à la Mondrian

Abstract

Mondriaan has worked most of his live as an abstract painter, influenced by the magic realism of Jan Toorop, and by Cubism and Pointillism. He was member of De Stijl and has lived in Paris and in New York. Some of his work seems to have been composed randomly, though he was very precise, as witnessed by the overpainting of various squares in his Victory Boogie-Woogie. Mondriaan's `random' work `Composition in Line 1916`, is emulated and varied in MetaPost and PostScript, in color, with the lines (position and size) randomly chosen. He was the first painter to frame work by Lozenges. Division of the sides of his `Lozenge with 2 lines` is near to the golden ratio. Emulated Lozenges obeying the golden ratio have been included. The variations look nevertheless Mondriaan-esque.

Introduction

My applied math professor Hans Lauwerier[1] published in 1987, long after I finished my math education, *Fractals—meetkundige figuren in eindeloze herhaling*. It contained the following picture, which he called 'à la Mondriaan'[2]

Lauwerier used this picture to illustrate a very simple algorithm[3] for generating a pseudo-random number sequence in BASIC

> "... start with a four digit number, the seed, square it and delete the first and last two numbers, and repeat the process of squaring and deleting ..."

He randomly positioned (place, horizontally or vertically) the line pieces of random length. I'll improve on his picture with the use of a shade of color, and variation in line thickness. Moreover, I'll cadre by different frames.

Mondriaan

Mondriaan was born in 1872 at Amersfoort and started drawing à la nature.

```
        Meisje 1890              Winterswijk 1895
```

Jan Toorop has influenced Mondriaan by his new realism. Mondriaan was often a guest at Toorop's in Zeeland in the beginning of the 20th century; the (light at the) seashore inspired Mondriaan.

```
     Zeeland farmer 1909        Red Cloud 1907
```

```
     Arum Lilies 1909     Lighthouse WC 1908/9
```

Mondriaan exercised an oval as a boundary, not as a frame. The `Composition in Oval 1913` reminds me of the work of George Braque.
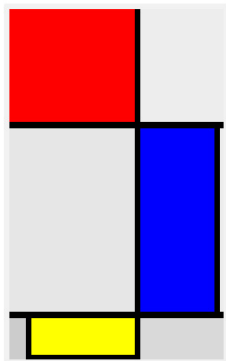

`Composition in Oval 1913`   `Composition in Oval 1914`

He has lived in Paris, 1919-1938, and was influenced by cubism and pointillism.
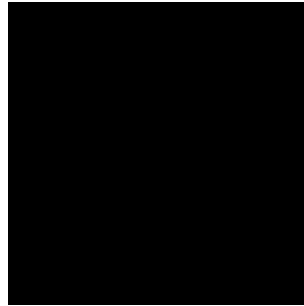
`Blossoming Apple Tree 1912`   `Beach with one Pier 1909`

I was familiar with some of Mondriaan's works from the 'De Stijl'[4] period, where he exercised the use of primary color panes and straight lines, which reminds me of stained glass windows.

emulation: `Large Composition with Red, Blue and Yellow 1928`

His series of `Lozenge`'s from the twenties, ended in a minimal one, given below at the right.
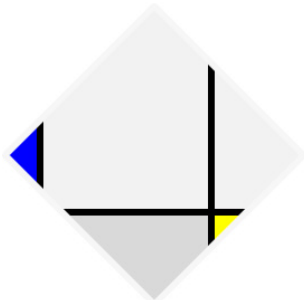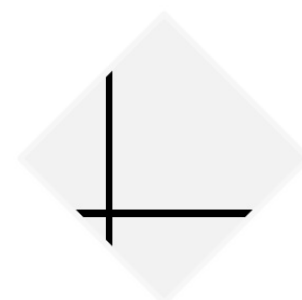
Lozenge with 3 lines 1925   Lozenge with 2 lines 1931

I measured his `Lozenges` and was suprised that he missed the divison of the sides by the golden ratio: his sides are divided in $3.9 : 5.6$; the golden ratio Φ does not hold, ie $3.9 : 5.6 \neq 5.6 : 9.5$. A tiny difference, but nonetheless.

