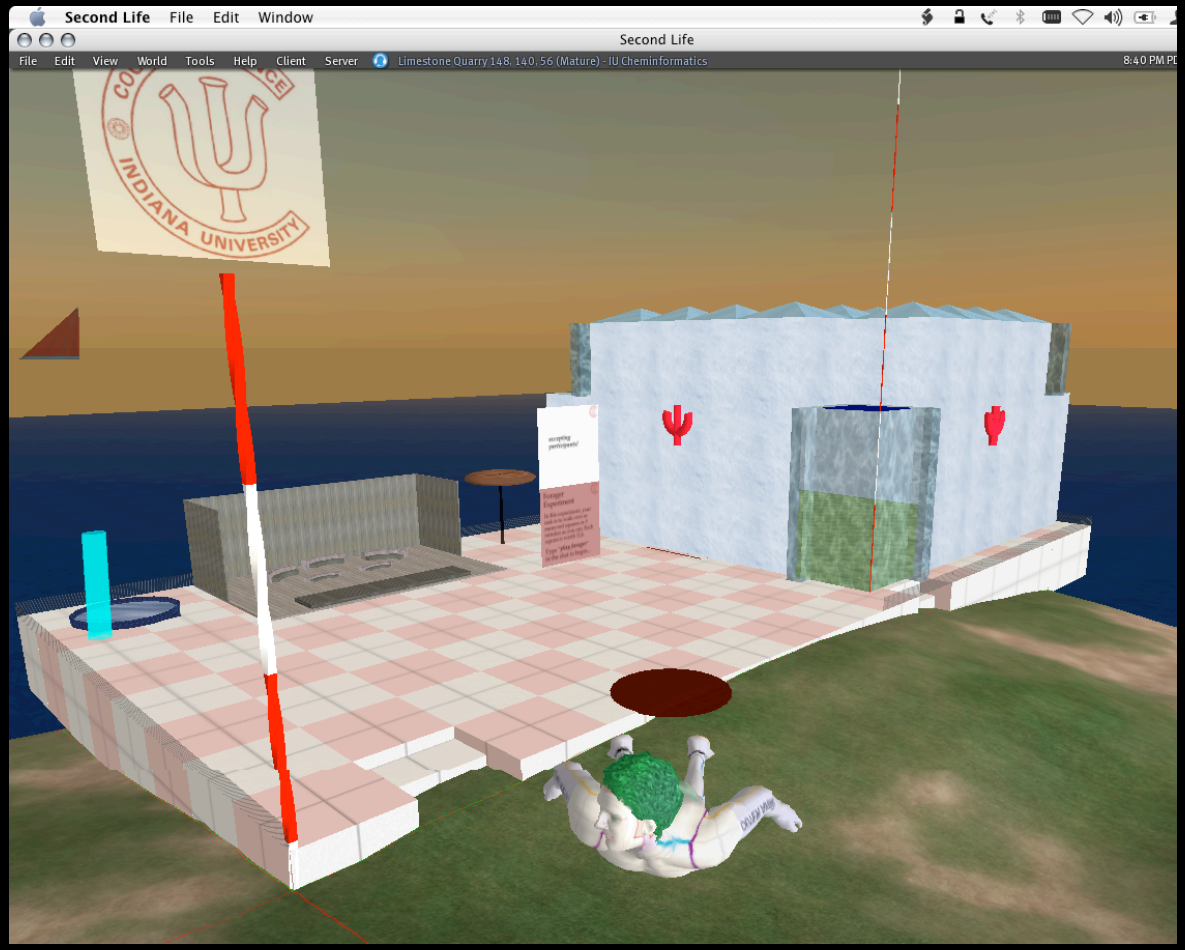
doing research in Second Life



"Abandon every hope, ye who enter here"

... upon the journey of our life I found myself within a virtual world, for the straightforward pathway had been lost ...

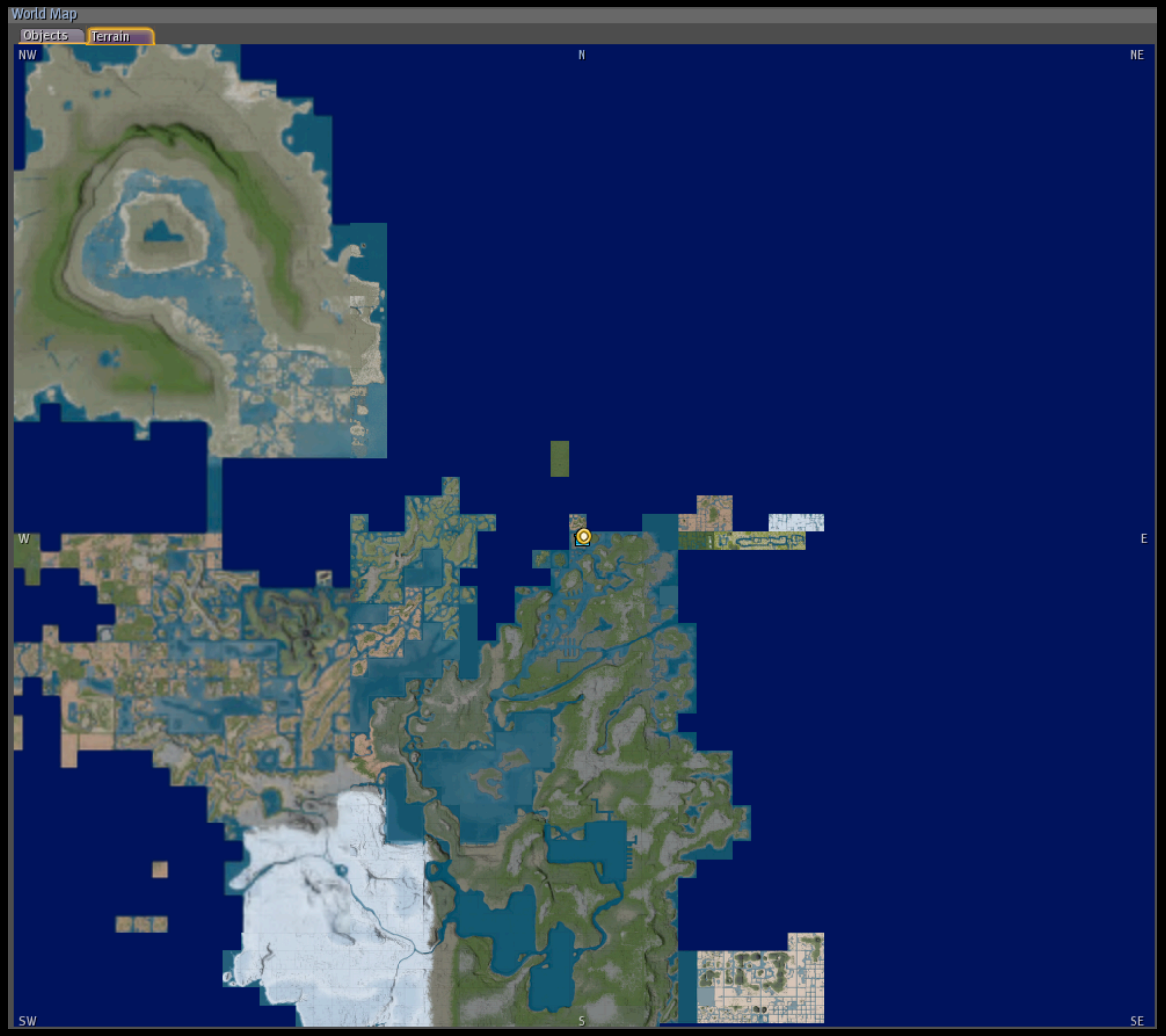
2008.02 Mitja Hmeljak mitja at indiana edu

introductory questions:

- how many of you know a programming language such as C, C++, Obj-C, Java, C# ...?
- how many of you have heard of Second Life?
- how many of you have a premium Second Life account?

