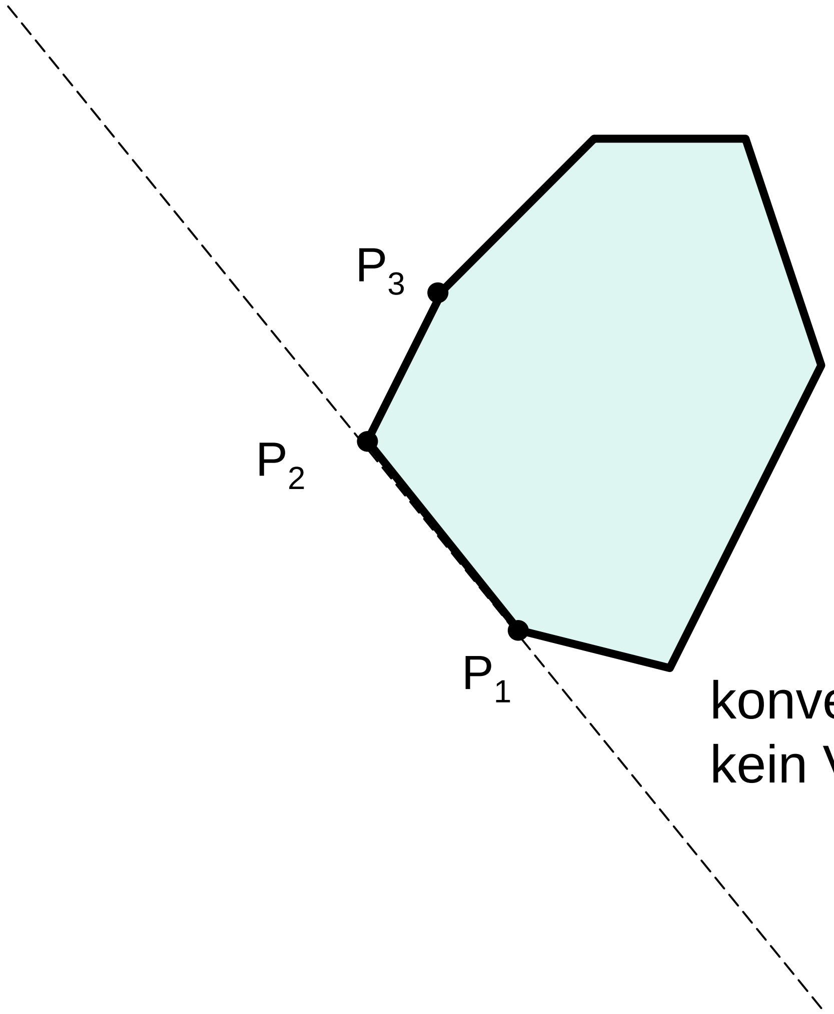


konvex



konkav

Konvexitätstest nach Paul Bourke



konvex, falls für alle P(x,y)
kein Vorzeichenwechsel bei F(x,y)

