

AI & GAMES: USING ALL THE TOOLS IN THE TOOLBOX

GAMEON

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INTRODUCTION

- **GREAT STRIDES** ARE BEING MADE IN **CREATING** AND **ADAPTING** POWERFUL NEW **AI** TECHNIQUES FOR COMPUTER **GAMES**
- OK, SO THE GAMES:
 - MAY **NOT** BE FUN
 - MAY CORRAL A **FIXED IDEA** OF FUN
 - MAY HAVE BEEN FUN IF THEIR **AI** WERE **FASTER**
 - MAY BE ACTUAL, **GENUINE** FUN BUT REAL PEOPLE WON'T **PLAY** THEM
- STILL, AT LEAST WE'RE MAKING **PROGRESS!**

CAT UP A TREE

- THIS IS A **CAT UP A TREE:**



GAMES AND AI

- PEOPLE WORK ON GAMES AND AI FOR ONE OF **TWO** MAIN REASONS:
 - ULTIMATELY, THEY WANT BETTER **GAMES**
 - ULTIMATELY, THEY WANT BETTER **AI**
- **I** FALL INTO THE **BETTER GAMES** CATEGORY
- I DID MY **PHD** IN AI BACK IN THE **1980S**
- I **WANTED** (AND **STILL WANT**) TO CREATE BELIEVABLE **VIRTUAL WORLDS** (MMOS)
- THE BIGGEST **OBSTACLE** I SAW TO THIS WAS THEIR NEED FOR VIRTUAL **INHABITANTS**
 - I STUDIED AI IN ORDER THAT I COULD **MAKE** THEM

BACK THEN

- BACK THEN, COMPUTERS WEREN'T AS **POWERFUL** AS TODAY'S COMPUTERS
 - OR INDEED TODAY'S **WASHING MACHINES...**
- AI PROGRAMS TOOK **AGES** TO RUN
 - 4 **SECONDS** TO GET A RESPONSE FROM *ELIZA*
- FURTHERMORE, PEOPLE WERE AIMING FOR **STRONG** AI RATHER THAN **WEAK** AI
 - ARTIFICIAL GENERAL INTELLIGENCE *VERSUS* DOMAIN-SPECIFIC SOLUTIONS
- IT'S **UNSURPRISING** THAT (A* ASIDE), AI DIDN'T HAVE MUCH **IMPACT** ON GAMES

WHAT HAPPENED

- UNTIL THE LATE 1980S, AI WAS ALL ABOUT **SYMBOLS AND PROBLEM-SOLVING**
- ABOUT **BEING** INTELLIGENT, RATHER THAN **SEEMING** INTELLIGENT IN A NARROW FIELD
 - "**NEATS**" USED LOGICS, "**SCRUFFIES**" USED WHATEVER WORKED
- THE **SCRUFFIES** EVENTUALLY WON ... SORT OF
 - **EXPERT SYSTEMS** FLOURISHED AS THEY **COULD** PERFORM VERY WELL IN **SPECIFIC** AREAS
- THIS LED TO THE **PRACTICAL** ATTITUDE WHICH **DOMINATES** AI TODAY

GOFAI

- THE **NEATS** NEATENED THE SCRUFFIES' WORK WITH SCIENTIFIC **RIGOUR**, SO **ALSO** WON
- TODAY'S AI IS ACTUALLY QUITE **FRAGMENTED**, BUT **NEURAL NETWORKS** RULE
- THE EMPHASIS OF THE CURRENT PARADIGM IS ON BOTTOM-UP, **EMERGENT** AI
- THE **GOOD OLD-FASHIONED AI** OF YORE WAS SIDELINED FOR BEING TOO **ABSTRACT**
 - IRONICALLY, AS **IT** HAD SIDELINED NEURAL NETWORKS (AS "PERCEPTRONS") FOR BEING TOO **CONCRETE**
- THAT **DOESN'T** MEAN GOFAI WAS **WRONG**

