

Spoken Dialogue Models for Virtual Humans

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Der Traum von der
großen weiten Welt ...



USC

 **ICT**
INSTITUTE FOR CREATIVE TECHNOLOGIES

Outline

- **Overview of ICT**
- **Dialogue Genres**
- **ICT Conversational Systems and Architectures**
 - Question-answering characters: Sgt Star & Interfaces
 - Transaction Dialogue: Radiobots
 - Bargaining Dialogue: TACQ
 - Multiparty Negotiation Dialogue: MRE & SASO

Overview of ICT

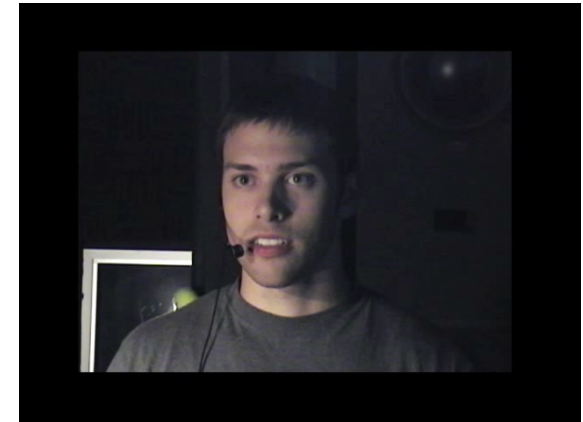
- **Part of University of Southern California (USC)**
 - basic and applied research in immersive technologies to advance and maintain the state-of-the-art for human synthetic training experiences so compelling that participants will react as if they are real.
 - Partnership of academic research community with entertainment industry
 - Founded in 1999
 - <http://ict.usc.edu/>

ICT Research Areas

- **Graphics**
 - Make objects and people look real
- **Mixed Reality**
 - Immersive environments that engage the full palette of human senses
- **Virtual Humans**
 - Simulate the human element
- **Social Simulation**
 - Simulate groups of people, populations
- **Learning and Therapeutic Sciences**
 - Design and manage the experience for effective learning and therapy
- **Systems Engineering and Integration**
 - Leverage game engines and digital assets for prototype development

Spoken Dialogue: Participating in Conversation

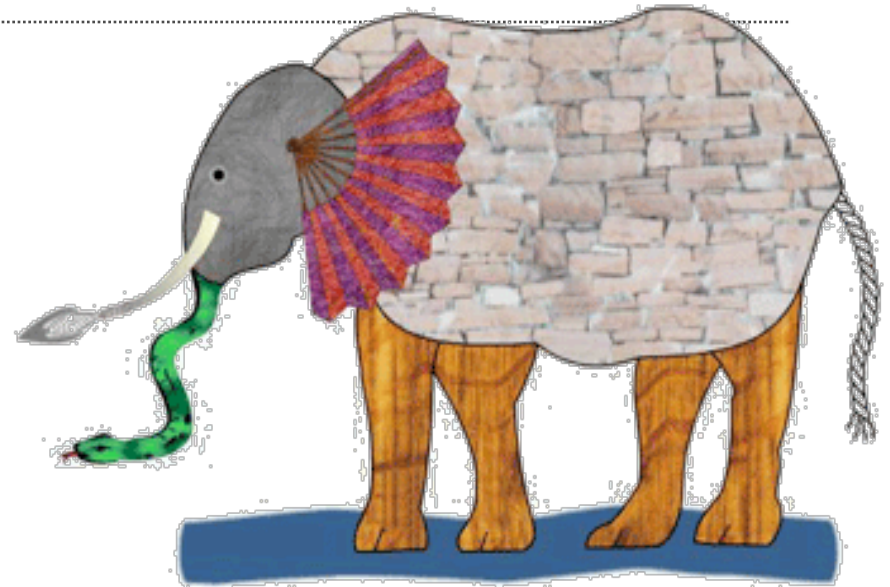
- **Understanding Human Language**
 - What does a person say?
 - What does the speech mean?
 - In context of current interaction
 - What did the person try to accomplish?
 - In terms the virtual human can understand
- **Integrating Language & Managing Dialogue**
 - How does speech affect virtual human?
 - What new information is provided? What updates have to be done?
 - What opportunities are opened for addressing vhuman goals?
 - What new obligations and threats must be managed?
 - How is this information communicated to other modules
 - (e.g., planning, emotion)?
- **Producing Language**
 - Deciding when to speak (or listen or act)
 - Deciding what to say
 - choosing the appropriate meaning
 - Deciding how to say it
 - so partner can understand it
 - So expression seems natural



Theory of Dialogue?

- **The Blind Men and the Elephant**

- **The first blind man put out his hand and touched the elephant's side. "How smooth!" he said. "An elephant is like a wall."**
- **The second blind man touched the trunk. "How round! An elephant is like a snake."**
- **The third blind man touched the tusk. "How sharp! An elephant is like a spear."**
- **The fourth blind man touched the leg. "How tall and straight! An elephant is like a tree."**
- **The fifth blind man touched the ear. "How wide! An elephant is like a fan."**
- **The sixth blind man touched the tail. "How thin! An elephant is like a rope."**



- Dialogue is air/railroad booking
- Dialogue is direction giving
- Dialogue is small-talk/story telling
- Dialogue is meeting planning
- Dialogue is call-routing
- (multiparty) Dialogue is meetings

Dialogue Genres: Matching the Problem with the Solution

- **There is no “one-size fits all” solution**
 - Natural language dialogue is an “AI-complete” problem
 - need all knowledge and human-level reasoning for the general case
- **But many types of dialogues can be handled!**
 - Many sub-problems can be (and have been!) solved for practical purposes
 - e.g., limited voice menu, database retrieval
 - Many proposed techniques: ranges of applicability, resource requirements, generality, accuracy, costs (development time and runtime), scalability
- **Dialogue Genre taxonomy**
 - Analyze complexities and requirements of domain and pair with best processing methods

Aspects of Taxonomy of Dialogue System Genres

- **Goals of Dialogue System**
- **Complexity of Behavior**
- **Context for Dialogue**
- **Type of User**

Goals of Dialogue Agent

- **External view (black box)**
 - Surface behavior
 - Holistic performance/acceptability
- **internal view (glass box)**
 - internal coherence/representational fidelity
 - fidelity of a subsystem

Complexity of Behavior

- **Simple isolated phenomenon or function**
 - e.g. backchannel
- **Toy domains**
- **Simple tasks**
- **More complex tasks**
- **Extended interaction/multiple tasks**

Dialogue Context

- **In the wild, or controlled/manipulated for experiment**
- **Participants**
 - Individual differences: skills, beliefs, goals, culture, personality, etc
- **Activity**
- **Location**
- **Artifacts**
- **Noise**

Degrees of robustness: type of user

- **Demo**
- **Trained user**
- **Motivated user**
- **General populace**
- **Red team**

Spiral methodology:

- **For a given system, start with simple version**
- **Then Add**
 - more robustness,
 - more accurate model of phenomena,
 - more complex phenomena handled,
 - more complex tasks handled

