

# Programming Proverbs

- 5. “Construct the program in logical units.”
- Henry F. Ledgard, “Programming Proverbs: Principles of Good Programming with Numerous Examples to Improve Programming Style and Proficiency”, (Hayden Computer Programming Series), Hayden Book Company, 1st edition, ISBN-13: 978-0810455221, December 1975.

## AI in ioquake

- Quake 3 arena box AI is layered
- much like a network protocol stack
- decisions made at higher layers are executed through lower layers

# AI in ioquake



Team leader AI					4th
Misc AI	AI network		Commands		3rd
Fuzzy	Character	Goals	Navigation	Chats	2nd
Area awareness system		Basic actions			1st

## Layer one

- the input and output layer for the bot
  - area awareness system is the system which provides the bot with all information about the world
  - much of the information has already been preprocessed when building the maps
  - some of it will be dynamic
  - access to it is fast
  - everything the bot senses goes through the Area Awareness System AAS
  
- basic actions are the output of the bot
  - outputs are presented in a way which is very similar to keyboard/mouse input of a human player

## Layer two

- provides the intelligence that is often subconscious to a skilled human player
  - includes AI to select goals using fuzzy logic
  - AI to navigate towards a goal
  - AI to interpret chats
  - AI to construct chats
  
- functionality to store and retrieve characteristics of bots, for example
  - aim skill
  - aim accuracy
  - aggression
  - weapon jumping

## Layer three

- a mixture of production rules
  - and an AI network with special nodes for different situations and states of mind
  - very similar to a state machine
  - many `if then else` rules
  
- all higher level thinking and reasoning takes place in this layer
  
- it also contains the command module
  - which allows the bot to understand orders and commands
  - from other players or a team leader
  
- misc AI module supports AI for fighting, navigating around obstacles and solving puzzles

## Layer four

- one of the bots is designated as team leader which enables this layer
  - all other bots disable this layer
- typically the leader might request other bot to follow me
  - track enemy, attack enemy etc

## Tutorial work

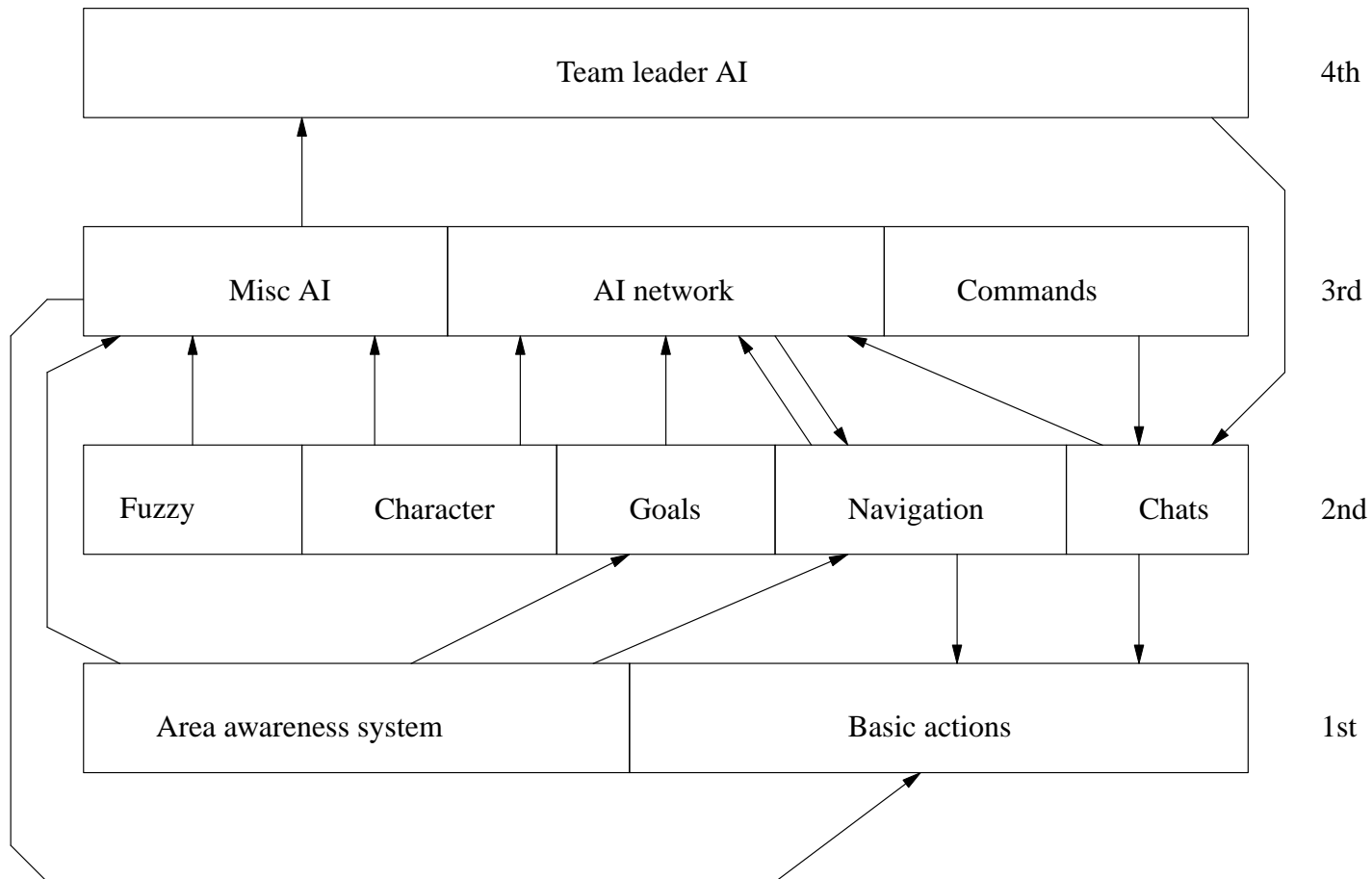
- for each .C file in `Sandpit/ioquake-latest/ioquake3/code/botlib`
- write a one line summary of what it does and determine to which level it belongs



