

15-294 Rapid Prototyping Technologies:

DXF Files

Dave Touretzky
Computer Science
Carnegie Mellon University

The DXF File Format

- Drawing Interchange Format
 - *or* –Drawing Exchange Format
- Proprietary file format, not an ANSI standard.
- Developed by AutoDesk in 1982 to allow their AutoCAD product to inter-operate with other programs.
- Partial specification now publicly available on AutoDesk's web site.

Types of DXF File

- ASCII (human readable) or binary.
- DXF version number:
 - R14, R13, R12
 - 2010, 2007-2009, 2004-2006
- Later versions add new features such as complex curves and 3D shapes.
- When exporting to DXF for use with a laser cutter, ASCII R2010 is a safe choice.

Sections of a DXF File

- HEADER – parameters such as units, min/max values
- CLASSES – application-specific data
- TABLES – line types, colors, layers, etc.
- BLOCKS – macros for repeating entities
- **ENTITIES** – where the lines and arcs are defined
- OBJECTS – data for non-graphical objects
- THUMBNAILIMAGE
- END OF FILE

Tagged Data Format

- Every element in a DXF file takes two lines:
 - Integer “group code” indicating the type of item
 - Value of the item (can be a number, string, etc.)
- Some common group codes:
 - 0: Entity type (string)
 - 2: Name of the entity (string)
 - 9: DXF variable name in header section (string)
 - 10, 20, 30: Primary X/Y/Z value (float)
 - 11, 21, 31: Secondary X/Y/Z value (float)
 - 40: radius

DXF File: One Line and One Arc

```
0
SECTION

2
ENTITIES

0
LINE
  10
  5.125
  20
  7.625
  11
  107.25
  21
  50.875
```

Line from
(5.125,7.625) to
(107.25,50.875)

```
0
ARC
  10
  60.0
  20
  75.0
  40
  25.0
  50
  0.0
  51
  180.0

0
ENDSEC

0
EOF
```

Arc at (60.0,75.0),
radius 25.0,
from 0 to 180 deg.

Do not put any
blank lines in
the file.

Python DXF Libraries

- Multiple DXF libraries exist for Python.
- **dxfwrite** is used in assignment #2:
 - Sets up reasonable header values and tables.
 - You can modify them if desired.
 - Provides primitives to make entities.
- **dxfgripper** reads a DXF file and returns a Python structure with all the info.

Using dxfwrite

```
from dxfwrite import DXFEngine as dxf
drawing = dxf.drawing('mypiece.dxf')

drawing.add(
    dxf.line((5.125, 7.625),
             (107.25, 50.875),
             color=1))

drawing.save()
```


Graphics in Python

- Use Tkinter for simple on-screen graphics
- Create a Canvas widget, then add lines etc.
- Coordinates are in pixels; must be integers.
- Use `mainloop()` to have Tk render the canvas.

Drawing A Line With Tk

```
from Tkinter import *  
  
master = Tk()  
  
w = Canvas(master, width=800, height=800)  
w.pack()  
  
w.create_line(51, 77, 1070, 508,  
              fill='red')  
  
mainloop()
```

Future Project: Vector Optimizer

- Drawing programs output vectors in seemingly random order.
- Laser cutting can go *much* faster if the vectors are ordered so as to minimize head motion with the laser off (not cutting = not useful).
- Many laser cutter drivers now include a vector optimizer, sometimes with user controls.
- Rabbit Laser's optimizer can be improved.