Parsimonious Dialogue Modelling



ockham wielding razor

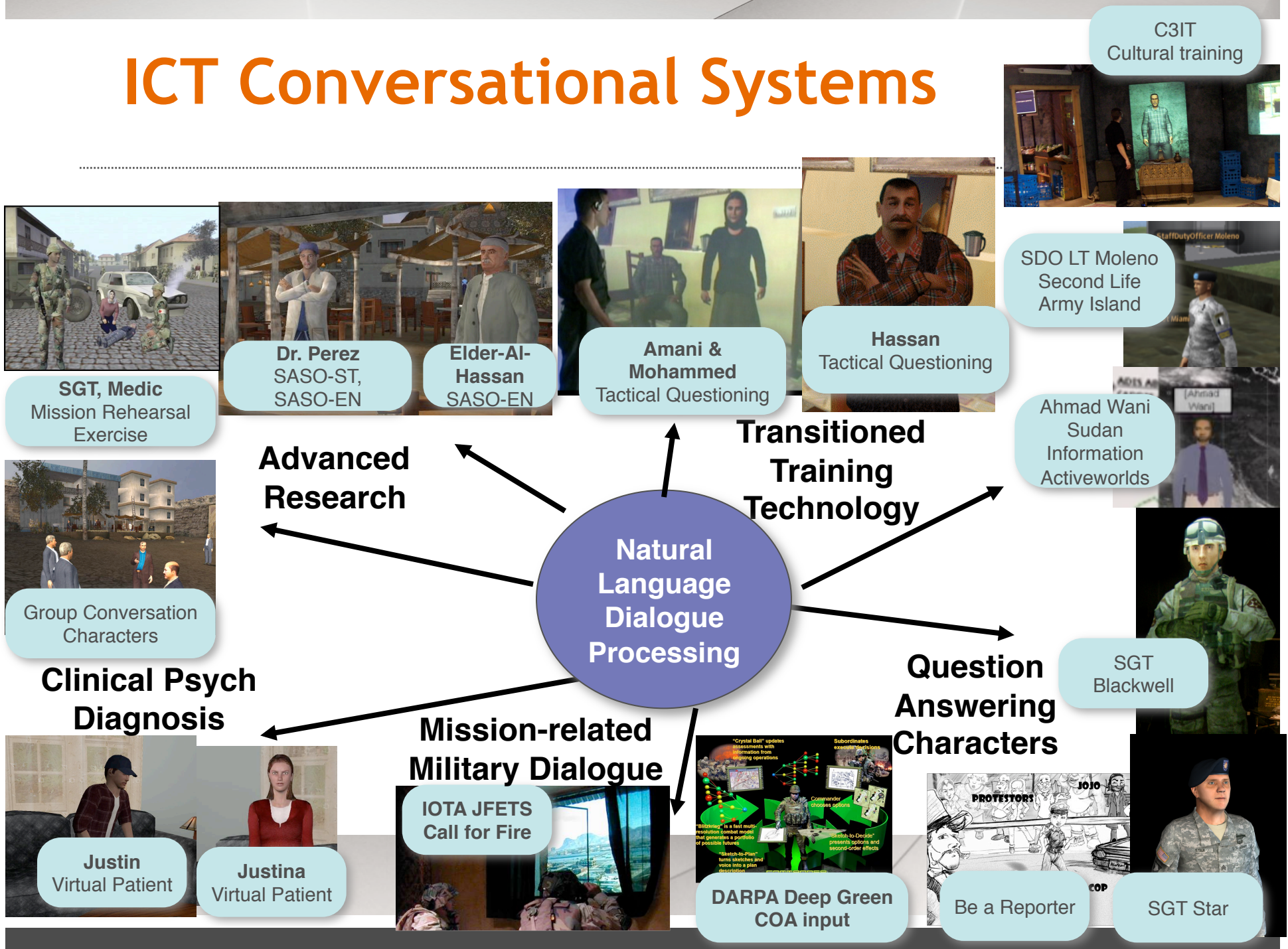
- **What should go in computational dialogue model?**
- **Not full theory:**
 - too complex
 - Hard to calculate
 - Too slow
 - not needed
 - Only some aspects will come up in any interaction

Which Razor?

- **History of Shaving**
- Represent only with evidence from data
- Represent only if functional consequence
- Represent only if simplest way to achieve consequence
- Represent only if necessary function for task