Φ emulation Φ emulation

```
%Mondriaan-like Lozenge with 3 lines. Fall 2009 kisa1@xs4all.nl
beginfig(0)
s=200;
z1=(0,.5s); z2=(.5s,s); z3=(s,.5s); z4=(.5s,0);
z5=0.618/1.618[z2,z3]; z6=0.618/1.618[z3,z4];
z7= 1/1.618[z3,z4]; z8=1/1.618[z4,z1];
z9=0.382/1.618[z1,z4]; z10=0.382/1.618[z1,z2];
z11= (z5--z7) intersectionpoint (z6--z8);
path p; p = z1--z2--z3--z4--cycle;
pw=4; pickup pencircle scaled pw;
fill p withcolor .95white;
fill z1--z10--z9--cycle withcolor blue;
fill z7--z11--z6--cycle withcolor red+green;
fill z8--z11--z7--z4--cycle withcolor .85white;
draw z5--z7;
draw z6--z8;
draw z9--z10;
clip currentpicture  to p;
draw p withcolor .97white;
endfig
end
```

For the right Lozenge the main part of the above reads

```
fill p withcolor .95white;
draw z5--z7;
draw z6--z8;
clip currentpicture  to p;
draw p withcolor .97white;
```

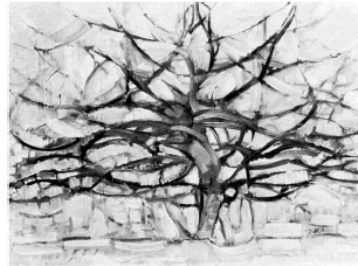*Remark.* In contrast with PostScript we don't have to translate the origin in MetaPost to somewhere in the middle.
For my last year's birthday Sveta and I composed the following à la Mondriaan invitation starting from the left Φ-Lozenge.

Not so long ago, I used one of his Apple trees, along with a little poetic proza, for our local gardeners bulletin. It is about one of our Apple trees, which in every season has something to offer:

- □ spring, blossoming beauty
- □ summer, healthy shade
- □ autumn, fruits to enjoy
- □ winter, beautiful silhouet à la Mondriaan.

Appelweelde

Bruingetinte
het is november,
zeldzaam zacht.
De appelboom
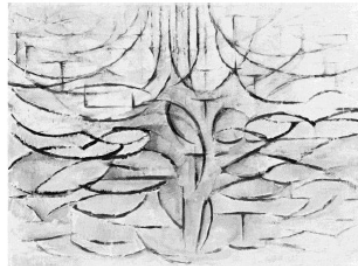majestueus,
met zijn takken
armen vol met
Wat een weelde,

bladeren op het gras
herfst, en

staat fier en
stevig geworteld,
als uitgespreide
appels.
wat een pracht!

Van de vroege, aangetaste appels heeft
deze reus zich al in juli en augustus ontdaan.
Nu hangen er nog een en al gave ponders,
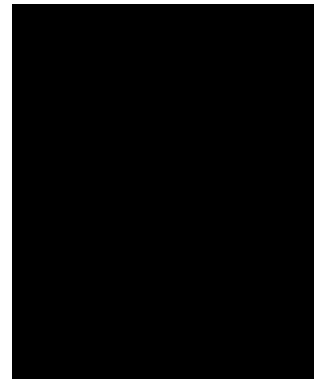tjokvol met sap.

Het is een
appelboom op en
tuin, een
jaar door:
bloesempracht in
schaduw in de
oogst in de
een Mondriaan
silhouet in de

rijkdom zo'n
ruime plek in de
genoegen het hele

de lente,
zomer,
herfst, en

winter.

His unfinished Victory Boogie-Woogie is shown on the cover of the biography about Mondriaan.

Mondriaan has the reputation to be very precise, and I was curious whether some of his works

"... could be generated randomly in color and nevertheless convey a Mondriaan impression ..."

although at the time he did not use color for the 'random' pictures given on the next page.

Composition in Line, 1916

Composition 10, 1915

Variation of Mondriaan's 'random' art

Is it random?

