Simulation Interoperability Standards Organization

"Simulation Interoperability & Reuse through Standards"

Workshop theme for 2017: "Simulation – Enabling Real-World Innovation"

New Technologies to Enhance Computer Generated Interactive Virtual Humans

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Basic Thesis of Paper

The use of Virtual Humans is increasingly important to the defense of this nation. The human qualities of these entities continues to grow, but there are still many grand challenges facing this community. Fortunately, new advances in technology are emerging that may help meet the remaining grand challenges. This paper examines the use of Virtual Humans, identifies many of the Grand Challenges, and identifies a few of the more promising approaches to implementing the new capabilities in the quest of more effective training, analysis and evaluation. The authors then consider the various impacts of these issues.

The US is Under Attack

- The US faces a growing number of threats
- Defense budgets continue to be curtailed
- Operations tempos continue to rise
- Simulation offers an economical way to counter this

Gallup Poll results for US Enemies

N. Korea, Russia, Iran, China Rotate Top Spots on "Greatest Enemy" List

What one country anywhere in the world do you consider to be the United States' greatest enemy today? (open-ended)

	2014	2015	2016
	%	%	%
North Korea	16	15	16
Russia	9	18	15
Iran	16	9	14
China	20	12	12
Countries in which ISIS operates	0	4	5
Iraq	7	8	5
Afghanistan	5	3	4
Syria	3	4	4
Other	13	15	11
None	2	1	4
No opinion	9	12	11

GALLUP

The Uses of VH's are Varied

- An critical part of the simulation tool kit is humans
- Virtual humans are used in many ways
- At ICT they are used to
  - Capture memories of holocaust survivors
  - Advise young STEM students
  - Counsel PTSD patients

VH's Take lots of Compute Power

- **Virtual Humans consume lots of compute cycles**
  - Voice recognition requires support
  - Visualization is compute intensive
  - Natural Language Processing must be fast and correct
  - Lighting subjects for holographic displays is complex

Grand Challenges of VH's

1	VH's recognizing and responding appropriately to: • Sarcasm • Humor • Irony
2	Distinguishing multiple speech acts represented by one word (e.g. "In the Navy, he took a new course.": Ship's direction or study regimen?)
3	Haptics (*e.g.* a handshake)
4	Emotional expression(s) of VH
5	VH's facial expression appropriate to what is being said by user
6	Being able to act in the world (virtual or real) as well as talk. (That is, have the VH be able to plan out and take actions that affect the state of the real or virtual world.)
7	VH's ability to learn from interactions with persons and use what it learns intelligently
8	Knowing when and how for VH to utilize lifelike body language or hand movements
9	Merging clips to deliver responses with continuous smooth motion
10	Providing believable empathy/understanding as an AI
11	VH ability to interact with multiple humans or sources of input simultaneously
12	VH interrupting speech or being interrupted

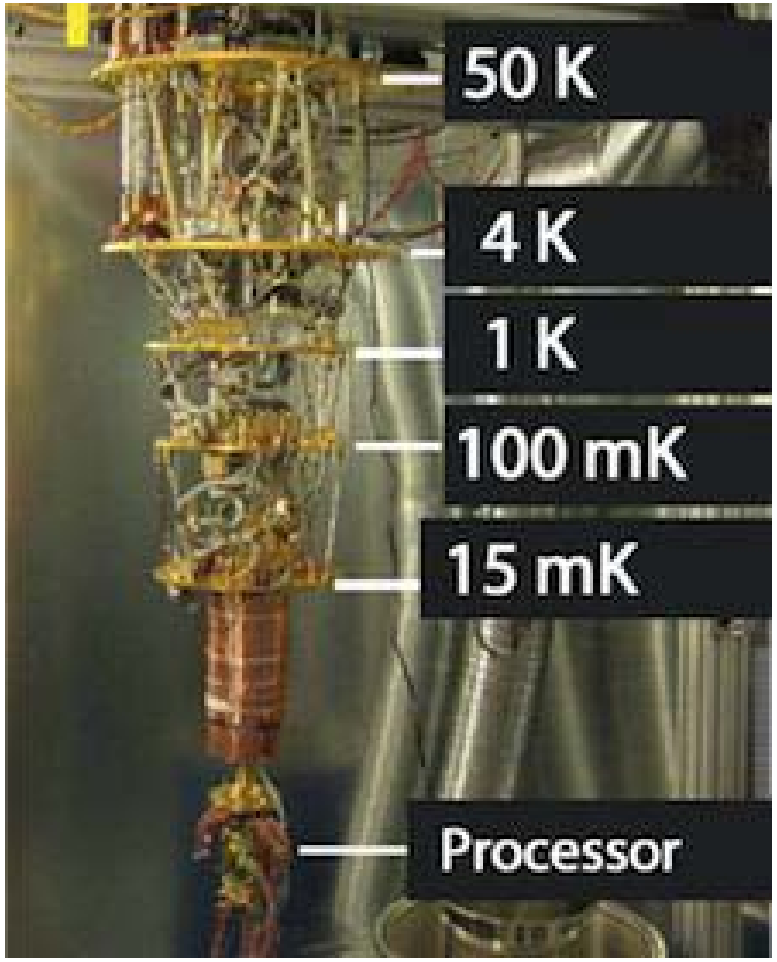
Quantum Computer

- Richard Feynman of Caltech proposed in the 1980's the power of a "Quantum Computer"
- Instead of a binary value of one or zero, it uses "qubit" with a quantum range of values.
- General purpose quantum computing is still the stuff of speculation and vociferous argument.
- D-Wave has delivered a quantum annealer to USC
- Another is Google's, in the San Francisco Area
- They operate at a chilly 0.0015K (15 milikelvins)