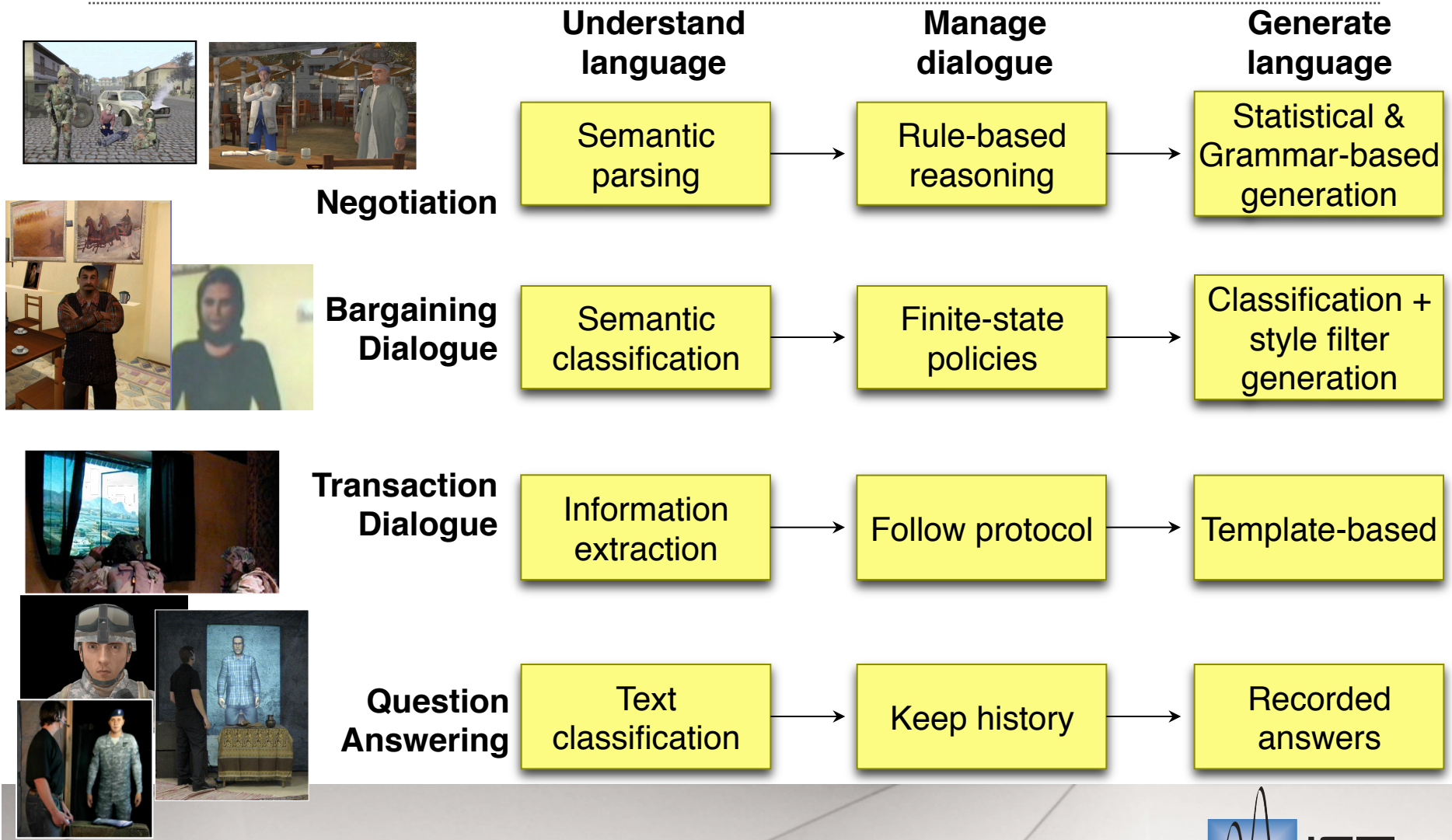
ICT Conversational Systems



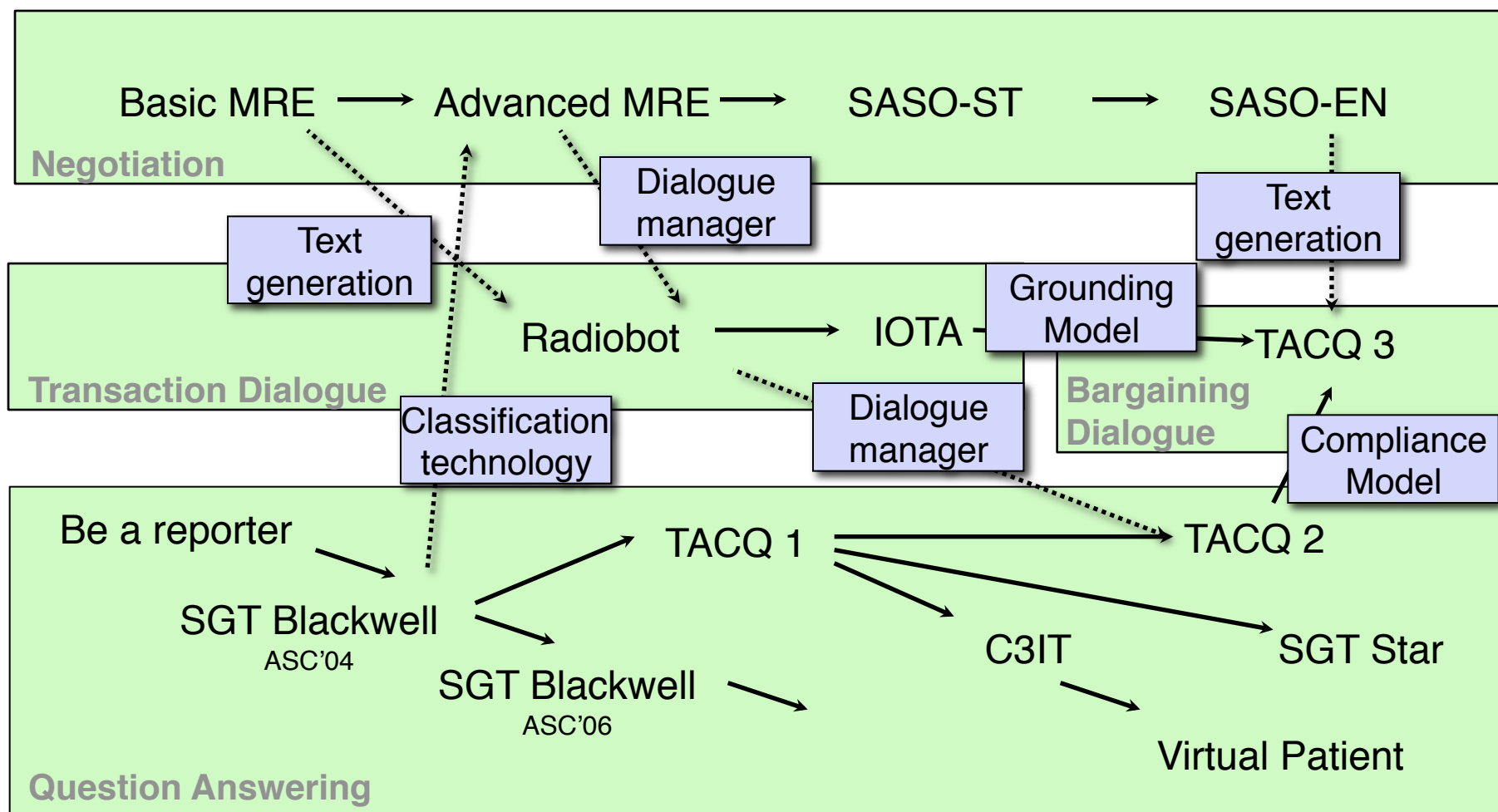
Dialogue Genres & Architectures for ICT Dialogue Agents

- **Question-answering characters**
 - Be interviewed
 - Respond in character
- **Transaction Dialogue**
 - Exchange information
 - Perform requested service
- **Bargaining Dialogue**
 - Beliefs, Goals, Policies
 - Deceptive & Uncooperative Behavior
- **Negotiation**
 - Assess alternative courses of action
 - Proposing and reacting to proposals
 - Coming to agreement
- **Background Conversation**
 - Group conversation simulation
 - Personality and cultural influence on behavior
- **Mediated Conversation**
 - Translator
 - Moderator
 - IUI for backend

NL Dialogue Processing: best techniques for genre & sub-task



Evolution of Virtual Human Dialogue Capabilities



Examples of ICT Question-answering Characters

SGT Star



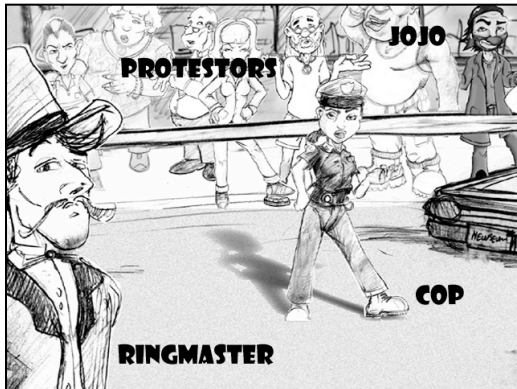
SGT Blackwell



C3IT/TACQ: Raed



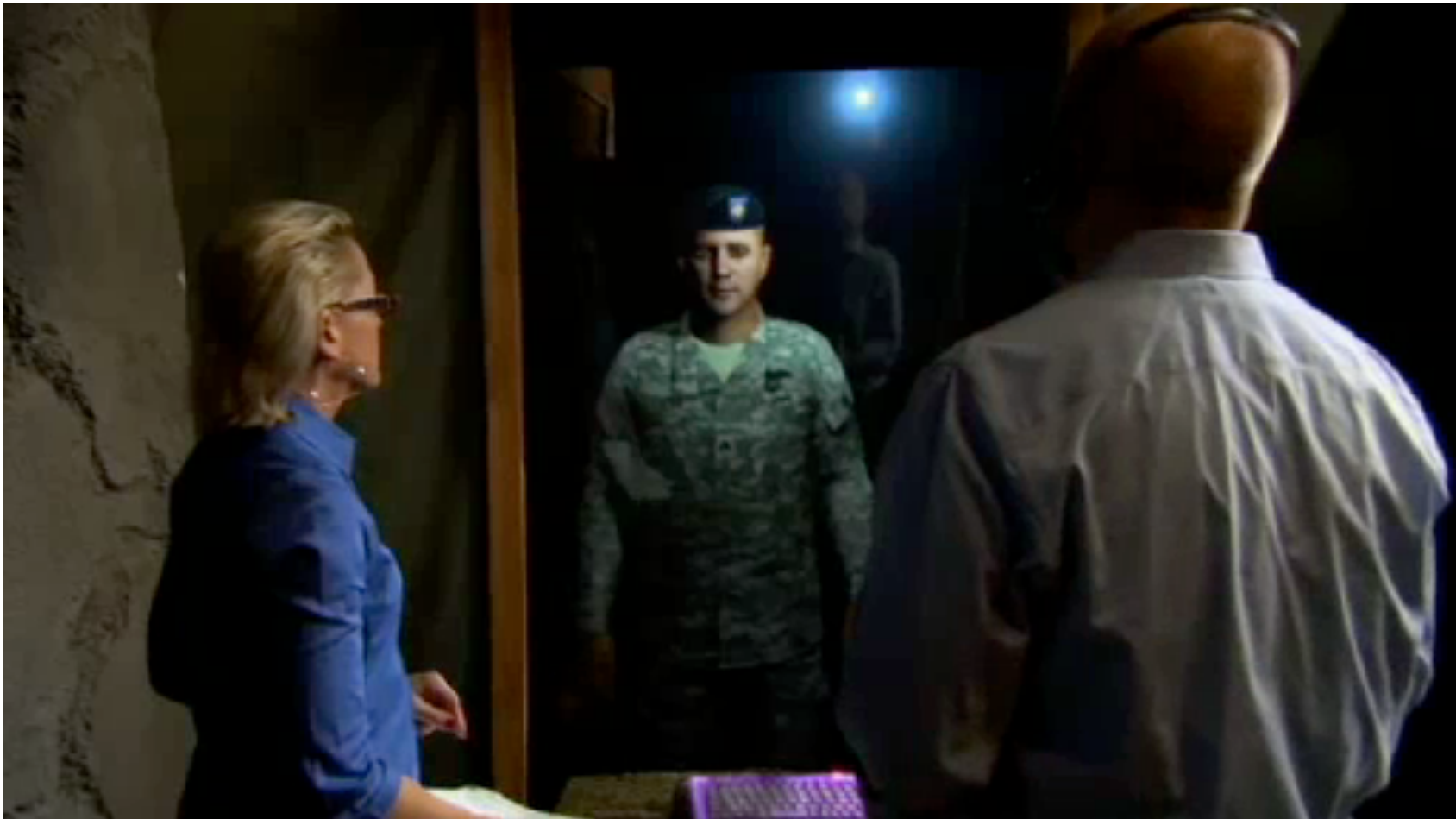
Be a Reporter



BMOS Interfaces Ada & Grace



SGT STAR (from LABTV segment)