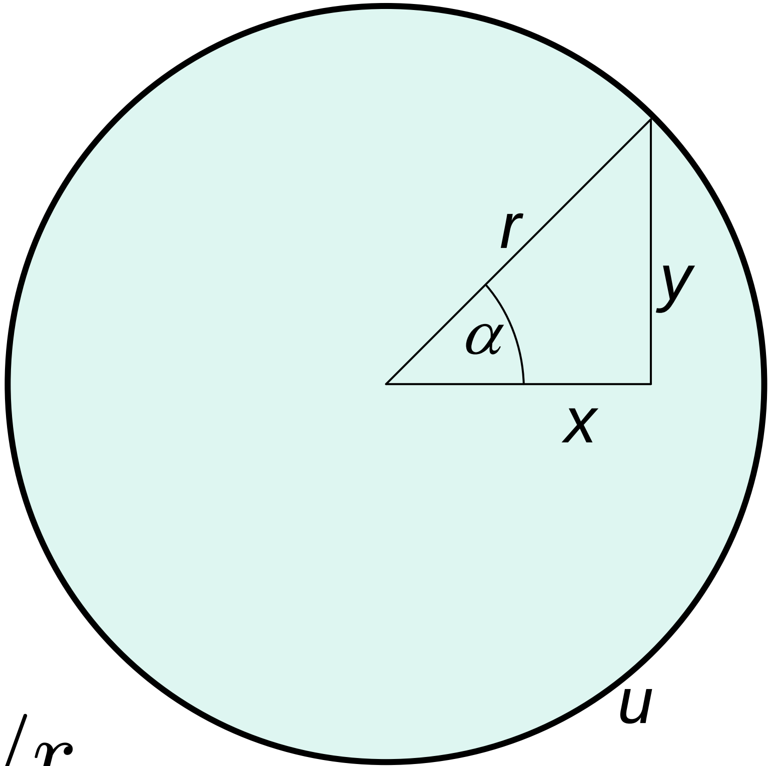
Kreis um (0,0), parametrisiert

$$x = r \cdot \cos(\alpha)$$

$$y = r \cdot \sin(\alpha)$$

$$u = 2 \cdot \pi \cdot r$$

$$step = \frac{2 \cdot \pi}{2 \cdot \pi \cdot r} = 1/r$$



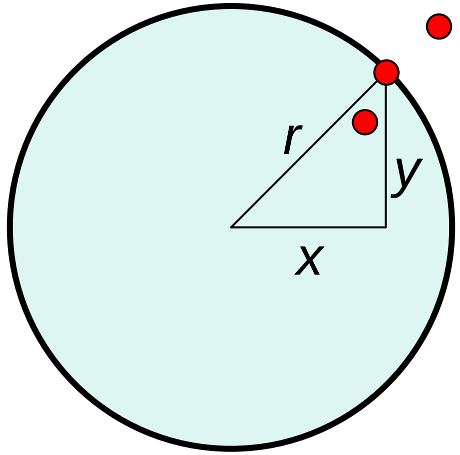
TriCalcCircle

```
double step = 1.0/(double r);
double winkel;

for (winkel = 0.0;
     winkel < 2*Math.PI;
     winkel = winkel+step){

  setPixel((int) r*Math.cos(winkel)+0.5,
           (int) r*Math.sin(winkel)+0.5);
}
```

