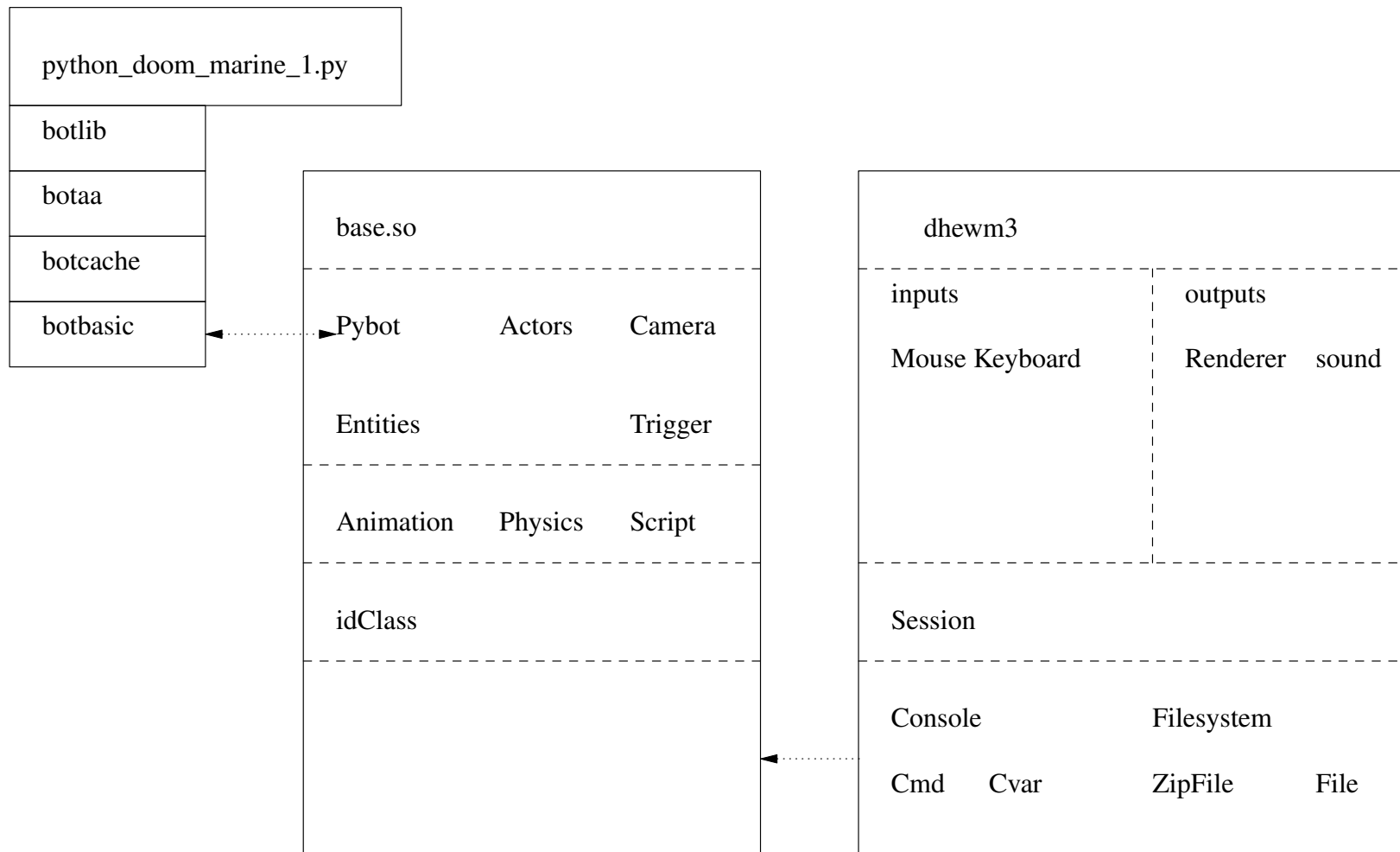


## John Romero Programming Proverbs

- 9. “Encapsulate functionality to ensure design consistency. This minimizes mistakes and saves design time.”
- John Romero, “The Early Days of Id Software - John Romero @ WeAreDevelopers Conference 2017”

# Implementing the Pybot API



## Implementing the Pybot API

- all assets in doom3 are in text format
  - other than images
- the remote procedure call marshalling is also achieved using text format
  - conventionally remote procedure call marshalling is achieved by sending raw binary format
- please read Tanenbaum's description of how remote procedure calls operate
  - and how marshalling is employed and why it is necessary
- Andrew Tanenbaum, Modern Operating Systems, Prentice-Hall International
  - sections 10.3, 10.3.1, 10.3.2

## Implementing the Pybot API

- text format is slightly less efficient than raw binary encoding
  - but it is much easier to debug and extend
  
- suspect the efficiency loss is minimal
  - the difference in format means the packet size increases
  - however the number of packets sent will remain the same
  
- caveat, this has not been measured and could be wrong!
  