USC's D-Wave

Using Quantum Computers

- A quantum computer should demonstrate incredible computational power
- It can be in multiple states at once, a condition called “superposition.” It can act on all its possible states simultaneously.
- It can evaluate a series of optima beyond the power of the largest digital computer.



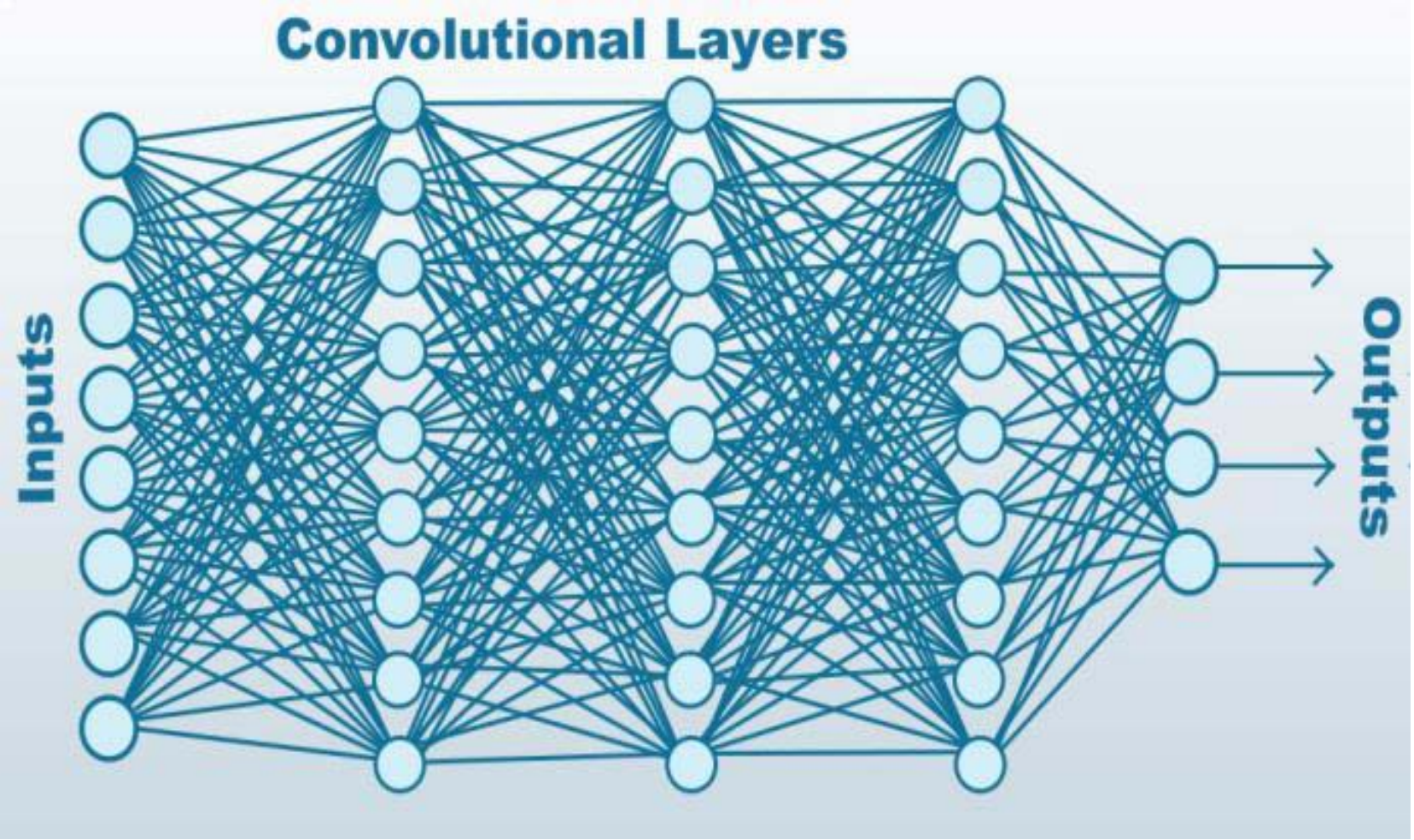
Slide based on "Double List"

- Virtual Humans need more sophisticated analytic techniques
- Much of what is needed depends on analysis of Big Data
- Big Data may be large amounts of text or imagery
- Analyzing this is not trivial
- Neural Net learning may fall short
- Deep learning promises to help overcome this obstacle
- Instead of applying the weights and selections of simple neural nets, deep learning filters using a series of steps called hidden layers
- This process is a technique that may also be amenable to implementation via a quantum computer