- ... how many of you think the world is flat?

… but the world *is* flat!



in Second Life, that is.

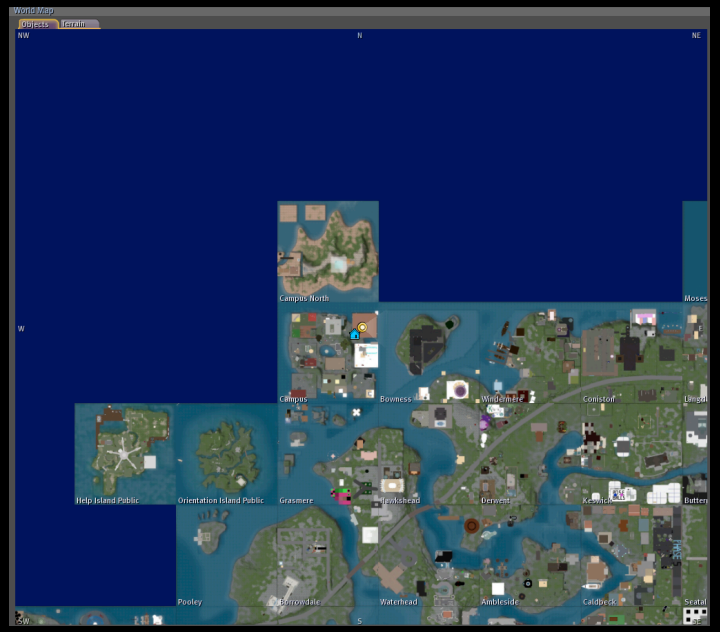
how to begin?

1. create a Second Life account (a free basic account will suffice) if you don't have one already
2. log in
3. populate the world with weird stuff!

- but first...

some Second Life concepts

- is it an MMOG, MMORPG, MMOSG, MUVE ...?



- in SL:
  - agents ≃ avatars
  - objects
    - made of prims
    - contain LSL scripts
  - regions run on simulators
    - island = region = simulator 1:1
  - physics simulation
    - not quite ≃ LSL

some SL terminology

- *prim* or primitive
  - ★ the simplest building block for SL objects. It's made of polygons.
- *rez* (verb) - to rez an object in SL:
  - ★ to create an object, for example by using `llRezObject()`
- *sim* = simulator ≃ region
- *HUD* or Heads-Up Display = 2D private object

is SL different from MMORPGs?

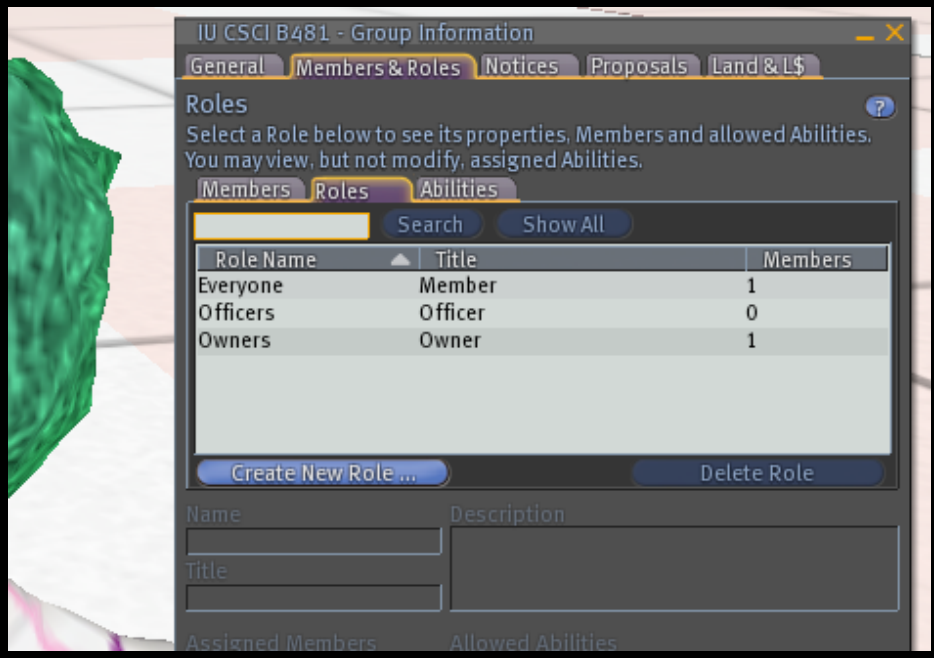
- SL users residents *build* and *own* most content
  - Linden Labs makes money on land maintenance (simulator runtime cycles)
- IP: creator's intellectual property
- in-world tools are the *main* content creation
  - most content creation happens in real time, in public

comparison to MMORPGs

- MMORPGs: users spend time to improve skills and advance levels
  - levels allow you to access new skills and abilities
- according to LL, SL is not a game (so, what's the point?)
  - there is no goal-conflict-resolution concept built in
  - all skills are reachable from day 1

groups in SL

- if you want to work with others in SL, create a group:
  - become group owner
- group officers
- everyone in group
  - abilities
  - land access



what really makes SL interesting for research and education?

- LSL = Linden Scripting Language
- available client-side to anyone with a basic *(free)* account
- affects agents and objects

SL underlying architecture, server side

- distributed grid of simulators
  - started with 20 CPUs
  - now several thousands simulators
    - Debian Linux, Opteron servers (*still?*)
  - each simulator holds object data and runs scripts (yes, even when everybody logs out)
- each simulator handles 16 *acres* (16 x 256^2m)
  - CPUs are mapped 1-to-1 with SL world geography
- million user processes (scripts) running on the SL grid at once
  - a few hundred million instructions per second - total!

SL simulators and LSL scripts

- *scripts* and *simulators* are (theoretically) close equivalents to ideal *programs* and *OS* according to the academic definition:
  - no script shall prevent the simulator from running
  - no script shall prevent other scripts from running
  - server-side CPU, memory limits
- *not* a guaranteed real-time system!

physics in SL... realistic simulations?

- Acceleration
- Buoyancy
- Energy
- Friction
- Force
- Gravity
- Impulse
- Mass (inertia)
- Torque
- Velocity

- Havok, Inc. engine
  - (soon to be updated to Havoc 4)
- rigid body simulation?
- mass, gravity, fluid
  - *(... insert spiffy SL demo here...)*
- avatar and object animations vs. physics
- users keep rewriting physics simulations in LSL
  - flight simulators
  - skateboards

LSL documentation: where is it?