Punkt versus Kreis



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

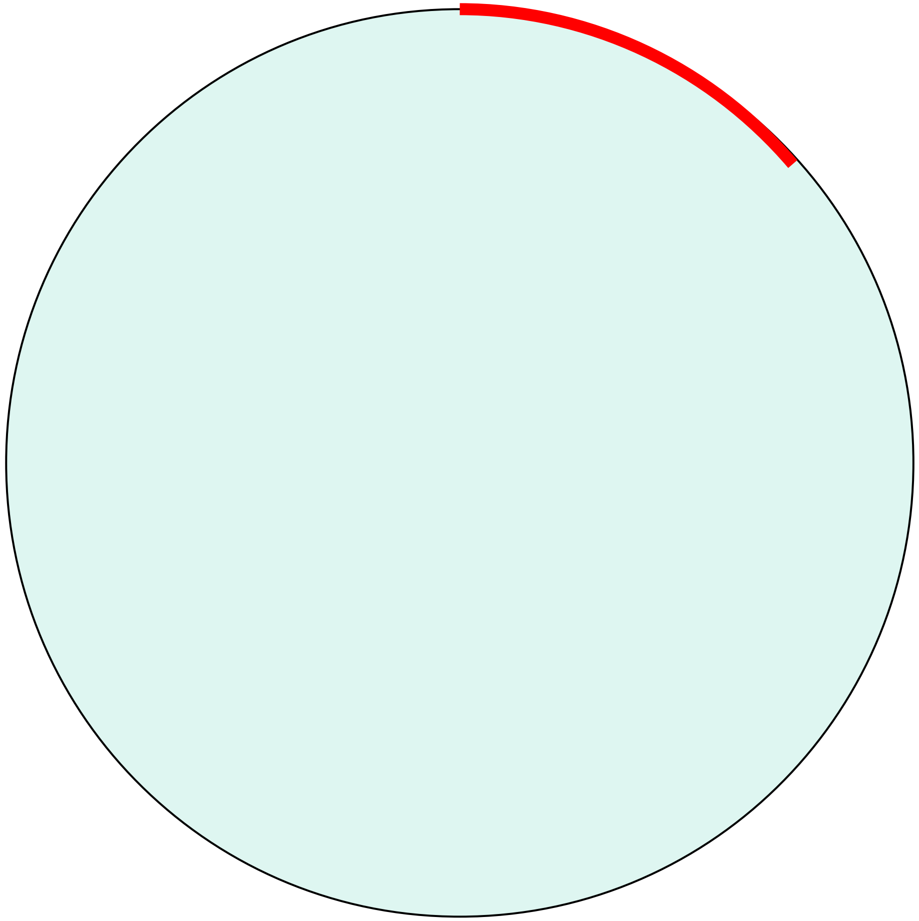
$$F(x,y) = x^2 + y^2 - r^2$$

$F(x,y) = 0$ für (x,y) auf dem Kreis

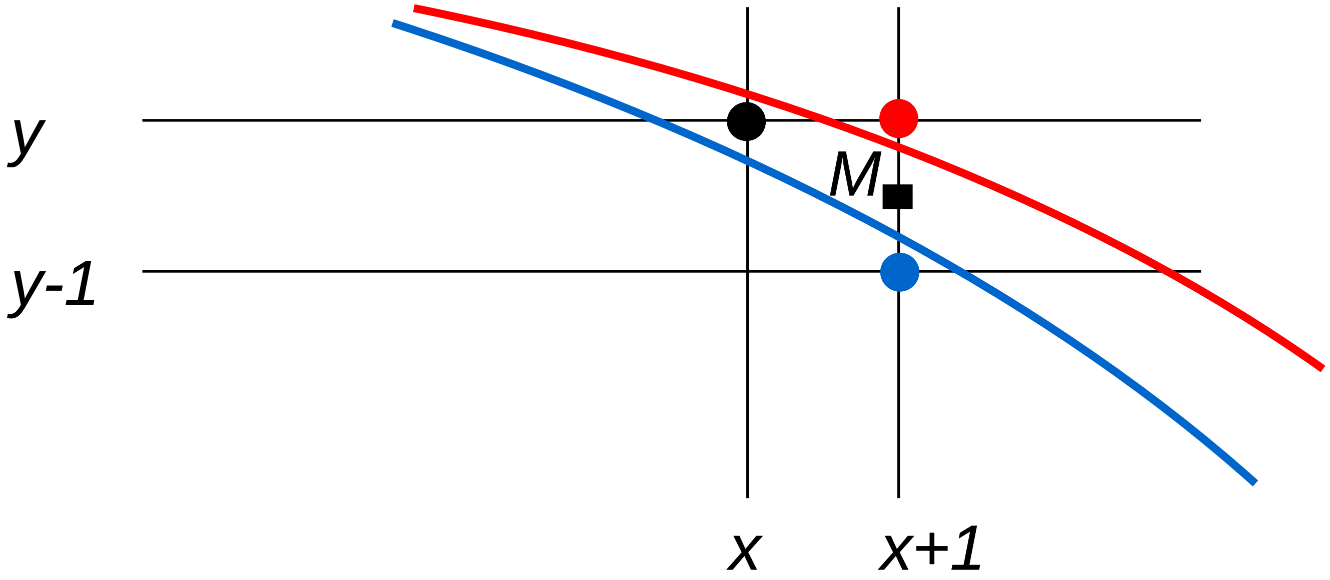
< 0 für (x,y) innerhalb des Kreises

> 0 für (x,y) außerhalb des Kreises

Kreis im 2. Oktanden



Entscheidungsvariable Δ



$\Delta = F(x+1, y-½)$

$\Delta < 0 \Rightarrow M$ liegt innerhalb $\Rightarrow$ wähle $(x+1,y)$

$\Delta \geq 0 \Rightarrow M$ liegt außerhalb $\Rightarrow$ wähle $(x+1,y-1)$

Berechnung von Δ

$\Delta = F(x+1, y-½) = (x+1)^2+(y-½)^2-r^2$

$\Delta < 0 \Rightarrow$

$\Delta' = F(x+2, y-½) = (x+2)^2+(y-½)^2-r^2 =$

$\Delta+2x+3$

$\Delta \geq 0 \Rightarrow$

$\Delta' = F(x+2, y-3/2) = (x+2)^2+(y-3/2)^2-r^2 =$

$\Delta+2x-2y+5$

Startwert $\Delta = F(1, r-½) = 1^2+(r-½)^2 - r^2 =$

$5/4-r$

BresenhamCircle, die 1.

