

# Design and Development of the ICEACE Simulator

Roni Bülent Özel

Reykjavik University  
School of Science and Engineering  
bulent.ozel@gmail.com

bulent@ru.is **Einar Jon Erlingsson, Marco Raberto, Hlynur Stefansson**

June 22, 2013

WEIHA 2013, Reykjavik, *n*Iceland

- Home: <http://iceace.github.io/home>
- Matlab: <http://iceace.github.io/MATLAB>
- FLAME: <http://iceace.github.io/FLAME>

- Agent Types:
  - Household
  - Firm
  - Bank
  - Equity Fund
  - Central Bank
  - Government
- Markets:
  - Labour Market
  - Production Markets (Consumption Goods, Housing Units)
  - Consumption Goods Market
  - Housing Market
  - Credit Market
- Communication Schemes:
  - Direct Messaging
  - Balance Sheet Flows
  - Agent-Agent Links
- Initialization

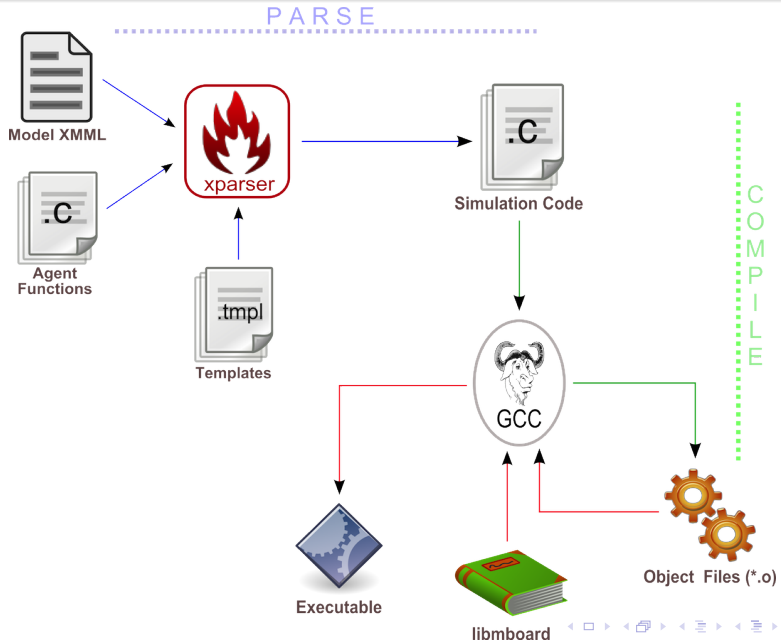
# Multi-agent Design Challenges

- Agents
  - Role Multiplicity
  - Beliefs, Desires, Intentions
  - Autonomy
- Environment
  - Context
  - Influence
- Communication
- Scalability

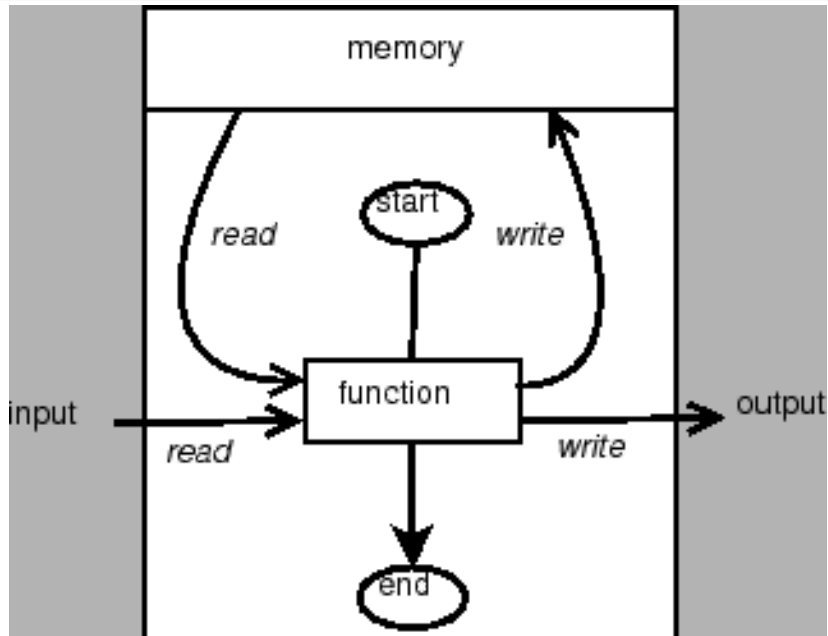
# ICEACE Implementation Choices (FLAME)