- mostly user-supported documentation
- many *in-world* resources
  - several tutorials
  - mostly ~10-20 lines of
    - actual LSL code

- SL for Dummies
  - by 2 IU people!

- LSL wikis
  - `http://lslwiki.net/`
  - `http://rpgstats.com/wiki/index.php?title=Main_Page`
  - `http://wiki.secondlife.com/wiki/LSL_Portal`

intro to content creation in SL

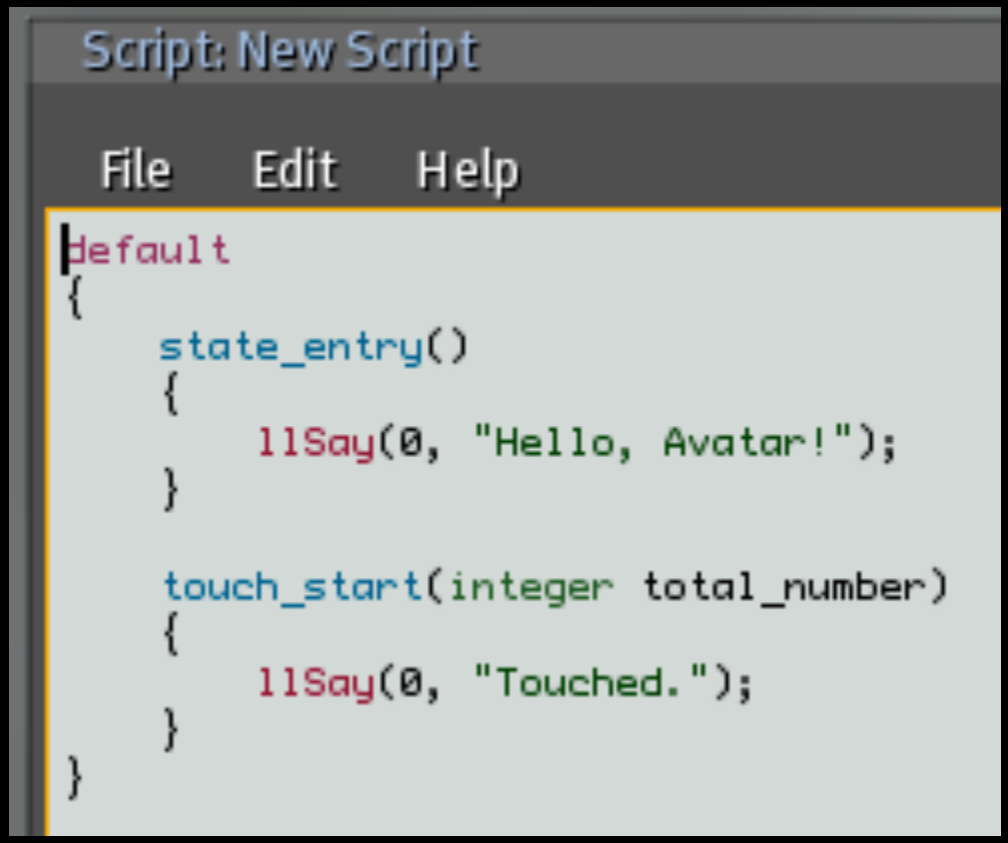
- how do you create content in SL?
  - objects and scripts = modeling and LSL
- how hard is it? LL says
  - web < wikipedia < SL < FPS mods < free SW
  - 25% of active SL user time is spent adding content
- objects:
  - solid-body modeler: not a polygonal modeler
  - client-side interface, server-side modeler (!)
- sculpties:
  - A **Sculpted Prim**, or *sculptie*, is a prim whose shape is determined by an array of `<x, y, z>` coordinates stored as RGB values in an image file (a Sculpt Texture or Sculpt Map).

LSL, the Linden Scripting Language

- scripts - just like for objects,
  - client-side editor
  - server-side bytecode interpreter runtime
- syntax is C-like (or Java-like?)
- interesting data types:
  - lists, vectors, quaternions (called *rotations*)

LSL semantics

- starting concepts:
  - events and
    event handlers
  - states
  - message-passing
  - library of functions



LSL details

- limit: each script no larger than 16kB total (code +data)!
  - message passing between scripts to achieve larger applications
- limits on: replication, emails, HTTP calls, memory, CPU use
- each region (= simulator) can handle several thousand scripts at once
  - the script scheduler is inside the simulator, not by mapping 1-to-1 scripts to OS threads
  - similar to how the JVM works