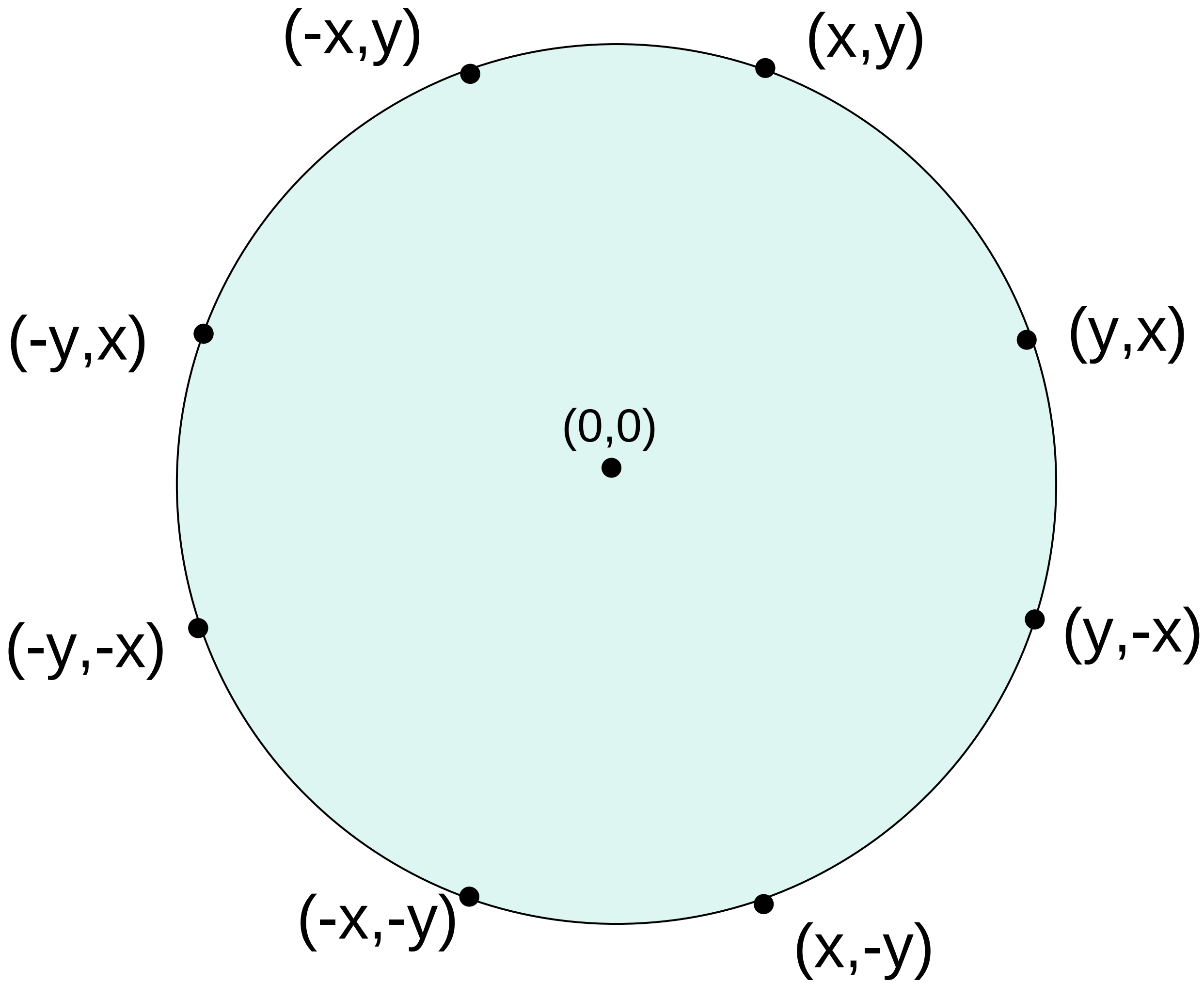
```
x = 0;
y = r;
delta = 5.0/4.0 - r;
while (y >= x) {
  setPixel(x,y);
  if (delta < 0.0) {
    delta = delta + 2*x + 3.0;
    x++;
  else {
    delta = delta + 2*x - 2*y + 5.0;
    x++;
    y--;
  }
}
```

BresenhamCircle, die 2.

```
x = 0;
y = r;
~~delta = 5.0/4.0 - r;~~                     d = 1 - r;
                                             dx = 3;
                                             dxy = -2*r + 5;
while (y >= x) {
  setPixel(x,y);
  if (~~delta < 0.0~~) {                     (d <= 0.0)
    ~~delta = delta + 2*x + 3.0~~;           d = d + dx;
    x++;                                     dx = dx + 2;
  else {                                     dxy = dxy + 2;
    ~~delta = delta+2*x-2*y+5.0~~;           d   = d + dxy;
    x++;                                     dx  = dx + 2;
    y--;                                     dxy = dxy + 4;
  }
}
```

d:=delta-1/4 dx:=2x+3 dxy:= 2x-2y+5

Oktanden-Symmetrie



BresenhamCircle, die 3.

```
x=0; y=r; d=1-r; x=3; dx=3; dxy=-2*r+5;
while (y>=x){
   setPixel(+x,+y);
   setPixel(+y,+x);
   setPixel(+y,-x);
   setPixel(+x,-y);
   setPixel(-x,-y);
   setPixel(-y,-x);
   setPixel(-y,+x);
   setPixel(-x,+y);
  if (d<0) {d=d+dx;  dx=dx+2; dxy=dxy+2; x++;}
  else     {d=d+dxy; dx=dx+2; dxy=dxy+4; x++;
   y--;}
}
```