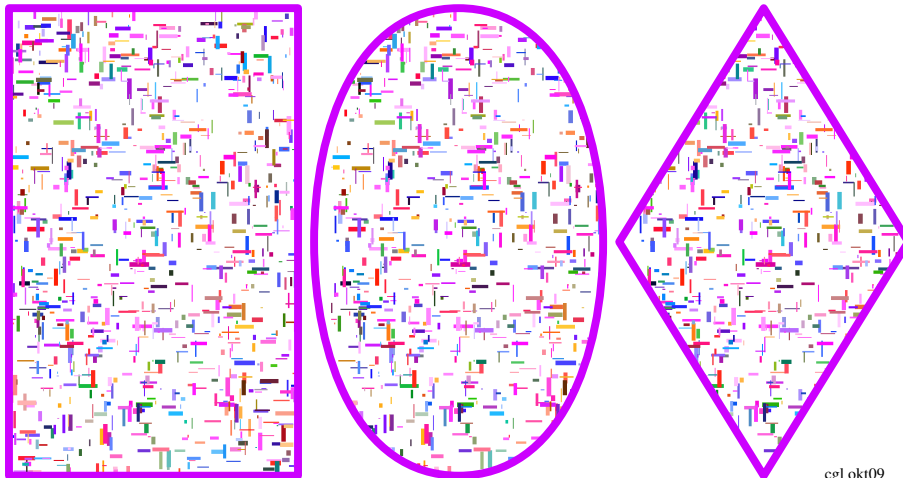As far as I understand it, his work was composed precisely, very precisely, as witnessed by his unfinished Victory Boogie-Woogie, where several squares have been painted over.

Square, Oval and Lozenge cadres.   I generated an abstract picture of lines, with a spread in size, thickness and with a color shade, such that the impression is blue-like, green-like,...

I intended these pictures as presents to my friends. Made them unique by using the date of birth (month and day) as seed for the pseudo-random number generator in MetaPost.[5] Colored the frame with their favorite color, which also biases the color shade.

Below is Sveta's one in pink, with 1007 as seed for the pseudo-random number generator.

cgl okt09

How to?

First, we have to decide on the size of the rectangle. Next the number of randoms. I chose 500, but that can be adjusted at will. The lines are drawn within a rectangle of 180 by 180 · 1.618, obeying the golden ratio. For the position in the rectangle the

random number generator must generate numbers between 0 0 180 ≈291, conform PostScript's BoundingBox convention to denote a rectangle.

uniformdeviate delivers a number between 0 and its argument. We have the intervals (0, u) and (0,v), so the invokes for the (x, y)-position read

```
hx:= uniformdeviate u;  hy:= uniformdeviate v;
```

I alternate between vertical and horizontal lines, where the lines have maximum length size=10, and maximum (pen)width pw=5pt. The actual size, horizontally as well as vertically, is determined by an invoke of uniformdeviate

```
draw (hx, hy)--(hx + uniformdeviate size, hy) withcolor rgb%vertical line
```

Line thickness is varied as follows:

```
pickup pencircle scaled ((uniformdeviate 1)*pw);
```

The most difficult part is the color, which I let vary a little around the chosen value, in order to generate a shade but ... gives the main color impression. I chose a multiplicative factor uniformdeviate 2 and called this spread.

To finish it up, I clip and border first to the rectangle, next to the oval, and finally to the diamond; all border increasingly the same pattern.

```
%Mondriaan-alike. Fall 2009 CGL
if scantokens(mpversion) > 1.005:  outputtemplate :=
else:                                  filenametemplate
fi                                        "%j.eps";
prologues:=3;
beginfig(0)
u:=180;    %rectangle u x v, golden ratio proportion
v:=1.618u;
size=10; pw=5;
n=500;     %number of randoms
path p.r,   %rectangle
       p.o,  %oval
       p.d; %diamond
picture  pic.r, pic.o, pic.d, signature;
defaultfont:="ptmr8r";
label.rt("cgl okt09", (2.75u+4pw, 2pw));%seed may be shown instead
signature:=currentpicture; currentpicture:=nullpicture;
%
color rgb, colorofchoice;
%parameters for Sveta
randomseed:=1007; colorofchoice:= .8*red +.2*green .7*blue;%roze
%
for j=0 upto n:
 pickup pencircle scaled ((uniformdeviate 1)*pw*pt); linecap:=squared;
 hx:= uniformdeviate u; hy:= uniformdeviate v;
 rgb:= .8*(uniformdeviate 2)*red + .2*(uniformdeviate 2)*green
       + .7*(uniformdeviate 2)*blue;
 draw (hx,hy)--(hx,hy+ uniformdeviate size) withcolor rgb;
 hx:= uniformdeviate u; hy:= uniformdeviate v;
 rgb:= .8*(uniformdeviate 2)*red + .2*(uniformdeviate 2)*green
       + .7*(uniformdeviate 2)*blue;
```

```
draw (hx,hy)--(hx+uniformdeviate size, hy) withcolor rgb;
endfor;
p.r= ((0, v)--(u,v)--(u,0)--(0,0)--cycle) shifted (2pw,2pw);
p.o= ((.5u,v){right}...(u,.5v){down}...(.5u,0){left}...(0,.5v){up}
      ...cycle) shifted (u+4pw,2pw);
p.d= ((.5u,v)--(u,.5v)--(.5u,0)--(0,.5v)--cycle) shifted (2u+6pw,2pw);
currentpicture:=currentpicture shifted (2pw,pw);
clip currentpicture to p.r;
pic.o:=currentpicture shifted (u+4pw,0);
clip pic.o to p.o;%clip more
pic.d:= currentpicture shifted (2u+6pw,0);
clip pic.d to p.d;%clip even more
addto currentpicture also pic.o;%add shifted pictures
addto currentpicture also pic.d;
%
pickup pencircle scaled pw; linecap:=rounded;
drawoptions (withcolor .8*red +.2*green .7*blue);
draw p.r; draw p.o; draw p.d;
addto currentpicture also signature;
endfig end
```