- however during the development of the bot API the simplicity of text based remote procedure calls cannot be overstated

# Implementing the Pybot API

■ `Sandpit/git-doom3/pybot-dhewm3/python-bot/python_doommarine_1.py`

```
#!/usr/bin/env python

import botbasic, time

b = botbasic.bot ("localhost", "python_doommarine_1")
print "success!  python doom marine is alive"
print "trying to get my id...",
me = b.me ()
print "yes"
print "the python marine id is", me
```

■ `botbasic.bot` creates an object which connects to the dhewm3 game engine

■ `b.me ()` returns an integer which is the id of the bot player

## `class basic __init__`

- purpose is to connect to the dhewm3 engine
  - ultimately it will connect and have a dedicated socket for this bot player into the engine
  - another bot player will have a different socket
- the dhewm3 engine needs to connect the new bot player socket with the in game bot
- the in game bot is created via `pen2map`

# In game bot creation

Sandpit/chisel/maps/python.txt

```
define 1 room 1
define 2 room 2
define 3 room 3
define s worldspawn
define i light
define M monster python_doommarine_mp

#####
# 1 i i i i# 2 # 3 #
#i # #
# s . # #
# . # #
# # . # #
# M # . # #
# # . # #
# i i i i # #
#####
```

## In game bot creation

- the keywords `monster python_doommarine_mp` are used to inform `pen2map` to generate an entity (id) for the in game bot

- [Sandpit/chisel/python/tiny.map](#)

```
// entity 2
{
    "classname" "python_doommarine_mp"
    "name" "python_doommarine_mp_1"
    "anim" "idle"
    "origin" "-600 -456 96"
    "ambush" "1"
}
```

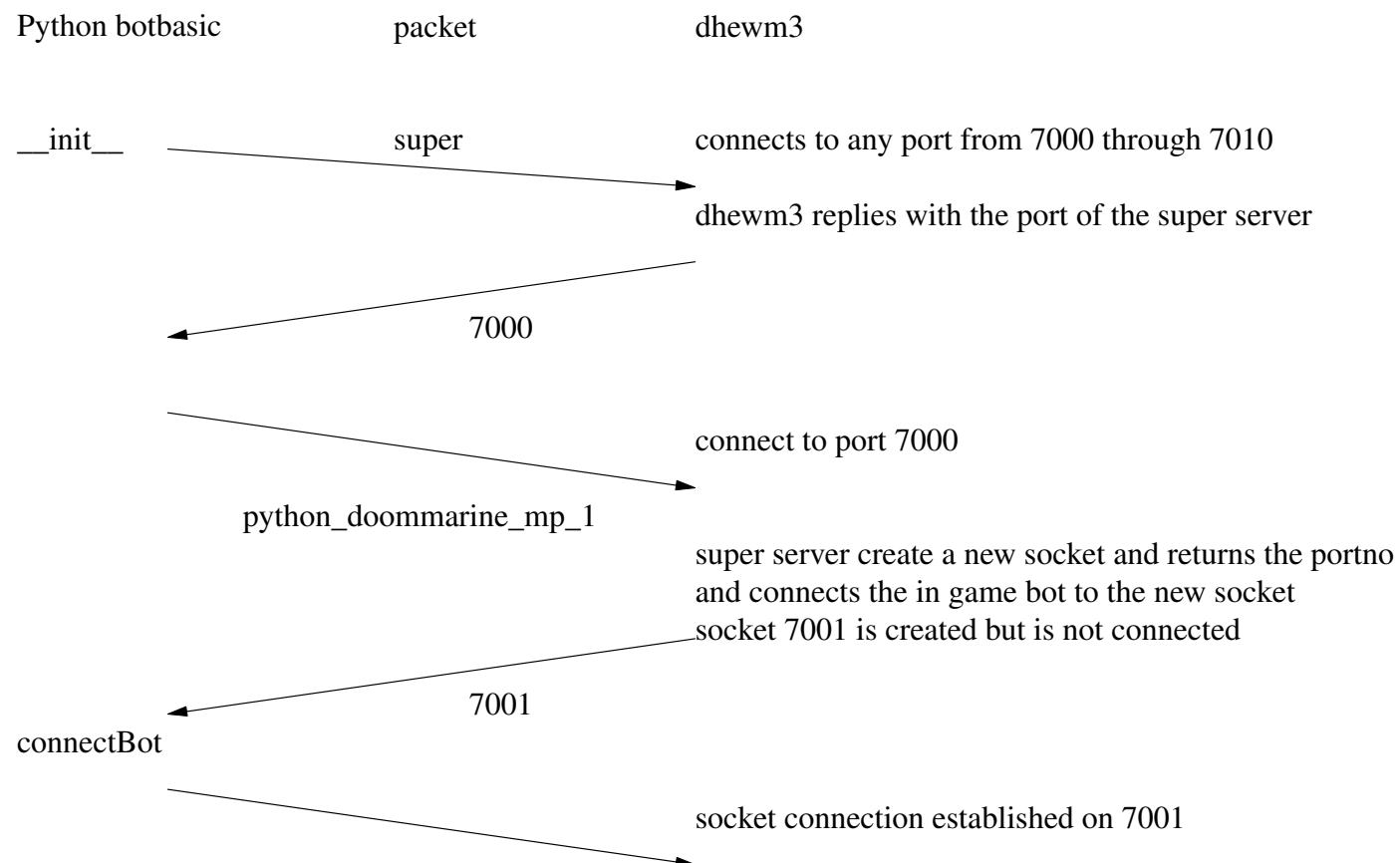
- we can see the return value for me will be 2