Source: ~cg/2016/skript/Sources/drawBresenhamCircle.jav

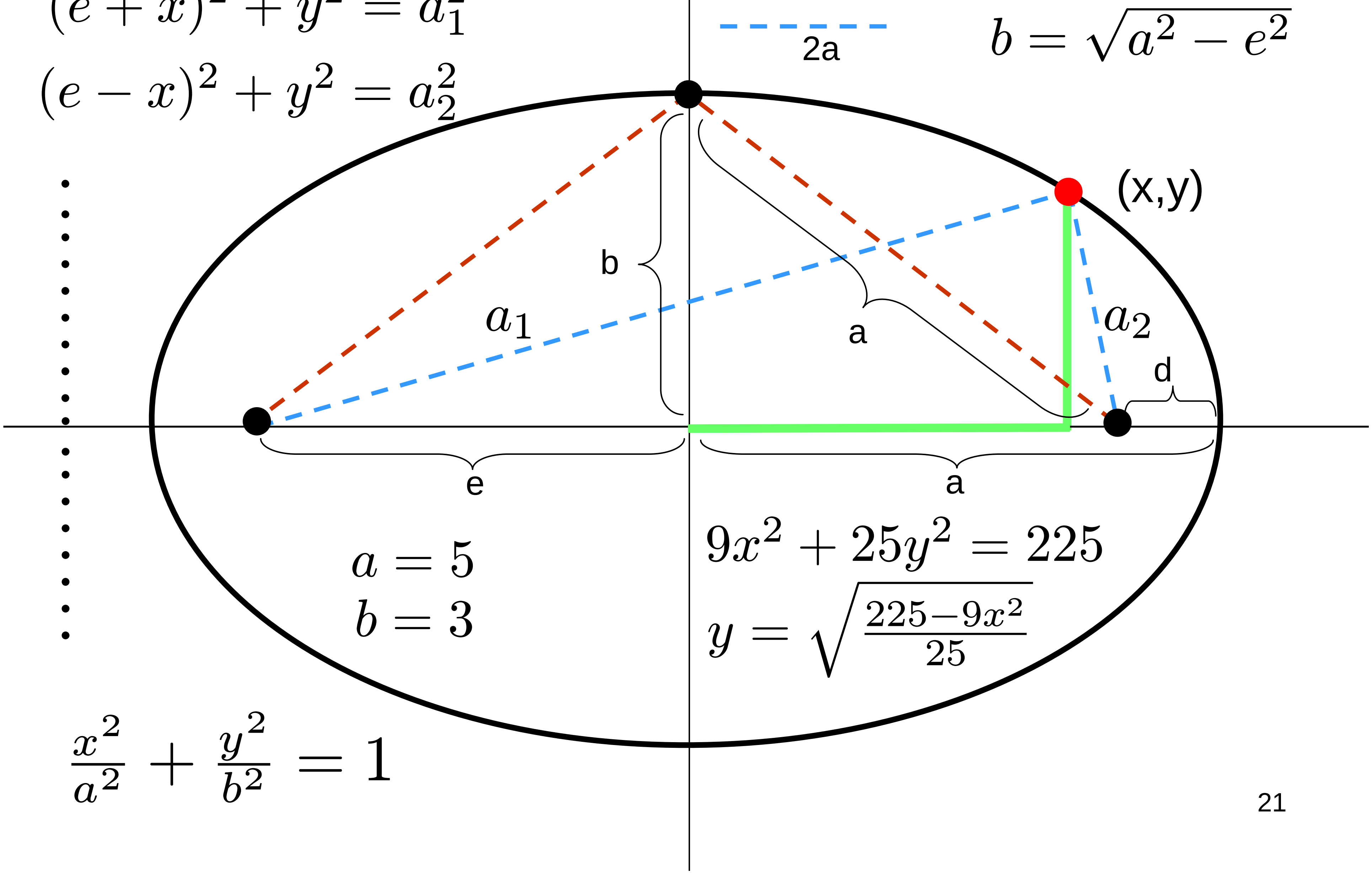
Java-Applet: ~cg/2016/skript/Applets/2D-basic/App.html

Ellipse um (0,0)

$$(e+x)^2 + y^2 = a_1^2$$

$$(e-x)^2 + y^2 = a_2^2$$

$$b = \sqrt{a^2 - e^2}$$



$$a = 5$$
$$b = 3$$

$$9x^2 + 25y^2 = 225$$

$$y = \sqrt{\frac{225 - 9x^2}{25}}$$

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$$