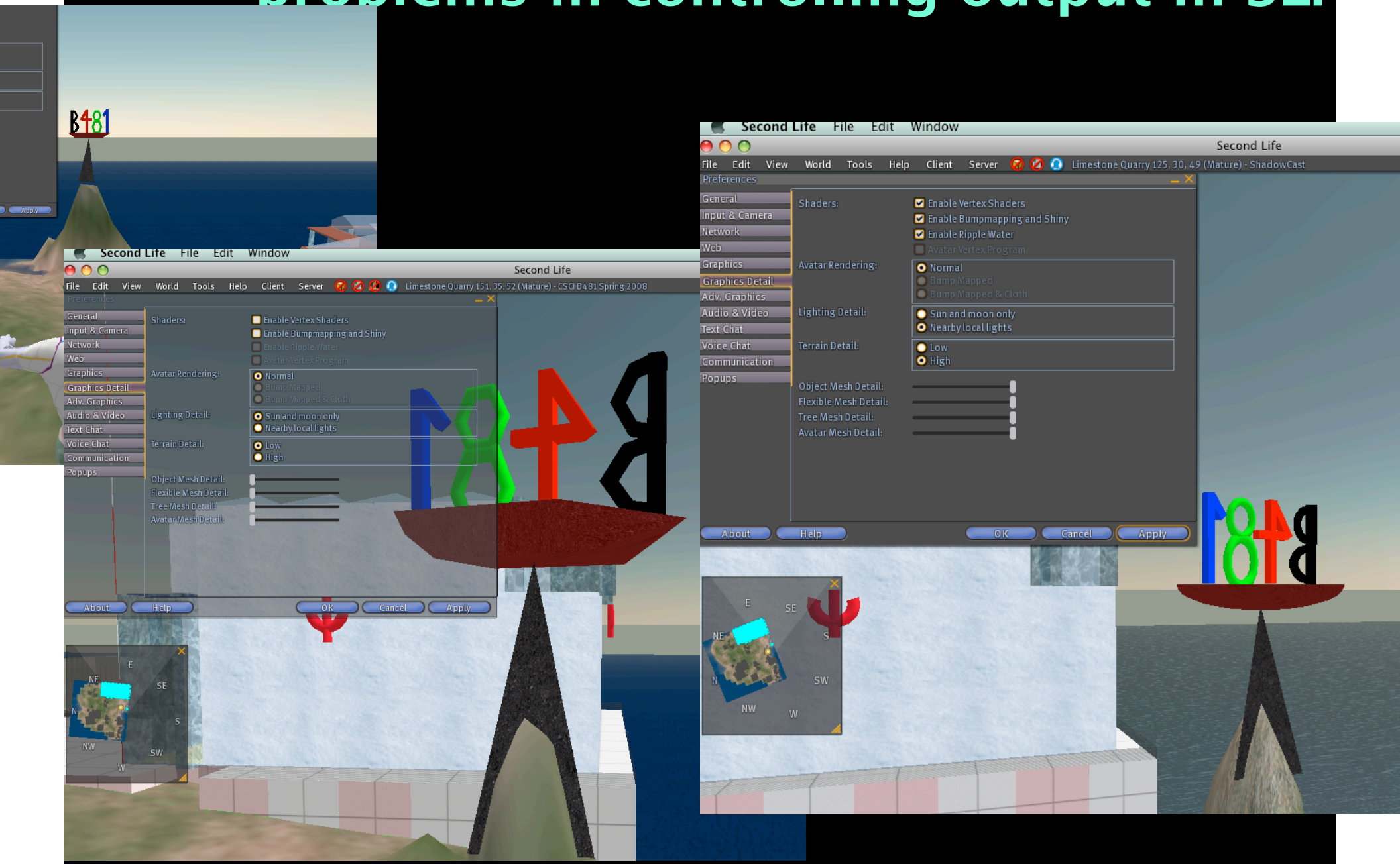
agent interaction

- agent as main interaction for user SL
- SL to agent, active:
  - dialog Y/N boxes
  - SL offering an object, L$, script, ... to agent
  - HUDs
  - SL returning an object, etc (automatically - lost & found)
- agent to SL:
  - direct touch/click actions
  - collision (involuntary?)
  - pie-popup menus
  - agent position detection (invisible)
  - object creation/editing/dropping

LSL communication methods

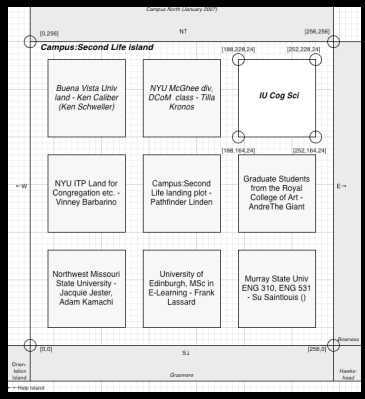
Method	Script Delay	Object owner	Other users	Other objects	Scripts in the same object	Send to computers outside SL	Receive from outside SL	Comment
Chat: Whisper, Say, Shout	No	Yes	Yes	Yes	No	No	No	Must be within chat distance to be able to receive.
`llOwnerSay`	No	Yes	No	No	No	No	No	Owner must be in the same sim.
`llDialog` Create	Yes	Yes	Yes	No	No	No	No	Only the directed user can receive and they must be in the sim.
`llDialog` Response	No	Yes	Yes	Yes	No	No	No	Receiver must be within chat distance of where the dialog box was created.
Instant Messages	Yes	Yes	Yes	No	No	No	No	
Link Messages	No	No	No	No	Yes	No	No	Only scripts contained within a given linked object may receive.
Email	Yes	No	No	Yes	Yes	Yes	Yes	link messages are better for intra-object communication.
XML-RPC	No	No	No	No	No	No	Yes	Only connections from an external computer to SL can be initiated.
HTTP	No	No	No	No	No	Yes	No	Only connections from SL to a non-Linden Lab server can be initiated.

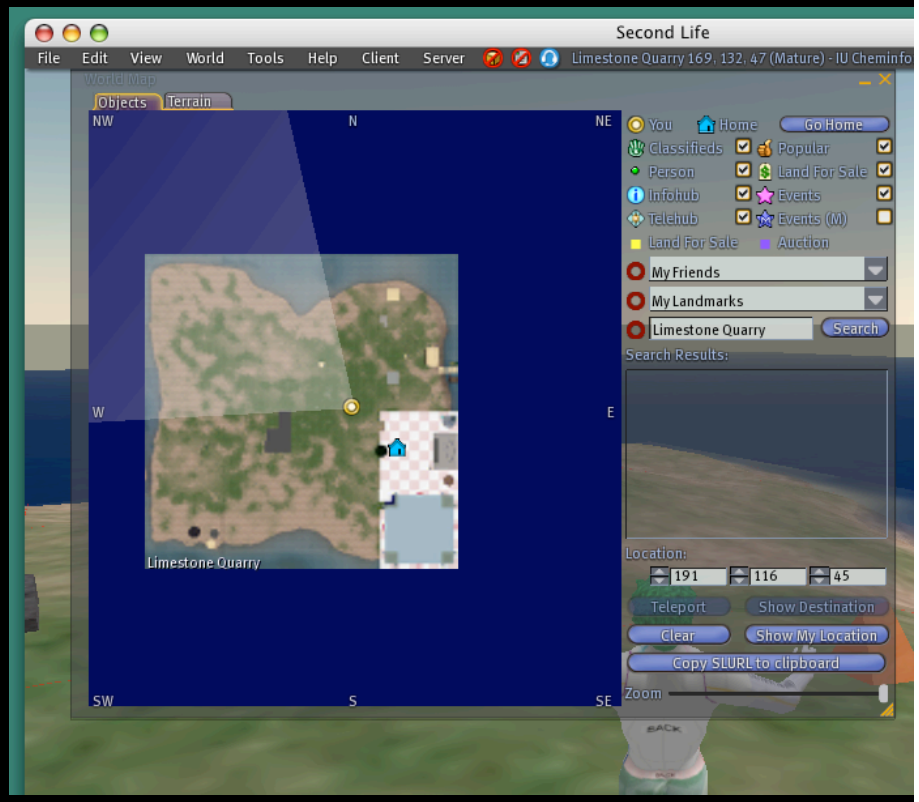
problems in controlling output in SL:



IU has an island in SL... or several!