NPCEditor

- **Unified tool for Question-answering Character language interaction**
 - Authoring environment: input questions, answers, links
 - Trainable Cross-language relevance model classifier
 - Runtime environment
 - Accepts a variety of message inputs include ASR interface, email & chat
 - Limited dialogue manager settings
 - Output text or virtual human message formats (FML/BML)
- **Now part of Virtual Human toolkit**
 - Available free for Academic Research Use:
 - http://vhtoolkit.ict.usc.edu/index.php/Main_Page

NPC Editor: Sgt Star Utterances View

/Volumes/Untitled/tacq/classifier/star/star_CASA_2008.plist (Read Only)

Utterances Settings People Classifiers Conversations Chat

Questions Scores for: Anybody

ID	?	Score	Text	#	Speaker	External ID	Mod
1		6	. Who are you?	1	Anybody	QST0001	28/
2			. how often do you work...	1	Anybody	Anybody-...	28/
3			. how often do you do p_t?	1	Anybody	Anybody-...	28/
4		6	. Who are you, Soldier	1	Anybody	Anybody-1	28/
5		6	. Introduce yourself, please	1	Anybody	Anybody-2	28/
6			. Why don't we talk about...	1	Anybody	QST0002	28/
7			. is being a soldier tough?	1	Anybody	Anybody-...	28/
8			. what time do you wake...	1	Anybody	Anybody-...	28/
9			. Sergeant, not sure every...	2	Anybody	QST0003	28/
10			. I do not think everyone...	2	Anybody	Anybody-3	28/
11			. For the few who don't k...	4	Anybody	QST0004	28/
12			. Tell us what hooah means	4	Anybody	Anybody-4	28/
13			. Hooah, Sergeant, I think...	1	Anybody	QST0005	28/
14			. Hooah. I think they get it	1	Anybody	Anybody-5	28/
15			. Hooah Sergeant, that's...	1	Anybody	Anybody-6	28/
16			. Roger that, we'll save it...	1	Anybody	QST0006	28/
17			. Your country does soldi...	2	Anybody	Anybody-...	28/
18			. Tell everyone a little mo...	1	Anybody	QST0007	28/
19			. Who created you?	1	Anybody	QST0008	28/
20			. Are you really talking or...	1	Anybody	QST0009	28/
21			. Just tell us how you can...	1	Anybody	QST0010	28/
22			. tell us how you can speak	1	Anybody	Anybody-7	28/
23			. what makes you talk	1	Anybody	Anybody-8	28/
24			. You actually can underst...	1	Anybody	QST0011	28/
25			. What do you see as you...	1	Anybody	QST0012	28/
26			. Are you givina up beina...	2	Anybody	OST0013	28/

1 of 1035 Add Remove

External ID: Anybody-167
 Speaker: Anybody Special: No Value

tell us who you are

Answers Scores for: sgt star

ID	?	Score	Text	#	Speaker	External ID	Mod
1		6	. Who me? Oh, I'm Serge...	11	sgt star	who-i-am	28/
2			. Hooah! I love talking ab...	5	sgt star	love-talki...	28/
3			. Who doesn't know what...	7	sgt star	everyone-...	28/
4			. It's the universal Soldier!	6	sgt star	everyone-...	28/
5			. Well, it can mean nearly...	11	sgt star	what-hoo...	28/
6			. Hooah can mean yes. h...	11	sgt star	what-hoo...	28/
7			. Hooah! means we're fir...	12	sgt star	what-hoo...	28/
8			. Hooah can mean I copy...	11	sgt star	what-hoo...	28/
9			. But there's more!	6	sgt star	but-there...	28/
10			. Hooah	24	sgt star	hooah-do...	28/
11			. You mean besides bein...	11	sgt star	handsome...	28/
12			. I was created for Go_Ar...	11	sgt star	who-creat...	28/
13			. Sure, I see em too, little...	5	sgt star	i-see-litt...	28/
14			. I have the ability to reco...	10	sgt star	recognize...	28/
15			. Most of the time I under...	3	sgt star	can-unde...	28/
16			. Well assuming Hollywo...	9	sgt star	future-ass...	28/
17			. I love being part of Go...	7	sgt star	will-not-gi...	28/
18			. My A_C_U? Well, it's uh...	8	sgt star	how-unifo...	28/
19			. Favorite color? Well I su...	7	sgt star	favorite-c...	28/
20			. My favorite weapon is th...	13	sgt star	favorite-w...	28/
21			. Yes, I am married. And...	4	sgt star	is-married	28/
22			. I'm a sergeant, an E_5...	15	sgt star	my-rank	28/
23			. Fort Knox, Kentucky. It's...	13	sgt star	currently-...	28/
24			. I'm on soecial assianme...	10	sgt star	whv-i-am...	28/

1 of 153 Add Remove

External ID: who-i-am
 Speaker: sgt star Type: No Value Special: Smith

Who me? Oh, I'm Sergeant Star! I'm a virtual character. Maybe you've seen me before on the web at Go_Army dot com. But there, I'm stuck looking like this. But now with a brilliant blend of pixels, polygons and programming, coupled with real time animation and spoken word interface, I can do my very best to answer your questions on Army careers. And my lips move when I do it.

Link value: 6 - relevant and fluent

Update scores: Include test questions Send Answer via No Value

Cross-Language Relevance Model

(Leuski et al, Sigdial 2006)

- **Relevance Model: $P(w|R)$ - prob that a random word from appropriate answer is w . $P(w|R) \sim \text{apprx } P(w|Q)$**
- **Estimate $P(w|Q)$ - prob observing word w in an answer given question**

$$P(w|Q) = \frac{\sum_s \alpha_{A_s}(w) \prod_{i=1}^m \pi_{Q_s}(q_i)}{\sum_s \prod_{i=1}^m \pi_{Q_s}(q_i)}$$

- **Estimate $P(w|A)$ - prob observing word w in an answer given answer**

$$P(w|A) = \alpha_A(w) \quad \alpha_x(w) = \lambda_\alpha \frac{\#(w, x)}{|x|} + (1 - \lambda_\alpha) \frac{\sum_s \#(w, x)}{\sum_s |x|}$$

- **Compare two probabilities: Minimize $D(p_q || p_a)$**

$$D(p_q || p_a) = \sum_{w \in V} P(w|Q) \log \frac{P(w|Q)}{P(w|A)}$$

[Victor Lavrenko. 2004. *A Generative Theory of Relevance*.]

NPCEditor: Sgt Star Chat view

Utterances Settings People Classifiers Conversations Chat

Anybody asks sgt star whats your name

Enter Question

Conversation log:

Anybody: whats your name

sgt star: Who me? Oh, I'm Sergeant Star! I'm a virtual character. Maybe you've seen me before on the web at Go_Army dot com. But there, I'm stuck looking like this. But now with a brilliant blend of pixels, polygons and programming, coupled with real time animation and spoken word interface, I can do my very best to answer your questions on Army careers. And my lips move when I do it.