## AI system

- AI system runs in small time frames
  - referred to as a time-based simulation
- system runs at 10Hz
- this matches the game physics, although they are not locked in step
- each frame the bot checks upon its health and situation and decides the best action to be taken

# Information flow between the layers



## Information flow between the layers

- upward arrows represent information about the bots environment and its status
  - used to keep up to date with the world
  - used in the decision making to achieve certain goals
  
- data moving up the layered architecture represents more and more abstract concepts
  
- all information flowing downwards is from the result of a decision taken by the bot
  - will normally result in a basic action being taken
    - jump, move forward etc

## Information flow between the layers

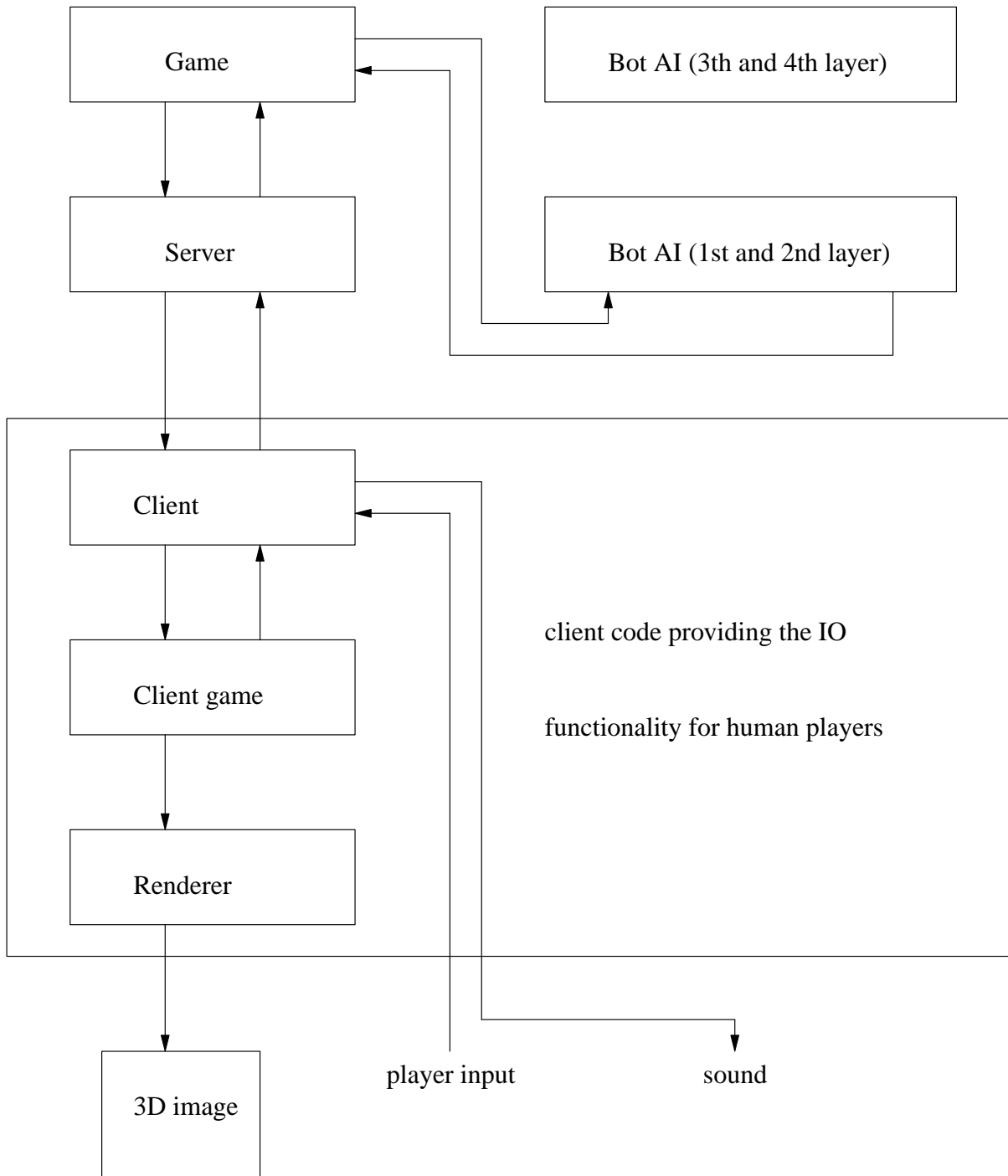
- limited inter layer communication
  
- in the third layer
  - AI network retrieves information from both the Misc AI and Command components
  
- in the second layer
  - Goals retrieves information from Fuzzy

## Information flow between the layers

- code at higher layers requests information from lower layers
- information readily available is passed back immediately
  - other calculations might need to be made, however such calculations must not take more than a couple of milliseconds
  - otherwise the game will hitch
- at 10Hz a delay during a calculation can become noticeable

# Structure of the ioquake game engine





## Structure of the ioquake game engine

- the game module sets the rules and dictates how the game works
  - capture the flag or death match or team arena