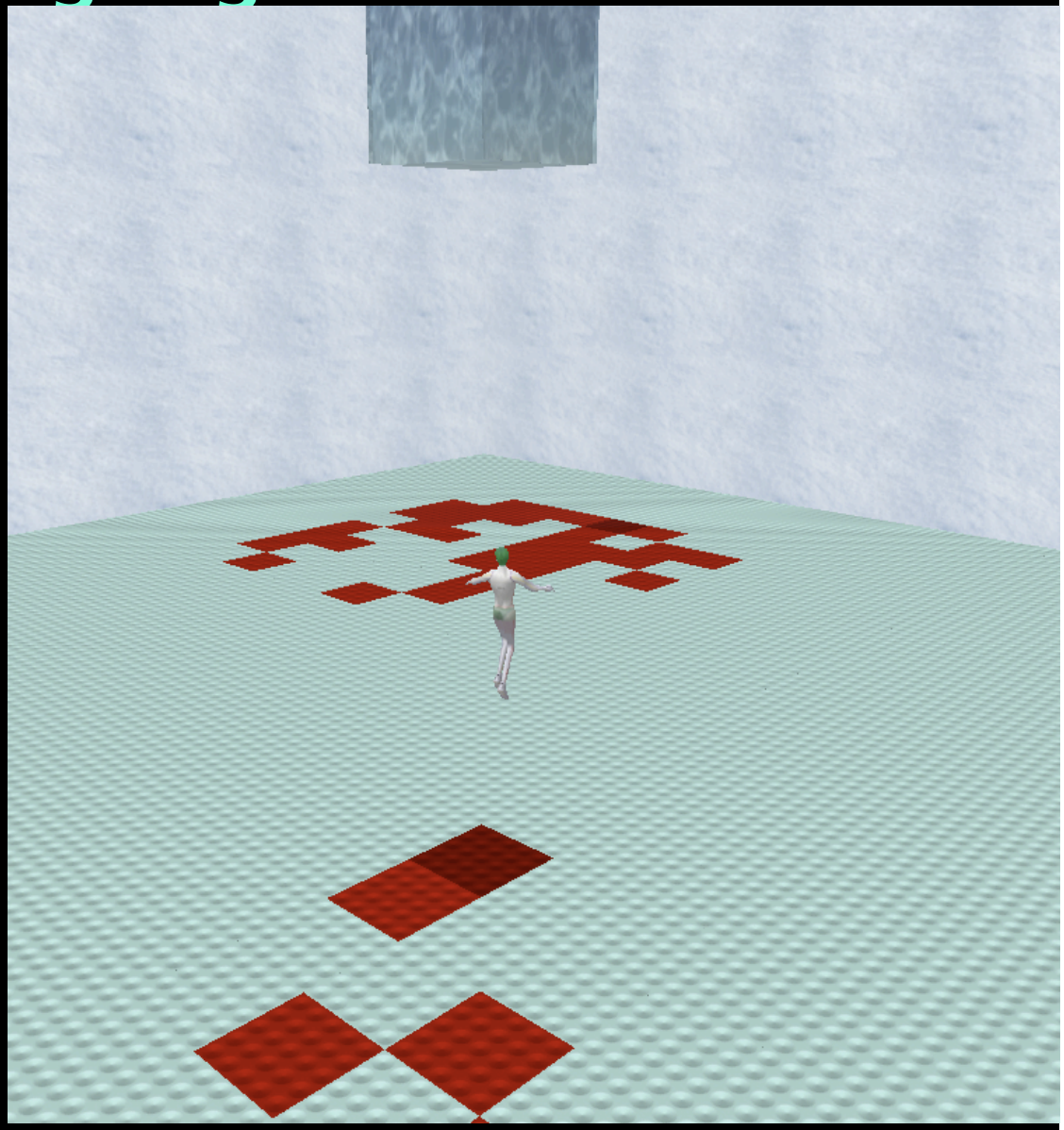
- before:
  - Campus: Second Life island
- now:
  - Limestone Quarry island
    - run by AVL
    - split in 1/8 parcels
    - COGS 1st user
    - IU courses...



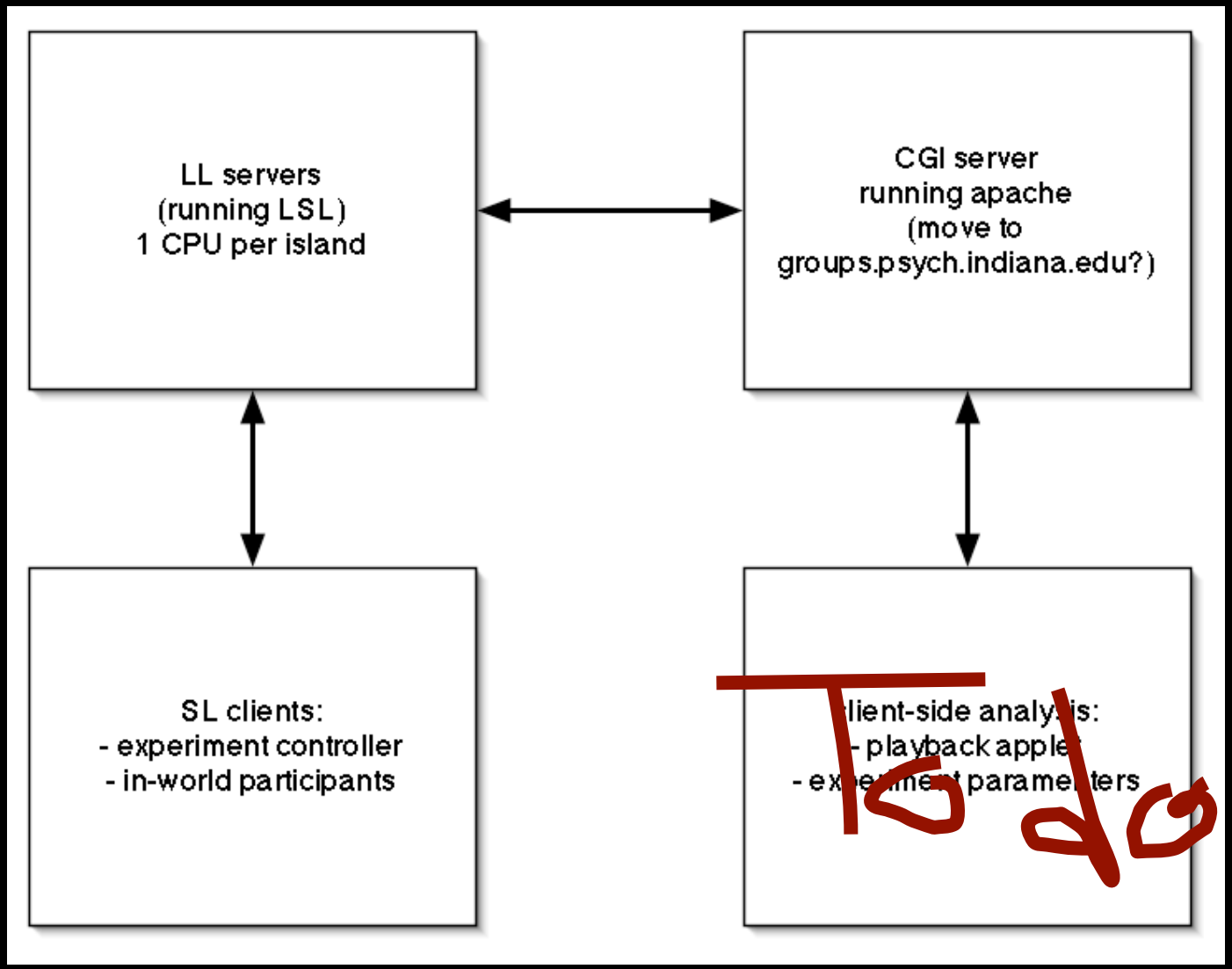


real-world (?) research in SL, example: Forager game in Second Life

- game room
- participants:
  SL avatars
- grid of squares
- gather L$
- participants
  - always visible
  - collision
  - walk/run