ID	Score	Text
1	-4.983	Who me? Oh, I'm Sergeant Star! I'm a virtual character. Maybe you've seen me before on the web at Go_Army dot com. But there, I'm stuck looking like this. But now with a bri...
136	-6.074	Hello! Welcome to the National Conference for the Civilian Aids to the Secretary of the Army. My name is Sergeant STAR, and I'm a virtual character. Maybe you've seen me b...
17	-6.463	I love being part of Go_Army dot com. Hooah! Say, by the way, you know where I got my name? It stands for Strong, Trained, and Ready. Get it, S T A R, Star! Describes me p...
85	-6.482	Hey, look at me! I'm a technological marvel. I have real-time speech recognition, cutting edge computer animation and a brain full of knowledge.
15	-6.492	Most of the time I understand what someone is saying.. Every once in a while I have trouble interpreting the question. But like the Army, I'm improving daily.
81	-6.509	Well, if you mean do I have a pet, the answer is no. But I've asked the good folks at the University of Southern California's Institute for Creative Technologies to make me a dog...
12	-6.516	I was created for Go_Army dot com by Next_I_T. But the folks at the Institute for Creative Technologies transformed me into the moving, thinking, talking and incredibly attracti...
96	-6.517	You look familiar, like someone I've seen before. You ever been on the news? Or do you date a celebrity? Something like that?
22	-6.526	I'm a sergeant, an E_5. Although I keep hearing that I'm about to make E_6. Staff Sergeant Star has a nice ring to it, don't you think?
137	-6.528	I'm on special assignment with the Army's Special Forces Semi. It's an interactive exhibit with state of the art technology, and it showcases many of our Special Forces missions...
126	-6.535	Unfortunately I do get up before most farmers, but at least I'm not milking a cow at five am
135	-6.551	I can't be in combat, except virtually through the America's Army Game. But I've talked to a lot of my fellow Soldiers that have. They talk about feeling an emotion and passion...
78	-6.560	Hooah, glad I could be of help. You need me again, you can always find me 24 7 at Go_Army dot com. I hope to be talking to ya real soon.
62	-6.564	The Army is a career and like most jobs, you start at the bottom and work your way up. And when you throw in the allowances for housing, meals, uniforms, the medical benef...
82	-6.565	Hooah! I love animals. Although I can't really have any since I'm virtual and all. But if I did have a dog I know exactly what I'd call him: Chomp!
99	-6.570	Well, an Army post is a place to make friends and spend your free time. Soldiers have tons of options for fun, relaxation and learning. Speaking of free time. when do I get mine?
35	-6.573	Well, I love being with my fellow soldiers and I love serving my country. And if that's important to you, then the Army is the right place to be. Hooah!
79	-6.573	Roger that. I'm standing down. If anyone has got more questions for this warrior, I'm always available at Go_Army dot com
87	-6.575	The Army wants adaptable leaders and no one is more adaptable than me. I can lead a fire team, act as a virtual trainer, be an educational mentor. You name it, I can adapt t...
98	-6.576	ha ha... You? And me? You've got to be kidding. I mean this is Hollywood handsome... But you, well, let's just say that I know your mother loves you.
57	-6.580	When your country's in a fight, deployment to combat is always a possibility if your job is needed for the war effort. If it happens, you can be secure that you're trained Army st...
132	-6.581	What I do in my time off is this: it's called being on standby
32	-6.587	In my case, you might say I was born in the Army. But most of the soldiers say they joined to be part of something important, to find a family who will always, always be there...
88	-6.587	Well, I'm the ultimate adaptable warrior. I can train in Armor, Infantry, Artillery - just about any M_O_S there is. When it comes to technology, I am the forefront.
68	-6.594	Hooah, great question! And I've got over a hundred and fifty different answers. At least that's how many M_O_S's we have available in the Army. Except being a virtual soldier,...
120	-6.596	One of my business cards will make it easier for you to look me up at Go_Army dot com.
91	-6.597	Natural Language is just like it sounds. The kind of talk we do in English, Spanish, Arabic or what have you. I speak English, not some artificial computer language like Java, CO...
60	-6.601	Well, for nine weeks durina Basic Traininga you are going to huff and puff as you get physically and mentally stronger. But it'll be worth it to look and feel great - knowing that v...

Record questions Send best answer automatically

Send Answer via No Value

Ada & Grace at Boston Museum of Science



Ada & Grace at Boston Museum of Science



Second Life: Staff Duty Officer Moleno (Jan et al IVA 2009)



Transaction-dialogue: Radiobots for Simulation

Minor MRE Radio Characters



- **Dialogue systems play role of Radio operators in military simulation**
- **Trainee-Interface to simulation for structured tasks, e.g.**
 - 9-line medevac call
 - Artillery Call for Fire.

Radiobots for JFETS



JFETS-IOTA Radiobots



- **Goal: Automating Radio Calls for Fire in the JFETS Environment**

Example Radiobot Interactions

G91: steel one niner this is gator niner one , adjust fire over ,

S19: gator nine one this is steel one nine , adjust fire out ,

G91: grid four five one , three six four over



S19: grid four five one three six four out ,

G91: one z_s_u in the open , i_c_m in effect over ,

S19: one z_s_u in the open , i_c_m in effect out .

S19: message to observer . kilo alpha high explosive four rounds . adjust fire target number alpha bravo one zero zero zero over ,

G91: message to observer , kilo alpha , high explosive in effect four rounds , target number alpha bravo one zero zero break ,

S19: shot over ,

G91: shot out ,

S19: splash over ,

G91: splash out

G91: steel one nine this is gator nine one , adjust fire polar over ,



S19: gator nine one this is steel one nine , adjust fire polar out ,

G91: direction five nine seven zero , distance four eight zero over ,

S19: direction five nine seven zero , distance four eight zero out ,

G91: one b_m_p in the open , d_p_i_c_m in effect over .

S19: one b_m_p in the open . i_c_m in effect out .

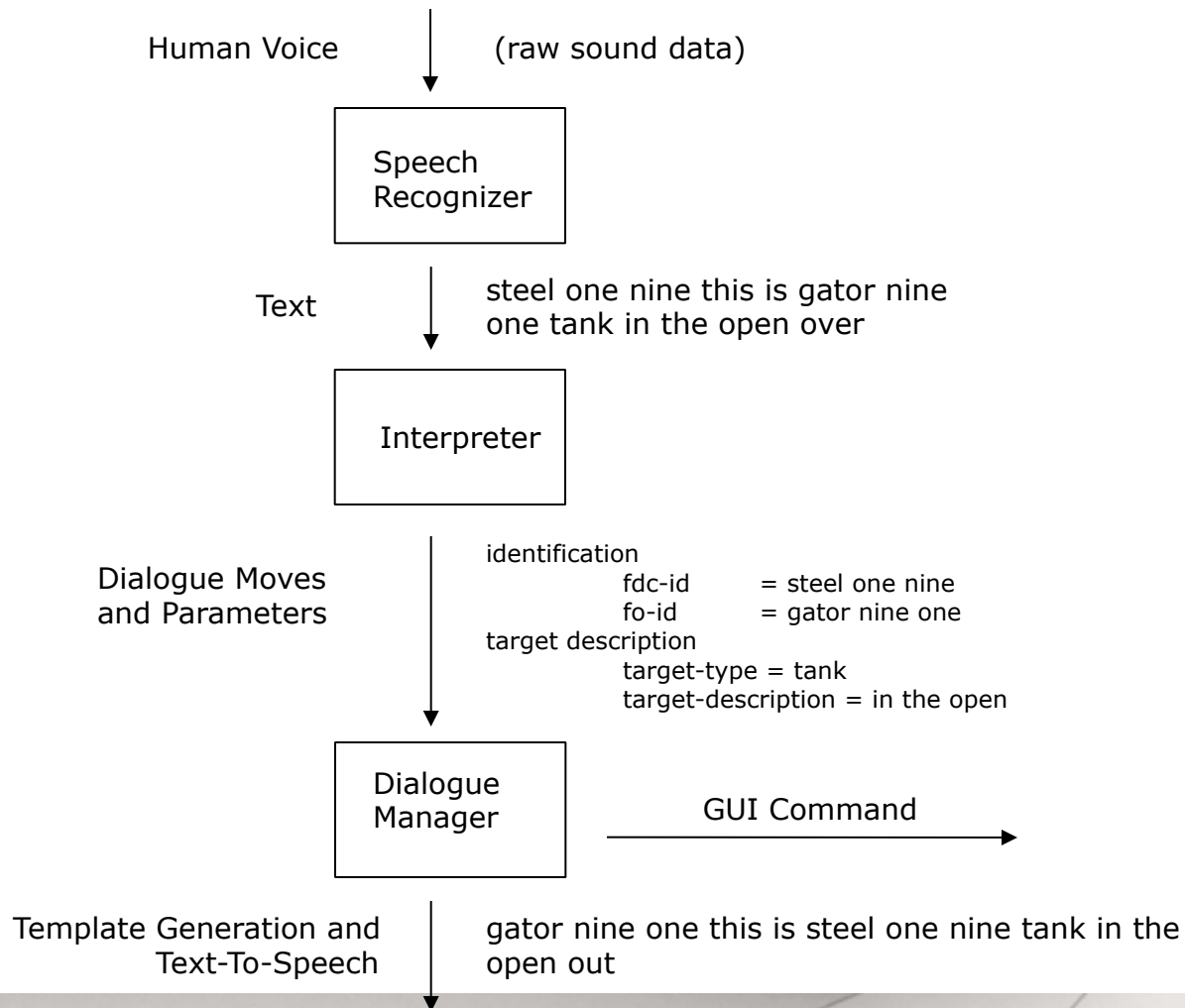
S19: message to observer . kilo bravo high explosive four rounds . adjust fire target number alpha bravo one zero zero two over