Deep Learning

- From simple Perceptrons to multi-layered deep networks
- Broad applicability to many real-world problems
- Extremely difficult to train good networks – may take thousands of hours on a server farm
- Techniques enabled by development of GPUs and efficient parallel computing methods
- The next step: introducing quantum devices to the mix
- We can translate certain types of networks into a form a D-Wave device understands

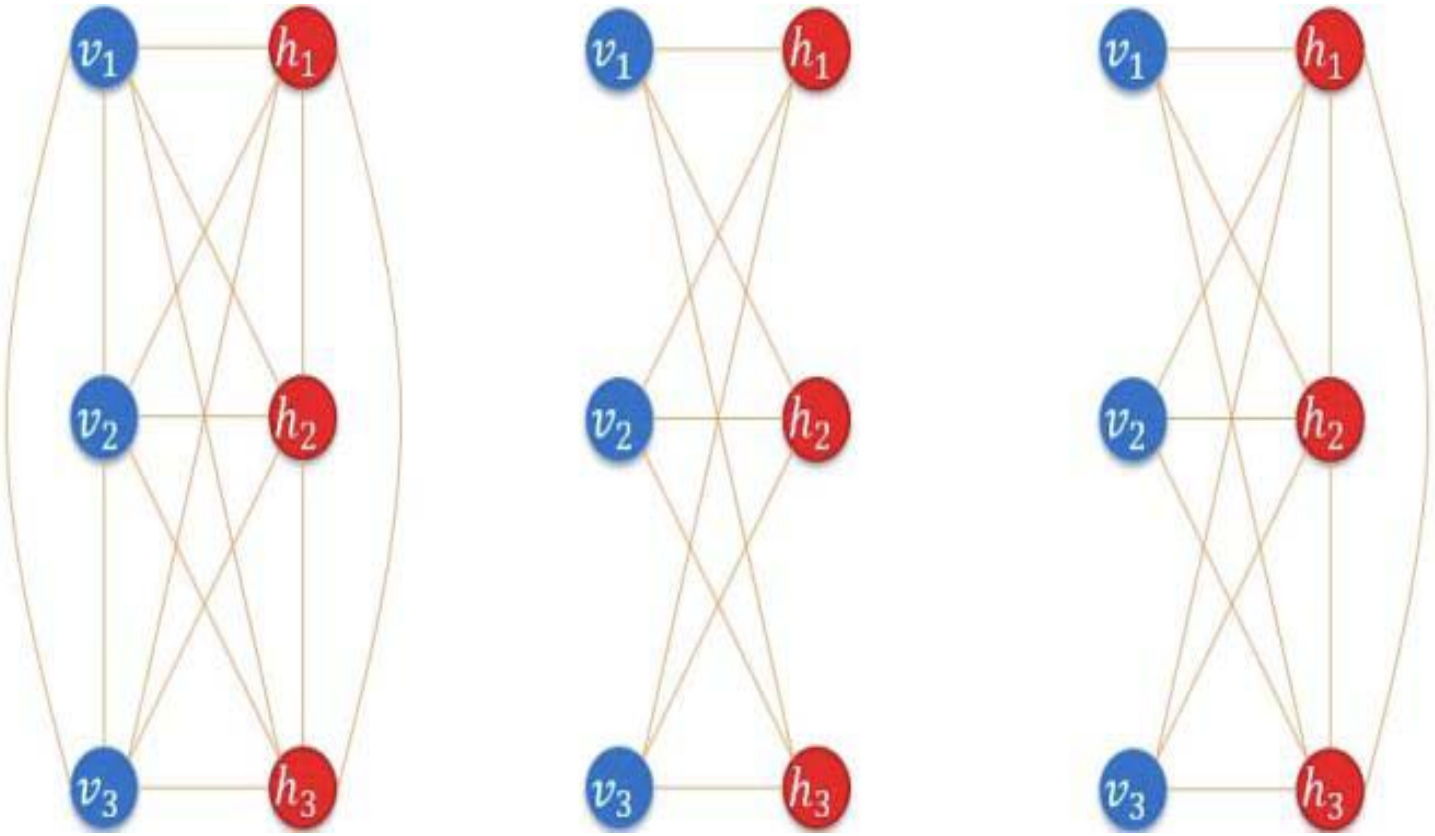
Deep Learning Layer diagram



Computing Networks

- Networks with “loops” are difficult to compute
- Even behemoth computing clusters will quickly find such complex networks to be intractable
- A potential niche for quantum devices: as accelerators
- D-Wave computes network optima, whether or not loops exist; may as well include them!

Boltzmann Machine Diagram



Caveats

- **Not a general-purpose computer**
- **Spatial reality: limited network connectivity**
  - A D-Wave qubit can only have 6 connections to other qubits
  - A human neuron can have thousands of connections
- **Stochastic process: we only have a "good chance" of getting an optimal answer**
- **Resource competition: few quantum devices, many users**

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QUESTIONS