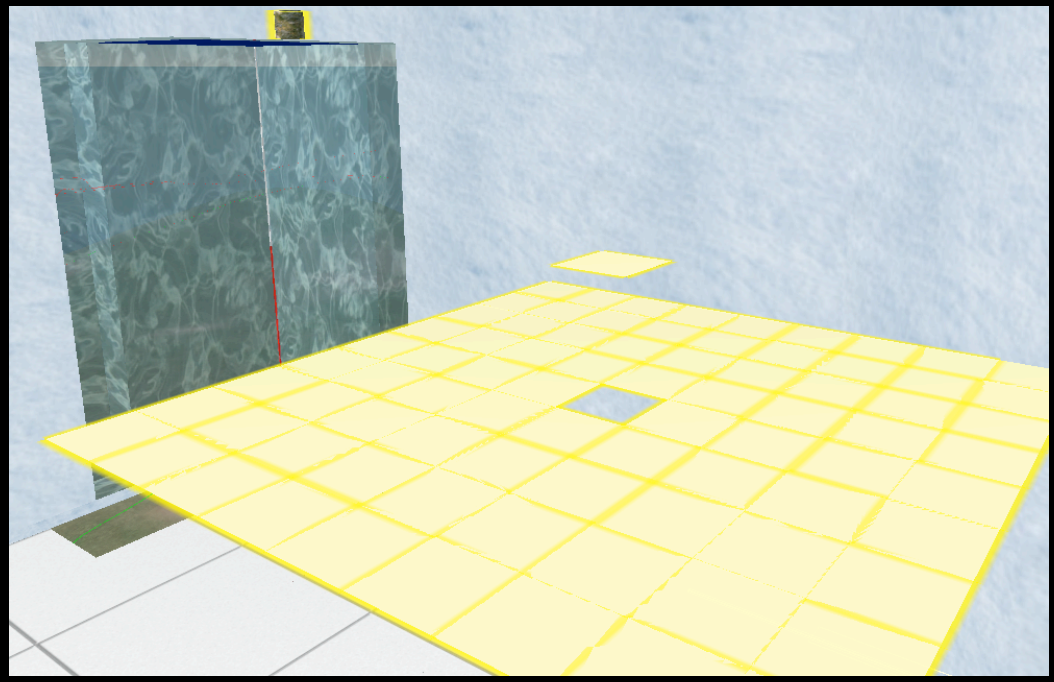


SL forager architecture

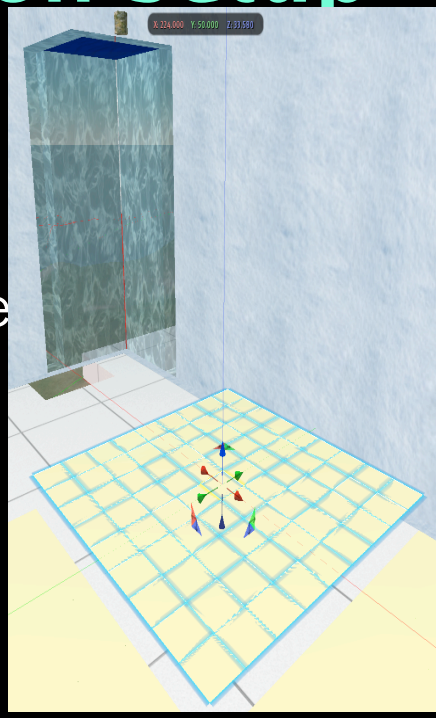


experiment infrastructure

- linked prims
  - (objects+scripts)
- 3-level structure
  - command receiver
  - 3x3 tile groups
    - each 9x9 linked tiles
  - master tile
  - tracking tiles



experiment communication setup



- command receiver:
  - listens to avatar controlling the experiment
  - computes experiment parameters
  - forwards commands & params to master tile
  - logs main run events
- master tile:
  - parses commands from command receiver
  - forwards to linked tiles (including itself)
  - listens to linked tiles for collision events
    - -> L$ payment to avatars
    - ->(determines resource pool growth, for CPR study)
- tracking tiles (all)
  - collision detection with avatars
  - logging events to remote server
  - linked message back to master tile

LSL forager architecture

master scripts: 1 per tile group	*slave scripts*=tiles: 9 groups of 9x9 tiles
llListen() to experiment controller object	*no* llListen()
llMessageLinked() to linked *slave* tiles	link_message() from linked *master* tile
llHTTPRequest() to remote cgi server	llHTTPRequest() to remote cgi server
no timer()	periodic timer()
no collision()	collision() for avatar tracking

data recording issues

- SL forager data
  - avatar movements
  - L$ collection
  - L$ generation
- data is sampled at *collision* between avatar and tile
  - data is recorded as soon as possible
  - it'd be nice to send it to HTTP server right away but...
- limit in HTTP communications:
  - used to be 20 calls / 100 seconds *per region per user!*
  - changed to 1 call / 1 script
  - there is an unspecified limit on HTTP calls/region

data recording implementation

- SL forager data collection
- local caching workaround
  - each tile holds data for up to 4 seconds
  - then sends bursts of collision data to HTTP server
- L$ generation triggers a separate event
  - data is sent to HTTP cgi server separately

data recording

- sample script on CGI server:
  - receives a number of lines from SL region
  - appends it to a local file
- sample tracking output from LSL forager:

```
xxxxx yyyyy|12345678-1234-1234-1234-123456789a02|0|
2007-09-20T04:09:35.142876Z|<222.00000, 42.00000, 32.00000>|
222.000000,42.000000
xxxxx yyyyy|12345678-1234-1234-1234-123456789a02|0|
2007-09-20T04:09:35.186389Z|<222.00000, 42.00000, 32.00000>|
222.000000,42.000000
L S|00000000-0000-0000-0000-000000000000|1|2007-09-20T04:09:35.857032Z|
<222.00000, 42.00000, 32.00000>|222.000000,42.000000

aaaaa bbbbb|22345678-1234-1234-1234-123456789fd8|1|
2007-09-20T04:09:35.340210Z|<222.00000, 46.00000, 32.00000>|
222.000000,46.000000
aaaaa bbbbb|22345678-1234-1234-1234-123456789fd8|0|
2007-09-20T04:09:35.429390Z|<222.00000, 46.00000, 32.00000>|
222.000000,46.000000
```

