John Romero Programming Proverbs

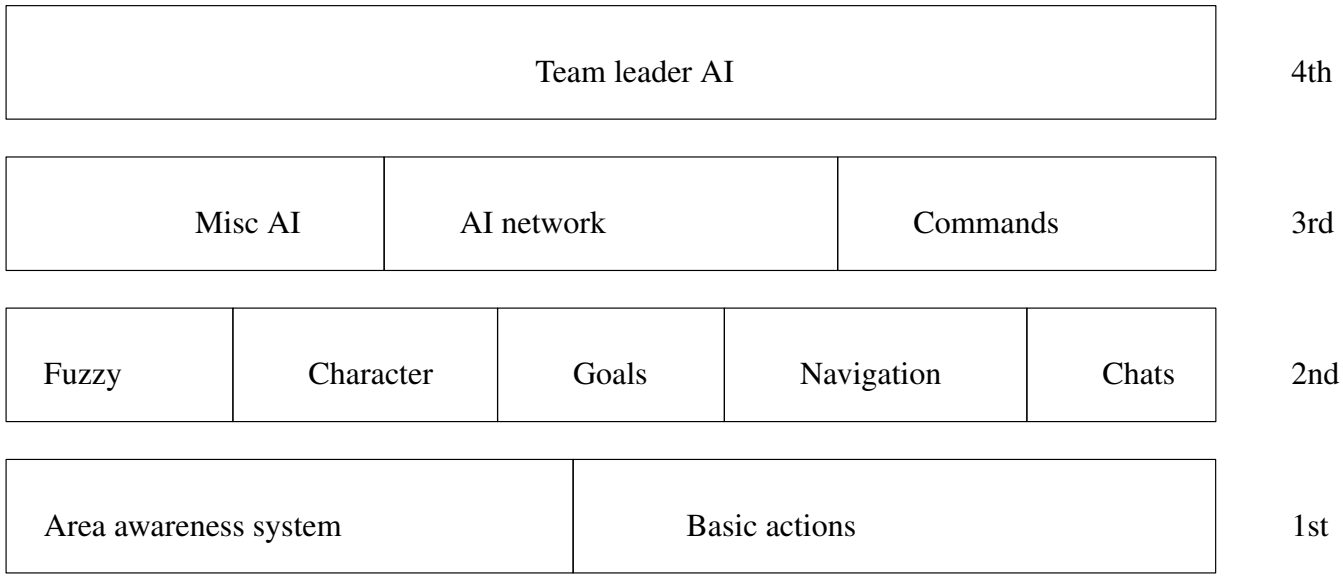
- 5. “We are our own best testing team and should never allow anyone else to experience bugs or see the game crash. Don’t waste others’ time. Test thoroughly before checking in your code.”

- John Romero, “The Early Days of Id Software - John Romero @ WeAreDevelopers Conference 2017”