- server provides functionality to allow players to connect to the game
- client, client game, and renderer modules together provide the input/output functionality for the human player



## Structure of the ioquake game engine

- `client` module passes input events to the server
- `client` also forwards information from the server to the `client` game
  - for example what is visible

## Structure of the ioquake game engine

- client game interprets this information and passes necessary data to the renderer
- client game sends information about which sounds can be heard to the client

## Structure of the ioquake game engine

- the game module provides the Area Awareness System with all the necessary information about the state of the game world
  
- information consists mainly of entity data
  - position, type, appearance of entities are communicated to the Area Awareness System
  - gibs, player models, skins etc
  
- bot input, or basic actions are sent to the game module

## Remote procedure call

- RPC marshalling of arguments
  - make sure you have read Tanenbaum's description of how RPC's 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

## md3 bot files

- a md3 file package is just a zip archive
- inside a md3 archive is a collection of files


## Some of Alien .pk3 files

- ```
alien/models/players/alien/head_1.md3
alien/models/players/alien/lower_default.skin
alien/models/players/alien/head_default.skin
alien/models/players/alien/animation.cfg
alien/models/players/alien/head.tga
alien/models/players/alien/lower_1.md3
alien/scripts/Alien.bot
alien/botfiles/bots/alien_i.c
alien/botfiles/bots/alien_c.c
alien/botfiles/bots/alien_w.c
alien/botfiles/bots/alien_t.c
alien/botfiles/bots/alien.bot
```