data recording

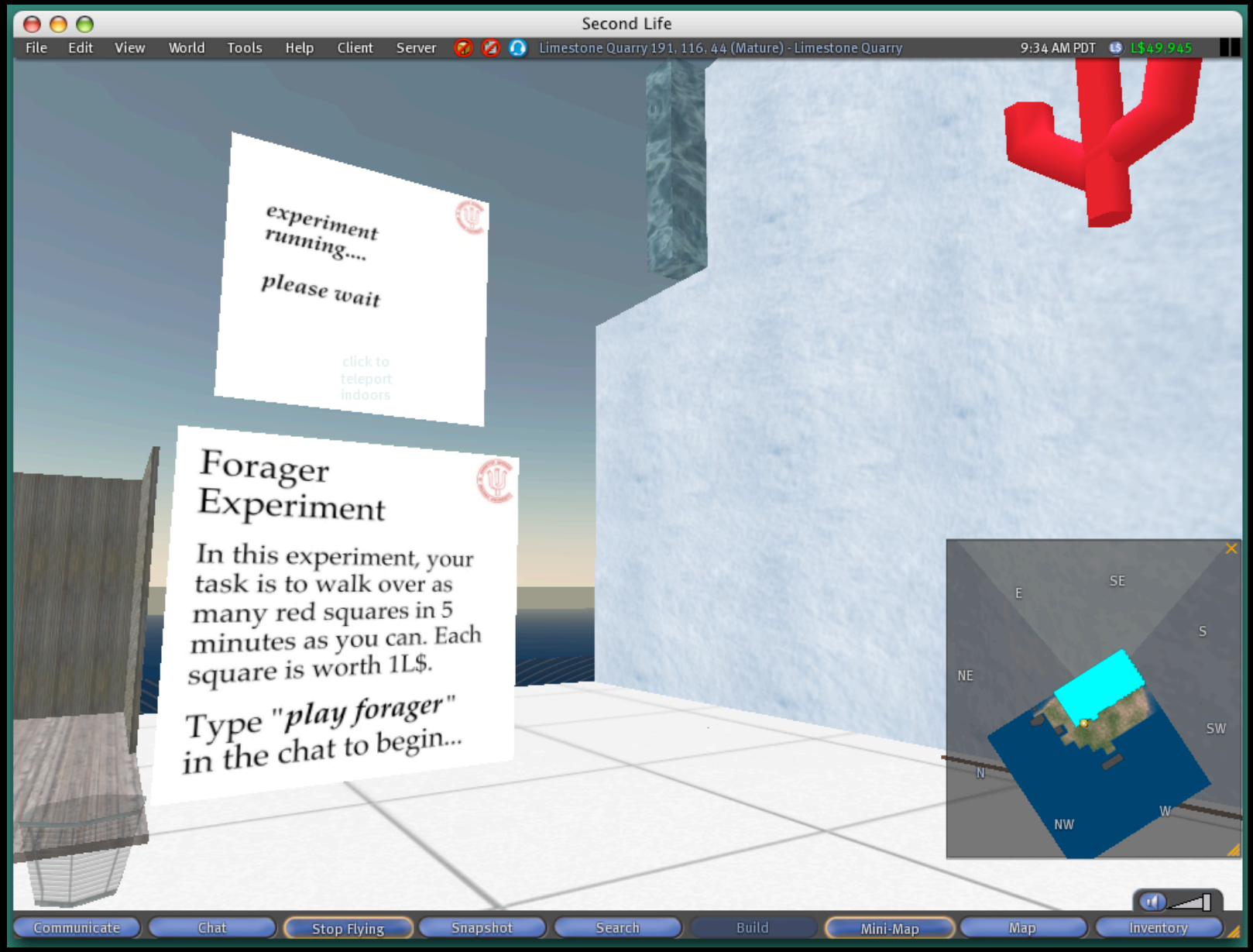
- sample log from apache server:

```
simXYZW.agni.lindenlab.com - - [20/Sep/2007:00:51:01 -0400] "POST /cgi-pub-script/lslTracking.php HTTP/1.0" 200 964 4315
simXYZW.agni.lindenlab.com - - [20/Sep/2007:00:51:01 -0400] "POST /cgi-pub-script/lslTracking.php HTTP/1.0" 200 719 4276
simXYZW.agni.lindenlab.com - - [20/Sep/2007:00:51:01 -0400] "POST /cgi-pub-script/lslTracking.php HTTP/1.0" 200 844 4314
simXYZW.agni.lindenlab.com - - [20/Sep/2007:00:51:01 -0400] "POST /cgi-pub-script/lslTracking.php HTTP/1.0" 200 985 4275
simXYZW.agni.lindenlab.com - - [20/Sep/2007:00:51:01 -0400] "POST /cgi-pub-script/lslCommands.php HTTP/1.0" 200 150 4310
simXYZW.agni.lindenlab.com - - [20/Sep/2007:00:51:01 -0400] "POST /cgi-pub-script/lslStatus.php HTTP/1.0" 200 209 4312
simXYZW.agni.lindenlab.com - - [20/Sep/2007:00:51:01 -0400] "POST /cgi-pub-script/lslStatus.php HTTP/1.0" 200 209 4269
simXYZW.agni.lindenlab.com - - [20/Sep/2007:00:51:01 -0400] "POST /cgi-pub-script/lslStatus.php HTTP/1.0" 200 209 4274
simXYZW.agni.lindenlab.com - - [20/Sep/2007:00:51:01 -0400] "POST /cgi-pub-script/lslStatus.php HTTP/1.0" 200 209 4316
```