TOOLS

- AI HAS **MANY** TOOLS IN ITS TOOLBOX
- **SOME** OF THOSE TOOLS MAY BE **RUSTY**, BUT THEY'RE STILL **SERVICEABLE**
- WHAT'S **MORE**, AT TIMES THEY MAY BE THE **RIGHT** TOOL FOR THE **JOB**
- MUCH OF THE AI-RELATED WORK THAT **GAMES** WANT TO DO IS AT THE **SYMBOLIC** LEVEL
- PERHAPS **GOFAI** MIGHT BE WORTH REVISITING?
- WELL YES, IT **IS**, AND I'LL USE THE **REST** OF THIS TALK TO GIVE AN **EXAMPLE** THAT **ILLUSTRATES** THIS

PROBLEM

- I'M GOING TO LOOK AT **MMORPGS**
 - BECAUSE I KNOW MORE **ABOUT** THEM THAN YOU DO, AND WILL THUS SEEM **COOLER...**
- MMOS HAVE A PARTICULAR PROBLEM WITH **QUESTS**
- QUESTS ARE **GOAL-DRIVEN** PIECES OF **NARRATIVE** THAT PLAYERS FOLLOW
 - THEY **OVERLAP**, LIKE STORYLINES IN SOAP OPERAS
- WHEN THERE ARE **NO** QUESTS, MMO CONTENT IS CALLED **GRINDING**
 - USUALLY VERY **UNFUN**

HAND-CRAFTED QUESTS

- MMORPGS NEED SEVERAL **THOUSAND** QUESTS
- THE **BEST** ARE **HAND-CRAFTED**, BUT CREATING THESE IS **TIME-CONSUMING** AND **EXPENSIVE**
- HAND-CRAFTING CAN PRODUCE **GLORIOUSLY** LONG NARRATIVE **QUEST CHAINS**
- THAT SAID, THEY ARE **UNRESPONSIVE** TO OTHER ONGOING **EVENTS**
 - “HELP! MY **CAT** IS TRAPPED IN YONDER **TREE!**”
 - SO, THAT ARMY OF **ORCS** AT THE **GATES** DOESN'T **BOTHER** YOU..?

EMERGENT QUESTS

- **ALSO** EXCELLENT ARE **EMERGENT** QUESTS, CREATED BY **PLAYER NEEDS**
 - **EVE ONLINE**: MINING ASTEROIDS FOR METALS YOUR CORPORATION (GUILD) NEEDS SO IT CAN BUILD **SPACESHIP** COMPONENTS
- IF PLAYERS CAN GENERATE THEIR **OWN** GOALS (AND THUS **QUESTS**) FROM A SITUATION, THIS CAN BE **VERY** POWERFUL
- HOWEVER, FOR THEM TO DO SO REQUIRES A **RICH** WORLD - **EVEN MORE** EXPENSIVE

WIZARD!

- HERE'S A WIZARD!



DRUID!

- HERE'S A DRUID!



PROCEDURAL QUESTS

- DEVELOPERS RESPONDED TO THE DEMAND FOR QUESTS BY USING **PROCEDURAL** SYSTEMS TO GENERATE THEM **DYNAMICALLY**
- GENERALLY USED A **CHINESE MENU** APPROACH
 - PICK AN OBJECT FROM THIS COLUMN, AN NPC FROM THIS COLUMN, A REWARD FROM THIS COLUMN
- YOU GET A LOT OF **FED EX** QUESTS THIS WAY
 - “BRING ME THIS OBJECT” OR “TAKE THIS OBJECT OVER THERE”
- **ALSO** “KILL <THIS NUMBER> OF <THESE MOBS>”

FAILURE

- CHINESE MENU QUESTS PROVED SPECTACULARLY **UNSATISFACTORY** FOR PLAYERS
 - ARBITRARY, MEANINGLESS, **DEVOID** OF STORY
- PROCEDURAL QUESTS DEVELOPED A **BAD** REPUTATION AND ARE GENERALLY **ESCHEWED** BY MAJOR MMO DEVELOPERS
 - SINCE WOW: HAND-CRAFTED QUESTS USING **TOOLS**
- IT DOESN'T **HAVE** TO BE THIS WAY, THOUGH!
- WE CAN USE **AI PLANNING** TO HELP US
 - YES, I'M TALKING **STRIPS** AND **NONLIN** HERE...!