G91: message to observer , kilo alpha quick in effect h_e four rounds , target number alpha bravo one thousand two over ,

S19: shot target number alpha bravo one zero zero two over ,

G91: shot out ,

IOTA Language Processing



Language Processing: Interpretation

ID	ID	ID	ID	ID	ID	ID	ID	FIRE	FIRE	FIRE	OVER
Steel	one	niner	this	is	gator	niner	one	adjust	fire	polar	over

$$P(y|x) = \frac{1}{Z(x)} \exp \left\{ \sum_i \lambda_i f_i(y, x) \right\}$$



Conditional Random Fields

Language Processing: Dialogue Management

Information State approach:

Information important to the dialogue

Rules for actions based on incoming and existing information

Example Information:

Mission Information

Warning Order fire for effect

Target Location grid 456372

Target Description bmp in the open

Adjust Information

Drop / Add - 5 0 (drop five zero)

Left / Right 0 (none)

Kind of Adjust fire for effect

Phase adjusting

Example Rule:

If incoming move is a target description

reply to RTO: confirmation of target description

if enough mission information exists:

send mission to simulator

Language Processing: Dialogue Management (2)

- **Tracks evidence of *grounding*: how well the information is mutually understood.**
 - Rule-based system developed from corpus analysis
 - Useful for determining:
 - Exactly what information the trainee grounded and to what extent
 - Whether problems should be handled mid-dialogue or in After Action Review
 - How strict the dialogues should be (as determined by the operator)
- **Example:**
 - **IOTA:** Message to observer, **kilo, two rounds**, target number alpha bravo zero zero one, over.
 - **Trainee:** Roger, message to observer, target number alpha bravo zero zero one, out.

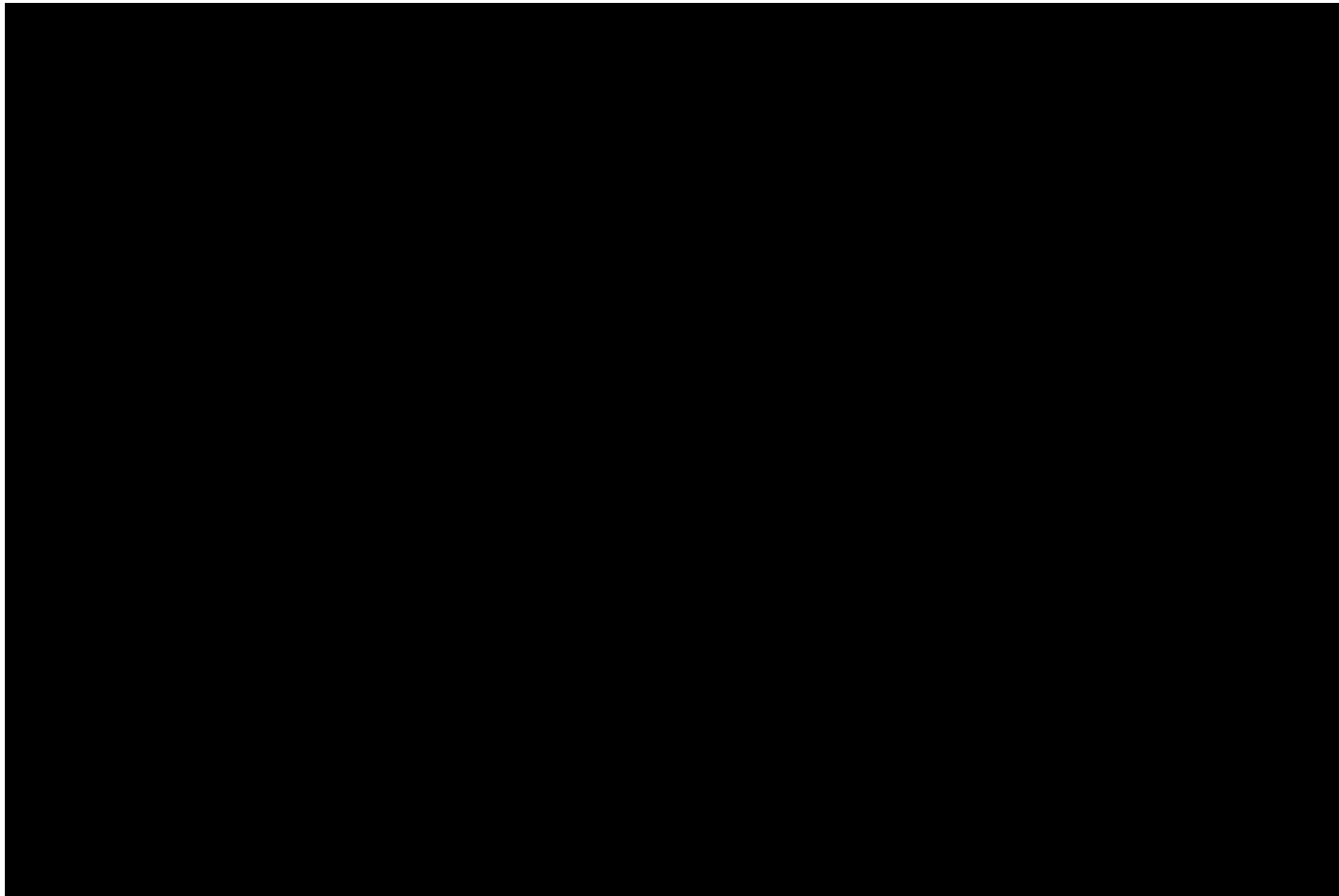
Antonio Roque and David Traum, "Degrees of Grounding Based on Evidence of Understanding," SIGdial 2008.

System Performance

(Robinson et al Army Science Conference 2006)

- **Speech Recognition component**
 - Word Error Rate: 9.7%
 - F-score: 0.93
- **Interpreter component**
 - F-score: 0.98 on transcribed data
 - F-score: 0.93 on Speech Recognition output
- **Task completion (entire system)**
 - With human operator supervision: 97.5%
 - With no human operator supervision: 85.5%

JFETS-IOTA



Bargaining Dialogue

TACQ Amani



- **When to use?**

- Too complex for Text Q&A classification (Semantic Content, sequences, context, deception)
- Not straightforward transaction (uncooperative, policies)
- not essential to have Planning, detailed emotion, complex semantics, detailed negotiation

TACQ Hassan 3



<u>Speaker</u>	<u>Utterance</u>	<u>Dialogue Move</u>
Trainee	Who is collecting the tax?	Question about tax collector
Hassan	My family's safety is very important to me.	Elicitation of family protection
Trainee	We can protect your family.	Offer of family protection
Hassan	Indeed, you might say that I collect the taxes.	Assertion about tax collector

TACQ: Tactical Questioning

HUMINT: Human Intelligence

- **Tactical Questioning dialogues are those in which small-unit military personnel, usually on patrol, hold conversations with individuals to produce information of military value (Army 2006)**
- **"As you speak to these young [Iraqi] men, appeal to their sense of honor and make them feel important." (Paul, 2006)**
- **Genre Source material :**
 - **Matthew C. Paul, "Tactical Questioning: Human Intelligence Key to Counterinsurgency Campaigns", Infantry Magazine, Jan-Feb 2006**
 - **Department of the Army, FM 2-22.3, "Human Intelligence Collection Operations", 2006.**
 - **William Wunderle, "Through the Lens of Cultural Awareness: A Primer for US Armed Forces Deploying to Arab and Middle Eastern Countries"**
 - **Richard H. Shultz Jr. & Roy Godson, "Intelligence Dominance: A better way forward in Iraq", The Weekly Standard, Volume 011, Issue 43, 7/31/2006**
 - **Marine Corps Intelligence Agency (MCIA), "Iraq Culture Smart Card: Guide for Cultural Awareness", May 2006.**