I reused this program for generating personalized presents several times, but I am happier with the PostScript operator given below. When the picture was for a man, I copied the Square or the Lozenge, and when it is for a woman I copied the Oval.[6] Frame the picture in a physical frame and ready it is, apart from a wrap-around paper.

Note that all three frames have the same pattern: the pattern is clipped by frame variations. Subtle is the printing of the signature outside the clipping area.

PostScript operator variant
Why a PostScript variant of the MetaPost program?

□ allows larger numbers (seed eg 22121943)
□ more convenient clipping
□ operator (library)
□ no invoke of MP
□ easier experimenting with color shade
□ improved code.

In this variant I generate only one framed picture triggered by the value 0, 1, or 2 for the last parameter on the stack, where 0=Square 1=Oval 2=Lozenge. The size is 420 by $420 \cdot 1.618$ and positioned with the lower left corner at

```
100 50 translate
```

for a centered result. The complete birthday date, ddmmyyyy, can be supplied. The code is not a direct translation, because of the language differences and because I matured in coding and was after a library operator. The thickness of the strokes are obtained as follows

```
/w  {maxwidth unifrmdev} def
... w setlinewidth
```

The line pieces are positioned symmetrically

```
/laux l 2 div def
xaux laux sub yaux moveto xaux laux add yaux lineto w setlinewidth
color setrgbcolor stroke%h-line
```

The spread in color has been implemented as: if an `rgb`-value = 0, it is changed into eps=0.1 and the resulting value c.q. the original non-zero value is multiplied by the spread factor.
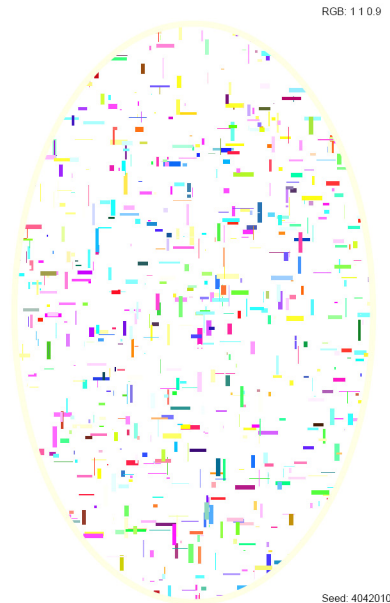
```
/spread {2 unifrmdev  mul }def%interval (0, 2)
/color{r 0 eq {eps}{r} ifelse spread
       g 0 eq {eps}{g} ifelse spread
       b 0 eq {eps}{b} ifelse spread} def
```

The strokes are in a shade of the desired color. The `rgb`-values are printed at the top, and the birthday date, the seed for the pseudo-random number generator, at the bottom.

The most Mondrian-like is maybe the Easter Egg.