- Distributed Computing
  - XMachine
- Object Oriented Programming Paradigm
  - XMachine Markup Language (XMML)
- Message Passing
  - Message Boards (Broadcasting)
  - Message Filtering (Links)
- Synchronization
  - Time Units: Day (1), Week (5xD), Month (4xW), Quarter (3xM), Year (12xM)
- Acyclic Dependencies
  - Exclusive State Transitions
- High Performance Computing
  - MPI Protocol
- Initialization
  - Pythonic Agent Initialization Description Language (PyAIDL)

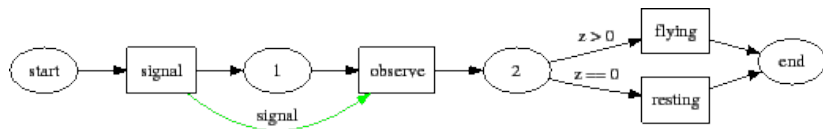
# FLAME Multi-agent Design Frame Framework



# XMachine - A Single Design Unit



# State Transitions





Overall state transition and communication graph of ICEACE model:

[http://iceace.github.io/FLAME/doxy/stategraph\\_colour.pdf](http://iceace.github.io/FLAME/doxy/stategraph_colour.pdf)

# Conceptual Design Vs Implementation

- Pseudo Agents
  - Real Estate Agency
  - Job Placement Office
  - Mall
  - *Census Bureau*
- Agent Subtypes
  - Households: Capitalist, Non-capitalist
  - Firm: Constructor, Regular
- Mortgage Durations & Annuity

<http://iceace.github.io/FLAME/doxy/summary.pdf>

- State Variables (memory)
- Functions (behaviours)
- Messages (communication)

## Model Descriptions:

`https://github.com/ICEACE/FLAME/blob/master/  
model\_v0.1.0.xml`

- Monthly
- Market opens first day of the month
- Payments are done at last day of the month
- Market closes either when all positions are filled or all households are employed.
- Employment turnover is possible
- Skilled households are given priority
- Firing, new hiring, and *wage adjustment* is possible

[http://iceace.github.io/FLAME/doxy/stategraph\\_colour.pdf](http://iceace.github.io/FLAME/doxy/stategraph_colour.pdf)

- Monthly
- Regular products are produced monthly
- A housing unit is completed in 12 months
- Production function
- Pricing
- Production planning
- Labour requirements

[http://iceace.github.io/FLAME/doxy/stategraph\\_colour.pdf](http://iceace.github.io/FLAME/doxy/stategraph_colour.pdf)

# Consumption Market

- Weekly
- Limited yet monthly adjustable disposable consumption budget
- Unspent budget maybe used in subsequent weeks
- Wealth effect as a mean of shock transmission mechanism from housing markets
- Arrival to mall is random
- Cheaper products have a higher probability to be consumed first

[http://iceace.github.io/FLAME/doxy/stategraph\\_colour.pdf](http://iceace.github.io/FLAME/doxy/stategraph_colour.pdf)

- Monthly
- Housing units or homogenous
- Constructor firms, buyers, sellers
- Fire sale cases
- Pricing
- Mortgage requirements
- Annuity

[http://iceace.github.io/FLAME/doxy/stategraph\\_colour.pdf](http://iceace.github.io/FLAME/doxy/stategraph_colour.pdf)



- Monthly
- Loans
- Mortgage annuity adjustment
- Equity Fund
- Illiquidity
- Insolvency

[http://iceace.github.io/FLAME/doxy/stategraph\\_colour.pdf](http://iceace.github.io/FLAME/doxy/stategraph_colour.pdf)

- Quarterly, monthly, weekly.
- Interest rates
- Tax rates and taxing
- Inflation, unemployment
- General benefits, unemployment benefits

`http://iceace.github.io/FLAME/doxy/statgraph\_`  
`colour.pdf`

# Computational Challenges

- Initialization
- Load Balancing
- Time Performance  $O(|AgentCount|)$
- Memory Management

# ICEACE Iterative Design Process

- **Theoretical Design**
- **Prototyping**
- **Iterative Multi Agent Design Cycle:**
  - **Model Description (XMML):**
    - Memory
    - Action Description
    - State Transitions
    - Activation Conditions
    - Inputs: (filtering, sorting, randomizing)
    - Outputs
  - Behaviors (C Functions)
  - Unit Testing
  - Modular Verificatation
- **Initialization (via PyAIDL):**
  - Setting policy parameters
  - Instantiating agents
  - Initializing agent memories
- *Validation Experiments*

- Calibration
- Randomness
- Parameter sensitivity
- Empirical Tests

# Serial Run Time

- Households: 8000, Firms: 125(regular) + 25(constructor), Banks:2, Central Bank, Government, Job Placement Office, Real Estate Agency, Mall
- Dual Core MacPro OS 10.8.4, CPU 2.26 GHz, RAM 4G 1067MHz
- Debug Mode
- 50 runs
- Avg clock time  $\approx 7min$