## Some of Alien .pk3 files

- some of the files have been left out of the list above
  - left out different colour alien
- notice that filenames are case insensitive
  - take care under GNU/Linux which by default differentiates between case

## contents of alien/botfiles/bots/alien.bot



```
{  
name           Alien  
model          Alien  
funname        Alien  
color          4  
aifile bots/alien_c.c  
}
```



## Contents of bots/alien\_c.c

```
#include "chars.h"

skill 1
{
    CHARACTERISTIC_NAME           "alien"
    CHARACTERISTIC_GENDER         "it"
    CHARACTERISTIC_ATTACK_SKILL   0.75
    CHARACTERISTIC_WEAPONWEIGHTS "bots/alien_w.c"
    CHARACTERISTIC_AIM_SKILL      0.5
    CHARACTERISTIC_CHAT_FILE      "bots/alien_t.c"
    CHARACTERISTIC_CHAT_NAME      "alien"

    ...

    CHARACTERISTIC_ITEMWEIGHTS    "bots/alien_i.c"
    CHARACTERISTIC_AGGRESSION     0.95
    CHARACTERISTIC_SELFPRESERVATION 0.25
    CHARACTERISTIC_VENGEFULNESS  0.95
    CHARACTERISTIC_CAMPER         0.5
    CHARACTERISTIC_EASY_FRAGGER   0.1
    CHARACTERISTIC_ALERTNESS      0.5
}
```

## alien/botfiles/bots/alien\_t.c

```
chat "alien"
{
#include "teampplay.h"

type "game_enter"
{
    "You cannot hide in ", 4, ". This we like.";
    "We hunt. We kill. We feed. Queen happy.";
    "We see ", 1, "! Good sacrifice for Queen. Much joy.";
    "There will be much meat in ", 4, ". You will all die.";
}

type "game_exit"
{
    "I go find Ripley.";
    "I go find some space marines to play with now.";
    4, " not good.";
    1, " is like newborn from pod.";
}
...
}
```

## extending .pk3 archive

- new files:
- `<name>/models/players/<name>/<name>.body`
- `<name>/bot-<name>/botfiles/bots/<scriptname>.py`
- `<name>/models/players/<name>/gibs/`
  - `abdomen.md3 arm.md3 brain.md3 fist.md3 foot.md3`  
`forearm.md3 gibs.jpg intestine.md3 leg.md3`  
`skull.md3`
- for example in alien we have:

## alien/models/players/alien/alien.body

```
//  
//  extra body features  
//  
{  
  BODY_NO_OF_SKULLS      3  
  BODY_NO_OF_BRAINS     3  
  BODY_NO_OF_ABDOMENS   16  
  BODY_NO_OF_ARMS       4  
  BODY_NO_OF_FISTS      4  
  BODY_NO_OF_FEET       4  
  BODY_NO_OF_FOREARMS   4  
  BODY_NO_OF_INTESTINES 32  
  BODY_NO_OF_LEGS       8  
}
```

# Tutorial

- make the model `vince` into a bot and give him:

- |                                    |                 |
|------------------------------------|-----------------|
| <code>BODY_NO_OF_INTESTINES</code> | <code>32</code> |
| <code>BODY_NO_OF_ABDOMENS</code>   | <code>32</code> |

- and the appropriate number of other entities

# Tutorial

- make a new legoman model copy (lego-red)
- which only has one colour and remove the blood from the lego gibs
  - restore the gibs to lego colours

## Extending bot scripts to use Python

- for example examine bot-  
legoman/botfiles/bots/legoman.py

## bot-legoman/botfiles/bots/legoman.py

```
import botlib, time

id = botlib.bot("localhost", 7000)
print "hello world, python is alive in Quake 3"
id.defaults()
print "bot is now active!"
id.disableAI()
while True:
    print "trying to crouch"
    id.crouch()
    print "in crouch position"
    time.sleep(1)
    id.jump()
    print "in jump position"
    time.sleep(1)
    id.fire()
    print "fire"
    time.sleep(1)
```



## Python botlib

- examine the botlib code and see how the parameters are marshalled  
`python-bot/bot-legoman/botfiles/bots/botlib.py`