## super server

- the roll of the super server in the dhewm3 python extensions is to:
  - create a new socket for every new python connection
  - assign the new socket into the appropriate in game player entity

## class basic \_\_init\_\_



## `class basic __init__`

- this connection sequence allows for the dhewm3 game to be restarted quickly after a crash
  - the super server port may differ, as the underlying operating system may hold onto the previous sockets for a while (minutes)
- since the botbasic always queries the port number of the super server (and all sockets above 7000 to 7010) understand the `super` request this will be transparent
- after `__init__` has completed the python botbasic has a direct connection to a socket which is owned by the in game player entity

## `class basic __init__`

- if the super server does not know about the requested python bot name then the port number returned will be 0
  - in which case `__init__` queries for the super server value and it loops back to the start
  
- this allows for the python script to be started before the game engine
  - and even allows a previous dhewm3 to be running, then it terminates and a new dhewm3 engine to be run and the python bot will eventually connect to the latest dhewm3 engine



■ [Sandpit/git-doom3/pybot-dhewm3/python-bot/botbasic.py](#)

```
#  
# me - return the id of this bot.  
#  
  
def me (self):  
    self.s.send ("self\n")  
    return int (self.getLine ())
```

## dhewm3 engine: bot api changes

- the file `Sandpit/git-doom3/pybot-dhewm3/neo/game/ai/pybot.cpp` contains the dhewm3 side api implementation
  - emacs key F9
- also read the file `Sandpit/git-doom3/pybot-dhewm3/neo/game/ai/pybot.h`

## dhewm3 engine: implementation of me

■ `Sandpit/git-doom3/pybot-dhewm3/neo/game/ai/pybot.cpp`

```
/*
 * interpretRemoteProcedureCall - a switch statement of all rpc commands.
 */

void pyBotClass::interpretRemoteProcedureCall (char *data)
{
    if (protocol_debugging)
        gameLocal.Printf ("rpc (%s)\n", data);
    if (strcmp (data, "super") == 0)
        rpcSuper ();
    else if (idStr::Cmpn (data, "getpos ", 7) == 0)    // Id's strncmp equivalent
        rpcGetPos (&data[7]);
    else if (strcmp (data, "self") == 0)
        rpcSelf ();
    etc
}
```

## dhewm3 engine: implementation of me

■ [Sandpit/git-doom3/pybot-dhewm3/neo/game/ai/pybot.cpp](#)

```
/*
 * rpcSelf - return our id.
 */

void pyBotClass::rpcSelf (void)
{
    char buf[1024];

    if (protocol_debugging)
        gameLocal.Printf ("rpcSelf called by python\n");
    idStr::snPrintf (buf, sizeof (buf), "%d\n", myid);
    if (protocol_debugging)
        gameLocal.Printf ("rpcSelf responding with: %s\n", buf);
    buffer.pyput (buf);
    state = toWrite;
}
```