PLANNING IOIA

- THE WORLD IS A **STATE** MADE UP OF **OBJECTS** WITH **PROPERTIES**
- **ACTIONS** TRANSFORM **ONE** STATE INTO A **NEW** STATE
- ACTIONS HAVE **PRECONDITIONS**
 - FACTS THAT **NEED TO BE TRUE** FOR THE ACTION TO BE EXECUTED
- ACTIONS HAVE **EFFECTS**
 - FACTS THAT **BECOME** OR **REMAIN** TRUE WHEN THE ACTION HAS EXECUTED

PLANNING IOIB

- **GOALS** ARE FACTS YOU **WANT** TO BE TRUE
- **SIMPLE** PLANNING IS **SEARCH**
- LOOK FOR AN **ACTION** THAT HAS THE **GOAL** AS AN **EFFECT**
- IF THIS ACTION'S **PRECONDITIONS** ARE SATISFIED, **EXECUTE** IT AND YOU'RE DONE
- OTHERWISE, **SET** ITS PRECONDITIONS UP AS **GOALS** AND RECURSE ON EACH
- DIRECTLY-CHECKABLE GOALS ARE **VERIFIABLE**
- DIRECTLY-EXECUTABLE ACTIONS ARE **PRIMITIVE**

THE IDEA

- GIVE NPCs (AKA QUEST DISPENSERS) **GOALS**
 - BASED ON THE NPC'S **PERSONALITY**, OR MASLOW'S HIERARCHY OF **NEEDS** – WHATEVER
- GIVE NPCs **SIMPLE** PLANNING SYSTEMS TO TRY **ACHIEVE** THESE GOALS
- **DON'T** MAKE MANY NPCs **DRIVEN** TO ACHIEVE THEIR GOALS, THOUGH!
 - YOU WANT MOST GUARDS TO **PATROL** A FIXED ROUTE, NOT CONTINUALLY PLOT THEIR **REVENGE** ON THE **WIZARD** WHO **SLIGHTED** THEM

PLAYERS

- NPCs WILL THEREFORE HAVE A SET OF **PLANS** IN VARIOUS STAGES OF **COMPLETION**
- UNLESS THEIR SITUATION **CHANGES**, MOST NPCs WILL PROBABLY BE **STUCK**
 - INSUFFICIENT RESOURCES, LACK OF SKILL, IMPORTANT MAINTENANCE GOALS, INSUFFICIENT INTELLIGENCE, ...
- THEY NEED THE **PLAYERS** TO ACHIEVE THEIR SUBGOALS **FOR** THEM
 - OR, CONCEIVABLY, OTHER NPCs
- THIS MEANS THOSE SUBGOALS ARE **QUESTS**

EXAMPLE

- LET'S SAY A PARTICULARLY **AMBITIOUS** NPC HAS THE GOAL **have power**
- SUPPOSE WE HAVE FOUR **ABSTRACT** ACTIONS THAT HAVE **have power** AS AN EFFECT:
 - **Acquire military power**
 - **Acquire religious power**
 - **Acquire economic power**
 - **Acquire political power**
- LET'S GO WITH **Acquire religious power...**

EXPANSION

- THIS ACTION HAS **lead a religion** AS A **PRECONDITION**
- SUPPOSE THERE ARE **TWO** OPERATORS THAT HAVE THIS AS AN **EFFECT**:
 - **Lead an existing religion**
 - **Start your own religion**
- LET'S HAVE OUR NPC GO WITH THE FORMER
- PERHAPS IT NOW FINDS THAT THIS IS AN EXAMPLE OF A **GENERAL** OPERATOR:
 - **Assume <position> in <group>**