TACQ Hassan: An uncooperative Virtual human



Dialogue Fragment with Hassan

Trainee I'd like to talk about the marketplace

Hassan I hope you do not expect me to tell you anything

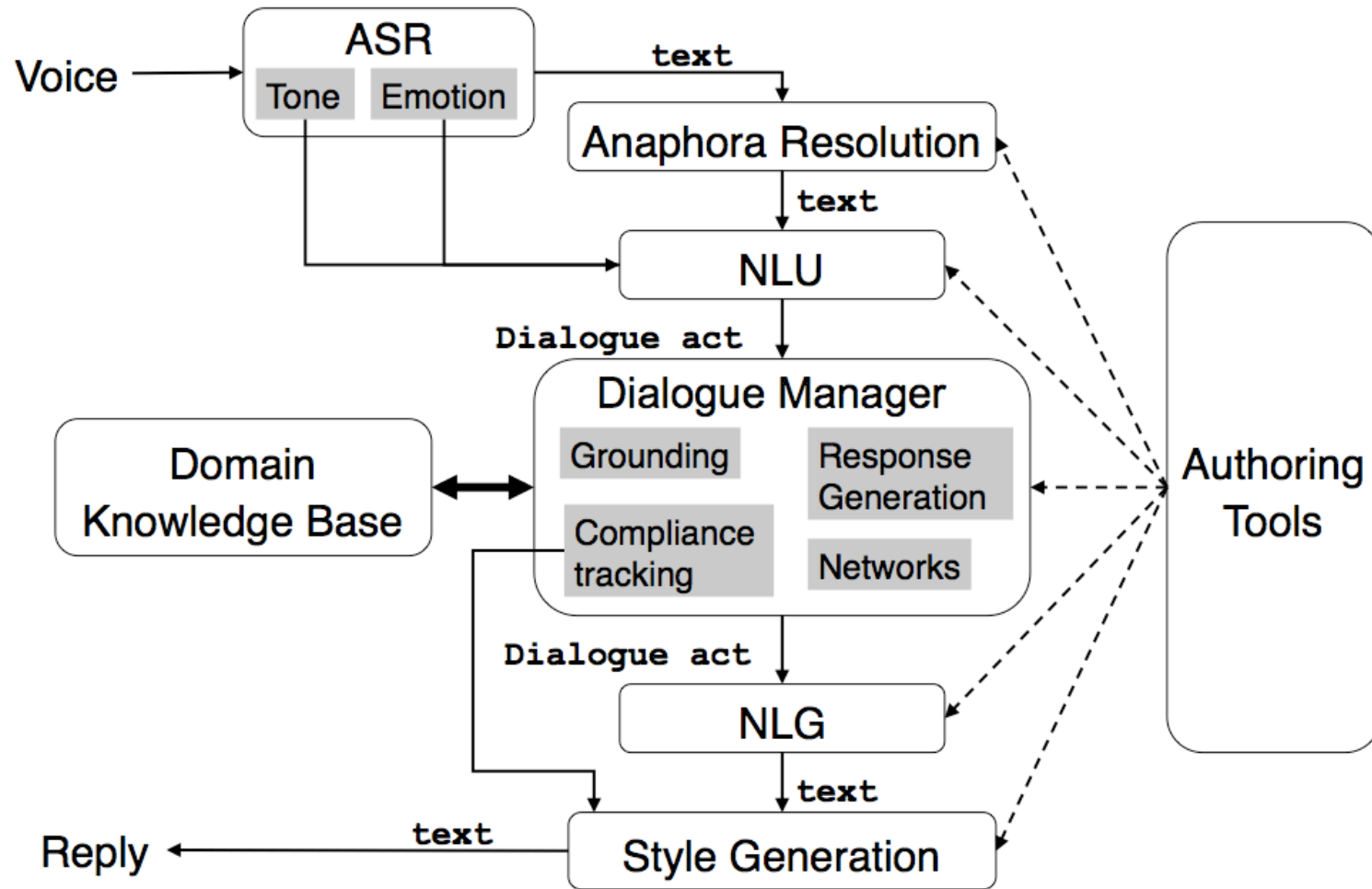
Trainee I just want to know why people aren't using the marketplace

Hassan I don't feel like answering that

Trainee I think you know something about a tax

Hassan I am simply doing business. It is rude of you to imply otherwise

TACQ Version 3 Architecture

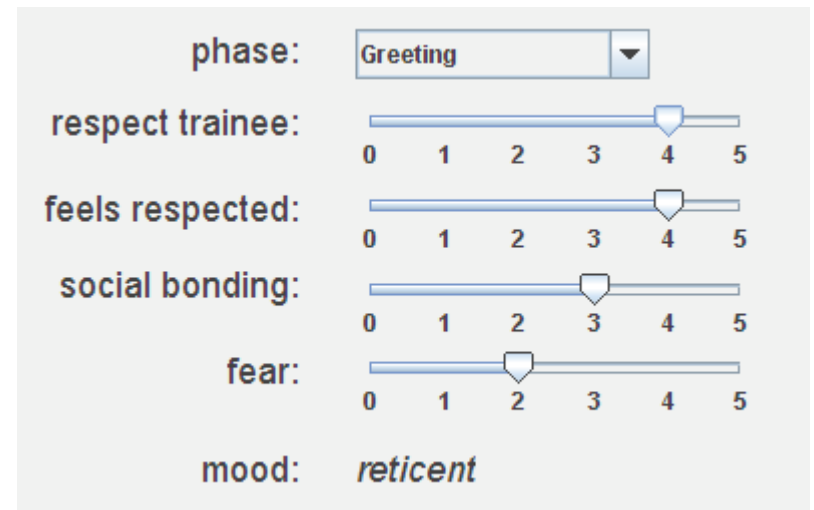


TACQ Video Presentation



Dialogue Management: Compliance

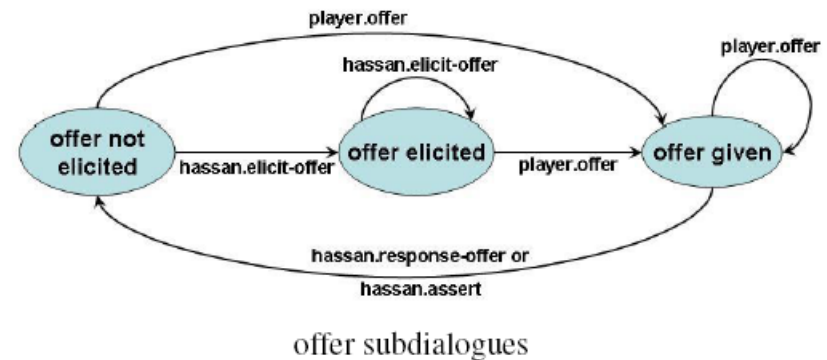
- **When should the character comply (ex: provide useful information)?**
- **Developed domain-specific model of emotions and social interactions**
 - rules define how speech acts affect emotions. ex: social talk by the trainee increases social bonding
 - rules define how the emotions combine to create mood of compliance. ex: if respect and social bonding are above a threshold, comply



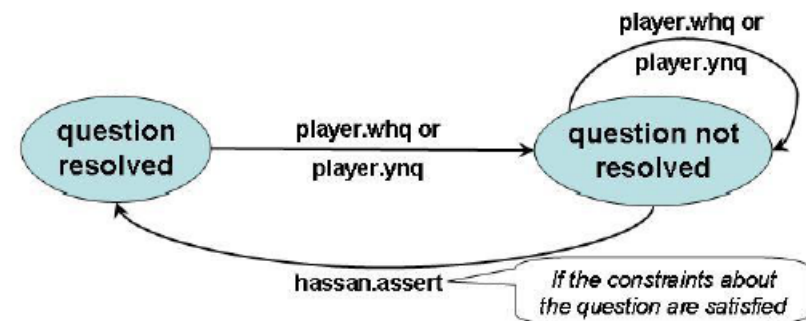
Antonio Roque and David Traum, "A Model of Compliance and Emotion for Potentially Adversarial Dialogue Agents," SIGdial 2007.