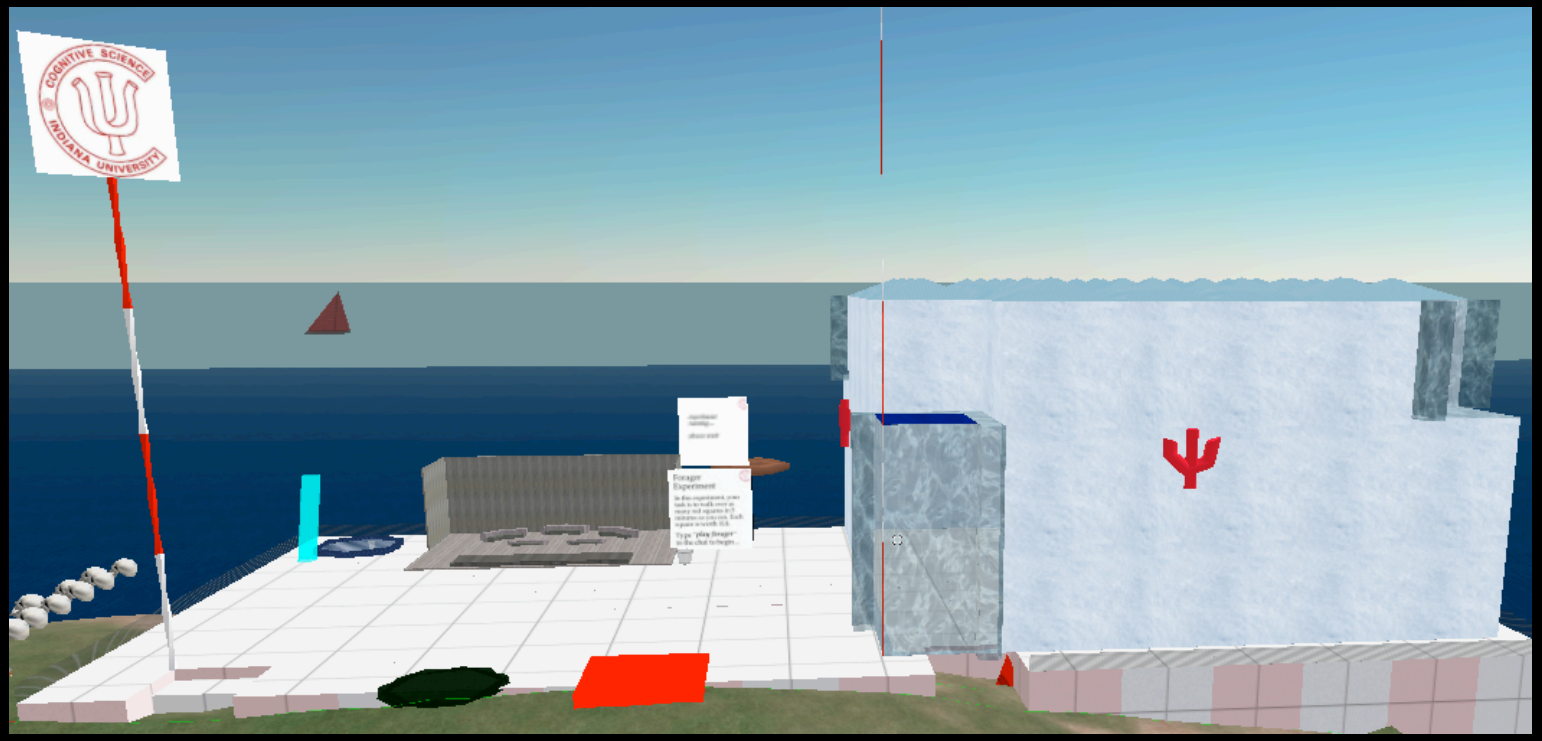
equal conditions for participants

- conditions for participants may vary:
  - client-side capabilities
  - SL experience, avatar movements
  - network delays
- level the field as much as possible:
  - instruct participants about *running* (cmd-R)
  - disable L$ notification pop-up
  - flying is disabled
  - graphics details to min.necessary
    - 128m draw distance for clipping
    - graphics rendering - all settings to low

how does it look like?

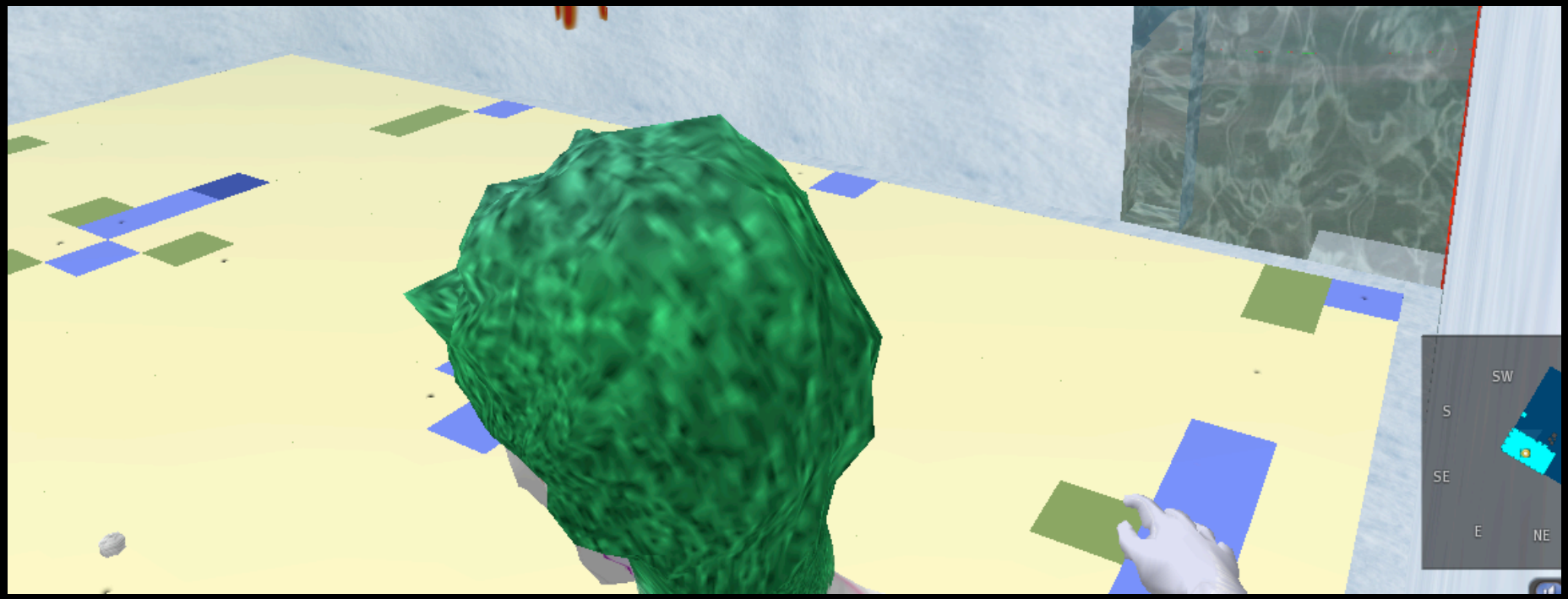


newly started experiment setup: Common Pool Resource study in VR:



- Second Life setting similar to Foraging study:
  - briefing/debriefing area
  - experiment room
  - access control

Experiment Setup for Common Resource Pool study in VR:



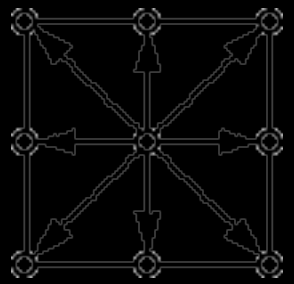
- resources appear in form of colored tiles
  - 27x27 grid of cells/tiles

resource growth and harvesting

- resources are collected by stepping on a tile
  - simplest setup: first-detected collision triggers 1L$ to avatar
  - better setup: collision adds L$ to avatar's account (visible somewhere near resources)

- resource growth probability:

  - for each cell c, $p_c(t) = p * [n_c(t-1) / N]$
    - n_c = number of active adjacent cells
    - p = growth parameter
  - N = 8-connected neighborhood



experiment to-do:

- allowing rules for common property regime:
- communication between avatars always possible (chat, voice)
  - possible private channels
- avatar movement restriction:
  - easy at parcel level
  - cumbersome to implement on less than entire parcel
  - possible to implement no-pay or no-harvest zones
- sanctions by group:
  - can't take away L$ from avatars
  - use draft account per participant
  - allow avatars to subtract L$ from others at personal cost

references *(need to be updated!)*

[1] - *A piece of place: Modeling the digital on the real in second life*, Cory Ondrejka, Design Computing Cognition 2004
http://wwwfaculty.arch.usyd.edu.au/kcdc/conferences/dcc04/workshops/workshopnotes7.pdf

[2] - Linden Scripting Language wiki:
http://rpgstats.com/wiki/index.php?title=LSL101Chapter1

[3] - Campus: Second Life program:
http://www.simteach.com/wiki/index.php?title=Campus:Second_Life

[4] - *User Creation and Scripting in Second Life*, Cory Ondrejka and James Purbrick, Lang.NET Symposium 2006

[5] - *SL Virtual Economy Metrics*, Linden Labs 2007.02.02

[6] - *Havok 2*, Andrew Meadows, SL Developer's Journal 2003.10.23

for more information

- mitja et indiana edu
  - in-world as Mitja Omlet (fine, alright...)
- on IU CogSci space on Limestone Quarry island
- also on **IU CSCI B481** course space on Limestone Quarry island for Spring 2008:
  - http://slurl.com/secondlife/Limestone%20Quarry/128/128/

- ...then we came forth, to see again the stars...