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



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

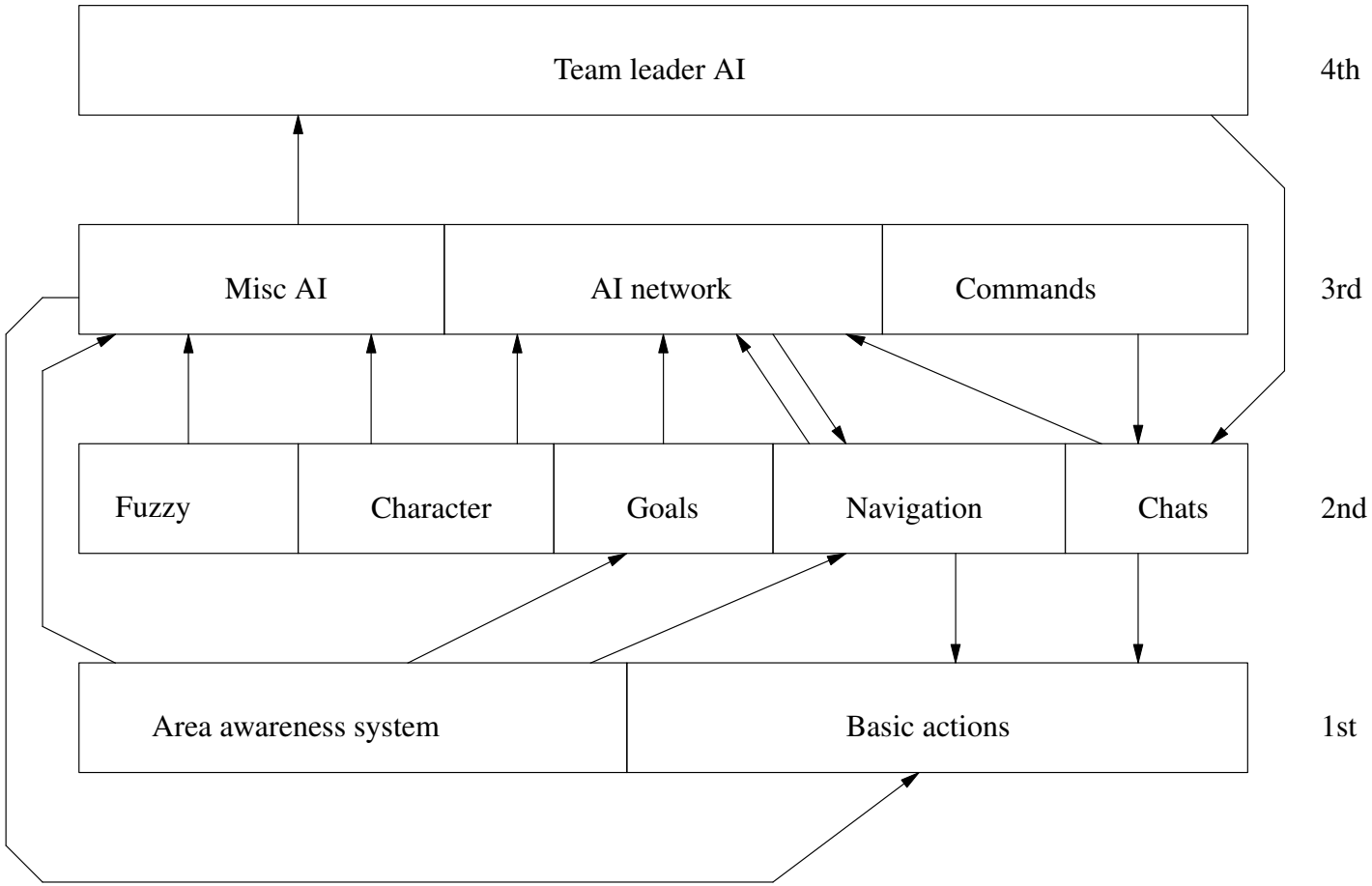
Tutorial work

- 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

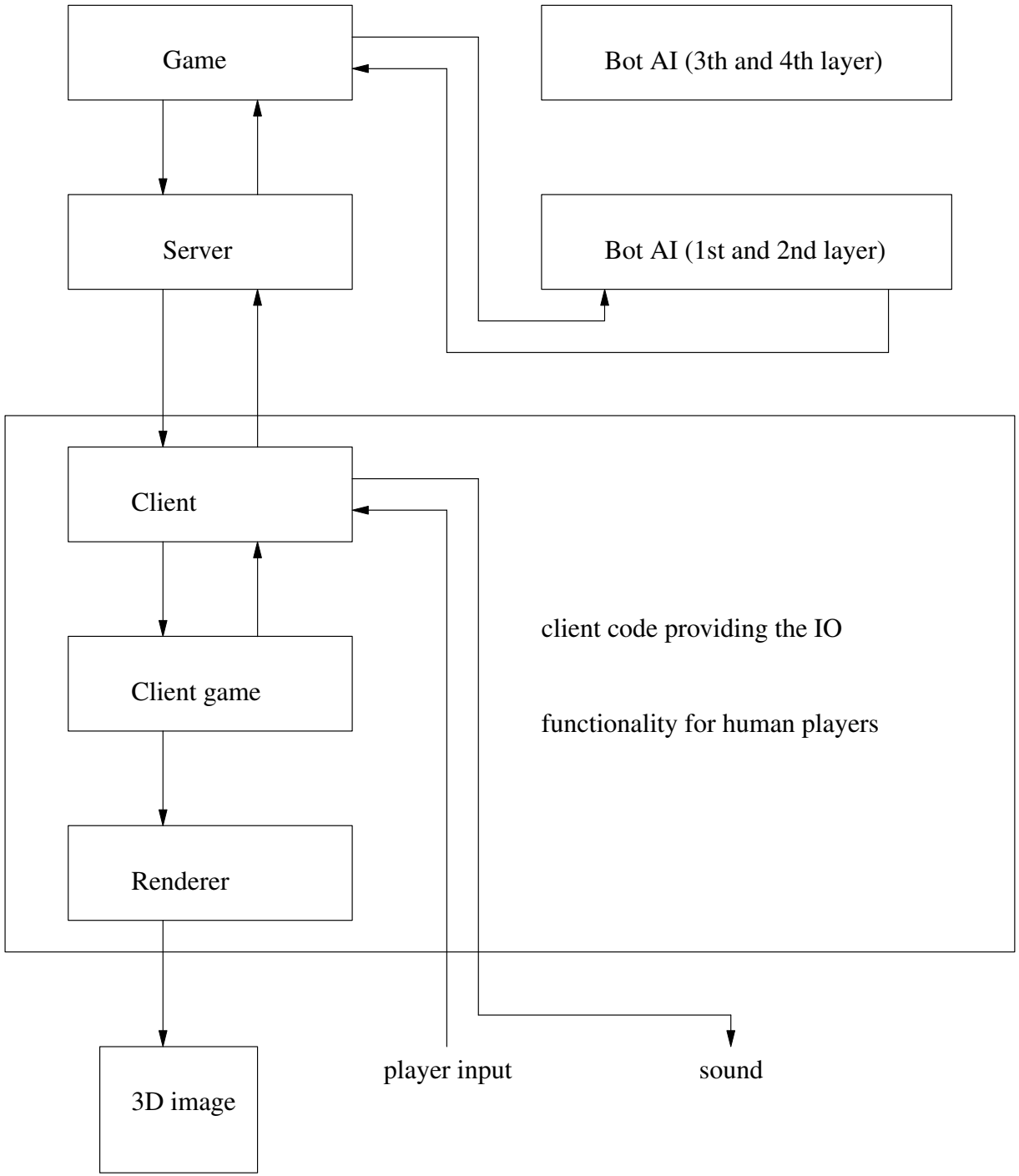
Information flow between the layers

- 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


Game
Bot AI (3th and 4th layer)
Server
Bot AI (1st and 2nd layer)
Client
client code providing the IO
Client game
functionality for human players
Renderer
3D image
player input
sound

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 "teamplay.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:

```
BODY_NO_OF_INTESTINES    32
BODY_NO_OF_ABDOMENS      32
```

- 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`