SUB-GOALS

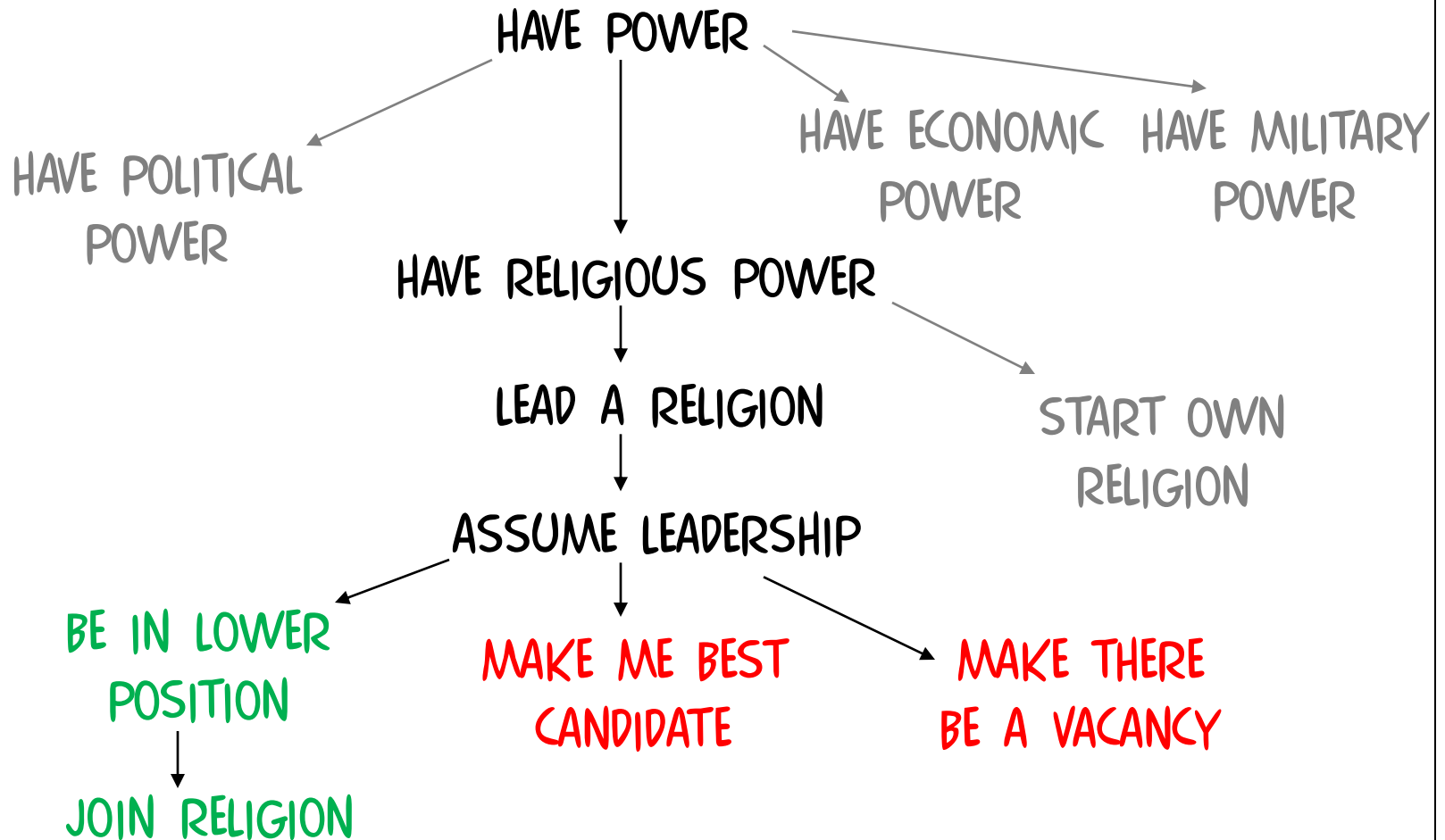
- **Assume** `<position>` in `<group>`
HAS **THREE** PRECONDITIONS:
 - be in a position lower than `<position>`
 - be the best candidate for `<position>`
 - there is a vacancy for `<position>`
- FOR THE FIRST OF THESE, THERE MAY BE A **PRIMITIVE** ACTION THAT CAN BE DONE TO ACHIEVE IT: `Join <religion>`
- THIS **ITSELF** PERHAPS HAS THE PRECONDITION `not (a member of a religion)`

EXECUTABLE

- IF OUR NPC IS **INDEED** NOT A MEMBER OF A RELIGION, THEN THIS MAKES THE PRIMITIVE ACTION **EXECUTABLE**
- LET'S SAY OUR NPC INSTANTIATES **<religion>** WITH **the druids**
- THE NPC NOW HAS A **PLAN**:
 - **Join the druids**
 - **Make (be best candidate for leader of the druids) true**
 - **Make (there is a vacancy for leader of the druids) true**
 - **Assume leadership of the druids**

HIERARCHY

- THIS SYSTEM IS A **HIERARCHY**:



KEY POINT

- **ALL** A PLANNER'S **VERIFIABLE** GOALS CAN BE USED AS **QUESTS**
- THIS MAKES FOR A **DYNAMIC** AND **LEVEL-SENSITIVE** QUEST SYSTEM
 - "I'M GOING TO JOIN THE DRUIDS. I WANT YOU TO MAKE ME BE BEST CANDIDATE FOR CHIEF DRUID"
 - "I'M GOING TO JOIN THE DRUIDS AND BECOME BEST CANDIDATE FOR CHIEF DRUID. I WANT YOU TO MAKE THERE BE A VACANCY"
 - "I SEEK RELIGIOUS POWER. I WANT YOU TO MAKE IT THAT I ASSUME LEADERSHIP OF THE DRUIDS"

QUESTIONS

- **WHY** QUESTIONS REFER TO **ABSTRACT** NODES
 - “WHY DO YOU WANT TO JOIN THE DRUIDS?”
 - TO BE IN A LOW POSITION IN THE ORGANISATION
- **HOW** QUESTIONS REFER TO **EXPANSIONS**
 - “HOW WILL YOU LEAD THE DRUIDS?”
 - I’LL JOIN UP, MAKE MYSELF BE BEST CANDIDATE, THEN MAKE THERE BE A VACANCY, THEN ASSUME LEADERSHIP
- REPLIES ARE **LIMITED** AT THE TOP AND BOTTOM OF THE TREE
 - “WHY DO YOU WANT POWER?” | JUST DO?
 - “HOW WILL YOU JOIN THE DRUIDS?” | JUST WILL!

CONTINUED

- **WHICH/WHAT/WHO** QUESTIONS REFER TO **VARIABLE BINDINGS**
 - “WHICH RELIGION WILL YOU LEAD?”
 - THE DRUIDS
- **WHEN** REFERS TO **POSITION** IN THE PLAN
 - “WHEN WILL YOU BECOME BEST CANDIDATE?”
 - AFTER I JOIN THE DRUIDS BUT BEFORE I MAKE THERE BE A VACANCY FOR THE LEADERSHIP
- **NOT** “TOMORROW AT 3:30PM”
 - **TEMPORAL** PLANNING IS **HARDER** ...

PROS/CONS

- ADVANTAGES:

- WE GET **MEANINGFUL**, INDIVIDUALISED QUESTS WITH A **COHERENT** NARRATIVE
- **REPLANNING** IS POSSIBLE IN RESPONSE TO **EVENTS**

- DISADVANTAGES:

- WE NEED A **LOT** OF PLANNING OPERATORS, SO IT COULD **STILL** BE EXPENSIVE...
- **TOO MUCH** OF THIS KIND OF THING WILL SLOW AN MMO SERVER DOWN **CONSIDERABLY**

USE

- **MODERN** MMO DEVELOPERS ARE STARTING TO **NOTICE** GOFAL AGAIN
- **SIMPLE** PLANNED ACTIONS **LOOK** INTELLIGENT
 - *STORYBRICKS* IS BEING USED IN *EVERQUEST NEXT*
- **PROCEDURAL** CONTENT-CREATION WENT OUT OF **FASHION** WITH *WOW* BUT IS NOW MAKING A **COMEBACK**
 - *RUNESCAPE'S* DUNGEONEERING SYSTEM CREATES RANDOM **DUNGEONS** SUITABLE FOR YOUR GROUP
 - *ELITE: DANGEROUS* CREATES ENTIRE **STAR SYSTEMS** ON THE FLY

CONCLUSION

- THE PAST CONTAINS **UNTAPPED** SEAMS OF **AI GOLD**
- I'VE USED MMO **QUEST** GENERATION AS AN EXAMPLE, BUT GAMES ARE **WIDE OPEN**
- WHAT **ELSE** CAN BE IMPROVED?
 - CRAFTING? COMBAT? TERRAIN? MAGIC? WEATHER?
 - **NOT** AUTOMATIC DIFFICULTY ADJUSTMENT THOUGH...
- I'M NOT SAYING YOU **SHOULDN'T** USE MCTS
- I'M JUST SAYING THAT THERE'S **MORE** TO AI THAN THE LATEST BIG IDEA, SO **CONSIDER** IT!