## pybot.h

- declares pyBufferClass, pyBotClass, pyServerClass  
registerName and populateDictionary

# pyBotClass

■ `Sandpit/git-doom3/pybot-dhewm3/neo/game/ai/pybot.h`

```
int myid;  
char *name;  
int portNo;  
bool enabled;  
pyBufferClass buffer;  
serverState state;  
struct sockaddr_in sa;  
struct sockaddr_in isa;  
int socketFd;  
int connectFd;  
bool connected;
```

## Tutorial: adding pybot access to health

- start `emacs` and press F9 and then F2
  - this loads in `pybot.cpp` and then splits the screen
- open up file `pybot.h` which is in the same directory as `pybot.cpp`
- now open up `Sandpit/git-doom3/pybot-dhewm3/python-bot/botbasic.py`

## Adding health method to botbasic.py

- search for the method definition for me
- now add

## Adding health method to botbasic.py

■ `Sandpit/git-doom3/pybot-dhewm3/python-bot/botbasic.py`

```
#
#  me - return the id of this bot.
#

def me (self):
    self.s.send ("self\n")
    return int (self.getLine ())

#
#  health - return the bots health
#

def health (self):
    self.s.send ("health\n")
    return int (self.getLine ())
```

- the string `health` indicates the remote procedure (method) that we want to call

## Adding health method to botbasic.py

- notice that `health` will return an integer to the python application
- we need to add the game engine code, so change to the `pybot.cpp` buffer (press F9)
- search for the method  
`pyBotClass::interpretRemoteProcedureCall`
  - and add the following code

## Adding health method to botbasic.py

■ `Sandpit/git-doom3/pybot-dhewm3/neo/game/ai/pybot.cpp`

```
else if (strcmp (data, "self") == 0)
    rpcSelf ();
else if (strcmp (data, "health") == 0)
    rpcHealth ();
```

- the method `pyBotClass::interpretRemoteProcedureCall` interprets all the api calls and is akin to a long switch statement

## Adding health method to botbasic.py

- search for the implementation of rpcSelf and underneath it place the following



## Adding health method to botbasic.py

■ Sandpit/git-doom3/pybot-dhewm3/neo/game/ai/pybot.cpp

```
/*
 *  rpcHealth - return our health.
 */


void pyBotClass::rpcHealth (void)
{
    char buf[1024];

    if (protocol_debugging)
        gameLocal.Printf ("rpcHealth called by python\n");
    idStr::snPrintf (buf, sizeof (buf), "%d\n", dictionary->health (myid));
    if (protocol_debugging)
        gameLocal.Printf ("rpcHealth responding with: %s\n", buf);
    buffer.pyput (buf);
    state = toWrite;
}
```

## Adding health method to botbasic.py

- notice the call to `dictionary->health()`
  - the remaining code convert the integer into a string and passes it back to the python library
- navigate to the method `dict::ammo`, underneath add the following code

## Adding health method to botbasic.py



```
/*  
 * health - return the health for the bot.  
 */  
  
int dict::health (int id)  
{  
    return entry[id]->health ();  
}
```

## Adding health method to botbasic.py

- we need to add a dictionary entry for health in the `class dict`

```
int reload_weapon (int id);  
int ammo (int id);  
int health (int id);  
bool aim (int id, int enemy);  
int turn (int id, int angle, int angle_vel);
```

## Adding health method to botbasic.py

- now we need a health method in item, so firstly add the declaration in class item

```
int stop_firing (void);  
int ammo (void);  
int health (void);  
void reload_weapon (void);
```

## Adding health method to botbasic.py

- underneath `item::ammo` add

```
/*
 * health - return the health of a python bot or monster.
 */

int item::health (void)
{
    switch (kind)
    {
        case item_monster:
            assert (false);
            return 0; // ignore
        case item_player:
            return idplayer->health;
    }
}
```

## Adding health method to botbasic.py

- add the method declaration to pybot.h

- `Sandpit/git-doom3/pybot-dhewm3/neo/game/ai/pybot.h`

```
void rpcSuper (void);  
void rpcGetPos (char *data);  
void rpcSelf (void);  
void rpcHealth (void);  
void rpcMaxObj (void);  
void rpcStep (char *data);  
void rpcRight (char *data);
```

## Homework

- write down a list of classes defined in `pybot.h` and `pybot.cpp` give a summary of their purposes
- examine the purpose of `dict` and `item`