RGB: 1 1 0.9

Seed: 4042010

```
/Mondrian
%birthday: ddmmyyyy, a number as seed for srand
%three numbers from the closed interval [0, 1], for the rgb-color values:
% red green blue
%number for the kind of frame (0=Square 1=Oval 2=Lozenge}: 0, 1 or 2;
%==>
%generated Mondrian-alike
{0 begin gsave %savety for not changing the graphics state outside
/form exch def
/b exch def /g exch def /r exch def /date exch def
date srand% start random generator with (birthday date) seed
100 50 translate
%wired-in parameters
/u 420 def /v u 1.618 mul def /hu u 2 div def
/hv v 2 div def% 0 0 u v BB of rectangle
```

```
/maxrandom 500 def /maxlength 20 def /maxwidth 3 def /eps 0.1 def
/hx   {u unifrmdev}            def
/hy   {v unifrmdev}         def
/l     {maxlength unifrmdev}def
/w   {maxwidth unifrmdev} def
/spread {2 unifrmdev mul }def                    %(0, 2)
%/spread {2 unifrmdev 1 add 2 div mul }def%(0.5, 1.5)
%/spread {2 unifrmdev 3 add 4 div mul }def%(0.75, 1.25)
/color{r 0 eq {eps}{r} ifelse spread
           g 0 eq {eps}{g} ifelse spread
           b 0 eq {eps}{b} ifelse spread} def
form 0 eq {/contour
  {0 0 moveto u 0 lineto u v lineto 0 v lineto closepath} def} if %Square
form 1 eq {/contour
  {hu hv hu hv 0 360 ellipse} def} if                          %Oval
form 2 eq {/contour
  {hu 0 moveto u hv lineto hu v lineto 0 hv lineto closepath}
  def} if                                              %Lozenge
%
gsave contour clip%random pattern will only show up in (is clipped to)
   contour maxrandom{%draw pattern in loop confined to contour
/xaux hx def /yaux hy def%position in u x v rectangle
/laux l 2 div def
xaux laux sub yaux moveto xaux laux add yaux lineto w setlinewidth
  color setrgbcolor stroke%h-line
/xaux hx def /yaux hy def/laux l 2 div def
xaux yaux laux sub moveto xaux yaux laux add lineto w setlinewidth
  color setrgbcolor stroke%v-line
}repeat
grestore %end clipping path
contour 7 setlinewidth r g b setrgbcolor stroke%original color od choice
H12pt setfont /nstr 8 string def
u 85 sub v 10 add moveto (RGB: ) show
                       r nstr cvs show ( ) show
                       g nstr cvs show ( ) show
                       b nstr cvs show
u 85 sub 0 moveto (Seed: ) show  date nstr cvs show
grestore end}def%end Mondrian
/Mondrian load 0 26 dict put
```

A variant suited for cmyk-color values, also some 50 lines, took me about 10 minutesje . When $k = 0$ I did not let it contribute to the spread. A brainfag is that cyan absorbs red, etc, an approach different from the rgb-model.

Example of use.

```
%!!PS Mondriaan-achtig. CGL April 2010
%BoundingBox: 0 0 620 790
(C:\\PSlib\\PSlib.eps) run
22121943   1  0  0 0 Mondrian showpage
22121943   0  1  0 1 Mondrian showpage
22121943   0  0  1 2 Mondrian showpage
22121943  .5 .5 .5 2 Mondrian showpage
%%EOF
```

No invoke of the MetaPost preprocessor is needed, just the use of distiller (as part of Adobe's Acrobat) or the `ps2pdf` batch program, or … will yield the visual result.

Acknowledgements

Thank you Hans Lauwerier for your inspiring material, and thank you Piet Mondriaan for your great art.

For a discussion of the differences in color on various devices, I refer to the LaTeX Graphics Companion or to Siep Kroonenberg's *Color in professional print production*, MAPS 20, spring 1998.

Thank you Jos Winnink for your suggestion to reorder the material.

Conclusion

Mondriaan was undoubtedly precise, but some of his 'random'-like works can be created by the use of a pseudo-random number generator and yield nevertheless a Mondriaan impression.

The positioning of the lines in his `Lozenge with 2 lines` and `Lozenge with 3 lines` is also precise, but … division of the sides by the golden ratio Φ yields equally-well artistic results.

I have input his Victory Boogie-Woogie in MetaPost, tedious work, and also scanned the picture. Don't have any use for it as yet.

My case rests, have fun and all the best.

Notes

1. For a survey of biographies of Dutch mathematicians http://bwnw.cwi-incubator.nl/cgi-bin/uncgi/alf.
2. Born as Piet Mondriaan. At the end of his live, in the USA, he used to call himself Mondrian.
3. Which obeys statistical tests for randomness.
4. A Dutch art movement which began in 1917. Its characteristics are the use of straight lines and primary colors. The artists were generally after utmost simplicity and abstraction. Main representatives were Theo van Doesburg, Piet Mondriaan, Bart van der Leck, Gerrit Rietveld, and J.J.P. Oud, active in various art forms, among others architecture.
5. Adding the year exceeds MetaPost number capacity for the moment.
6. This extra work is superfluous in the PostScript variant.

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