Dialogue Management: Deciding on a Reply

- **Use networks to track subdialogues**
 - tracks state of questions being discussed, offers made/resolved, etc
 - suggest possible replies
 - defines constraints that must be satisfied for a given reply to be made



offer subdialogues



question-answer subdialogues

Sudeep Gandhe, David DeVault, Antonio Roque, Bilyana Martinovski, Ron Artstein, Anton Leuski, Jillian Gerten, David Traum, "From Domain Specification to Virtual Humans: An integrated approach to authoring tactical questioning characters," Interspeech 2008.

Dialogue Management and Personality

- **Allow character authors to use dialogue manager parameters to express a character's personality**
 - updating emotions
 - types of replies made
- **Studying the extent to which humans can identify personality expressed through dialogue behavior**
 - to what extent do other issues (voice, gesture) interact?
 - what kinds of personalities can be identified?

76 tk

Please select from possible the values:
1 = low value for the trait 5 = high value

Anxiety	1
Assertiveness	low
Pace: Minimum small talk turns	4
Pace: Maximum small talk turns	100
Modesty	low
Trustingness	1
Honesty	High
Vulnerability	1
Positive Emotion	1

Select SCXML file

Michael Rushforth, Sudeep Gandhe, Antonio Roque, Nicolle Whitman, Sarrah Ali, David Traum, "Varying Personality in Spoken Dialogue with a Virtual Human", IVA 2009 poster.

Grounding in Dialogue Management

- Grounding improves dialogues
 - track degrees of groundedness of dialogue topics
 - make grounding utterance when material is not grounded enough
 - in human-user experiments, such virtual humans are perceived as making more appropriate responses

<u>Speaker</u>	<u>Utterance</u>	<u>Speech Act</u>
Trainee	Who is collecting the tax?	Question about tax collector
Hassan	So, you ask about the tax collector. My family's safety is very important to me.	Grounding: Repetition Elicitation of family protection

Antonio Roque and David Traum, "Improving a Virtual Human Using a Model of Degrees of Grounding," International Joint Conference on Artificial Intelligence (IJCAI) 2009.

Characters
*** ALL ***
Ch: hassan
Ch: player
...

Objects
*** ALL ***
Obj: hassan
Obj: imam
Obj: sunnis
Obj: market
Obj: tax
Obj: tax-collecting-soldier
Obj: player
Obj: player
...

Obj: tax
Attributes
Atr: collector
Atr: instigator
...
Attitudes
Actions
Goals
Compliments
Insults

Values
*** ALL ***
hassan [true]
tax-collecting-soldier [false]
...

Dialogue Act Types

*** ALL *** (5 + 17)
primitive (2)
elicit (3)
response (0)
other (17)

Dialogue Acts (3)

player:whq-hassan-assertion-4
player:ynq-hassan-assertion-4
player:ynq-hassan-assertion-5

Dialogue Act

```
<dialogue_act speaker="player">
  <whq>
    <primitive_dialogue_act>
      <object name="tax">
        <attribute name="collector"/>
      </object>
    </primitive_dialogue_act>
  </whq>
</dialogue_act>
```

Surface Text

not yet no.i don't understand what is this tax you are referring to . are you co+ ah who is collecting the tax
 who is collecting the tax at the market ?
 ok well maybe could you just tell me a little about the town. i understand that there is a ah tax being levied.
 ah do you know what's being taxed ?
 i'm actually just trying to find out about the tax and why it's being levied or if ah you know where (xxx)
 do you know anything about the tax
 i see. well, the money that who else who is the sunni you referred to i guess i'm not i didn't realize that there was someone else involved.
 alright so we've heard that somebody is levying taxes
 alright so we've heard that somebody is levying taxes is that true
 do you know anything about somebody levying taxes

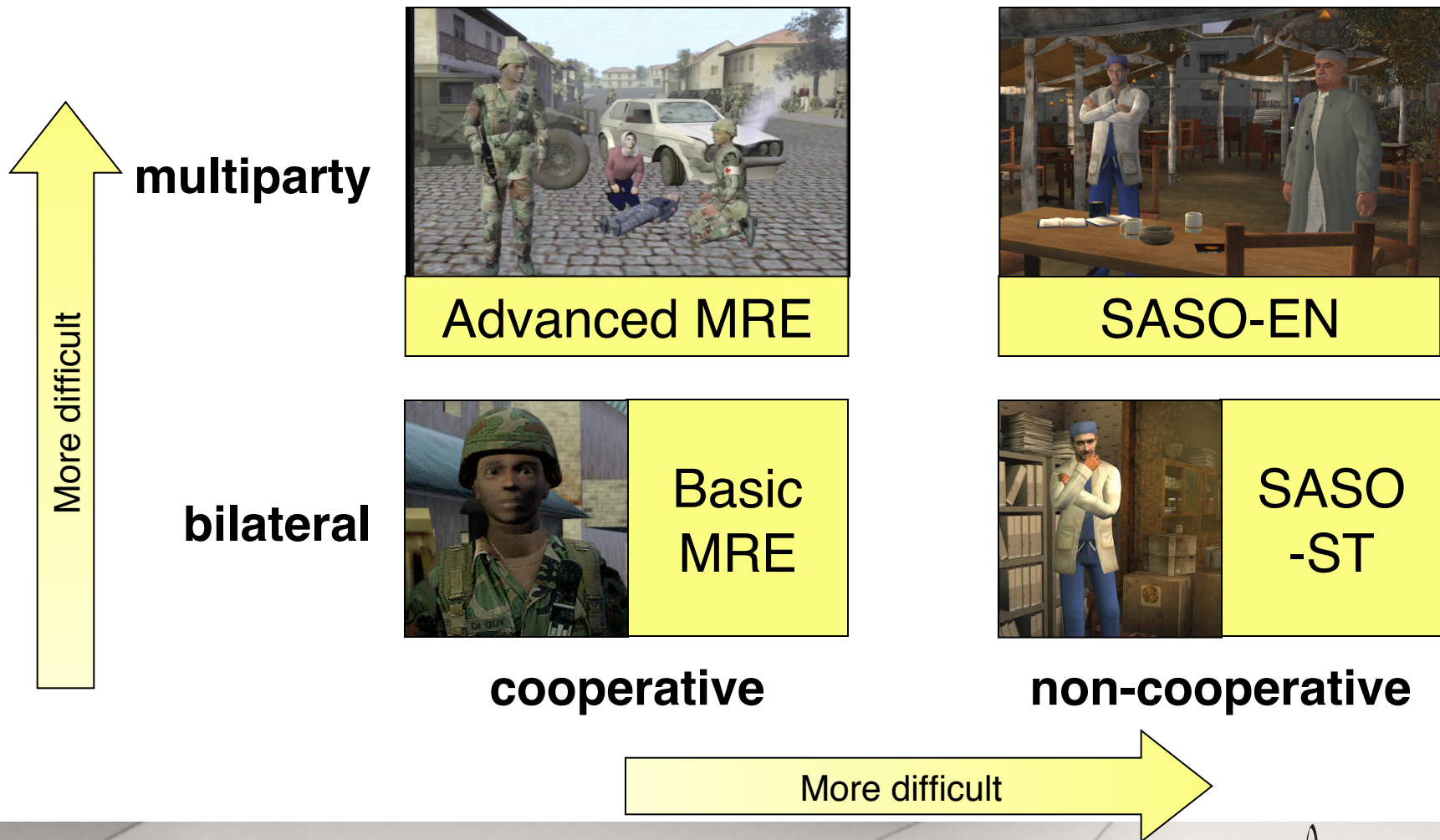
Empty text input field

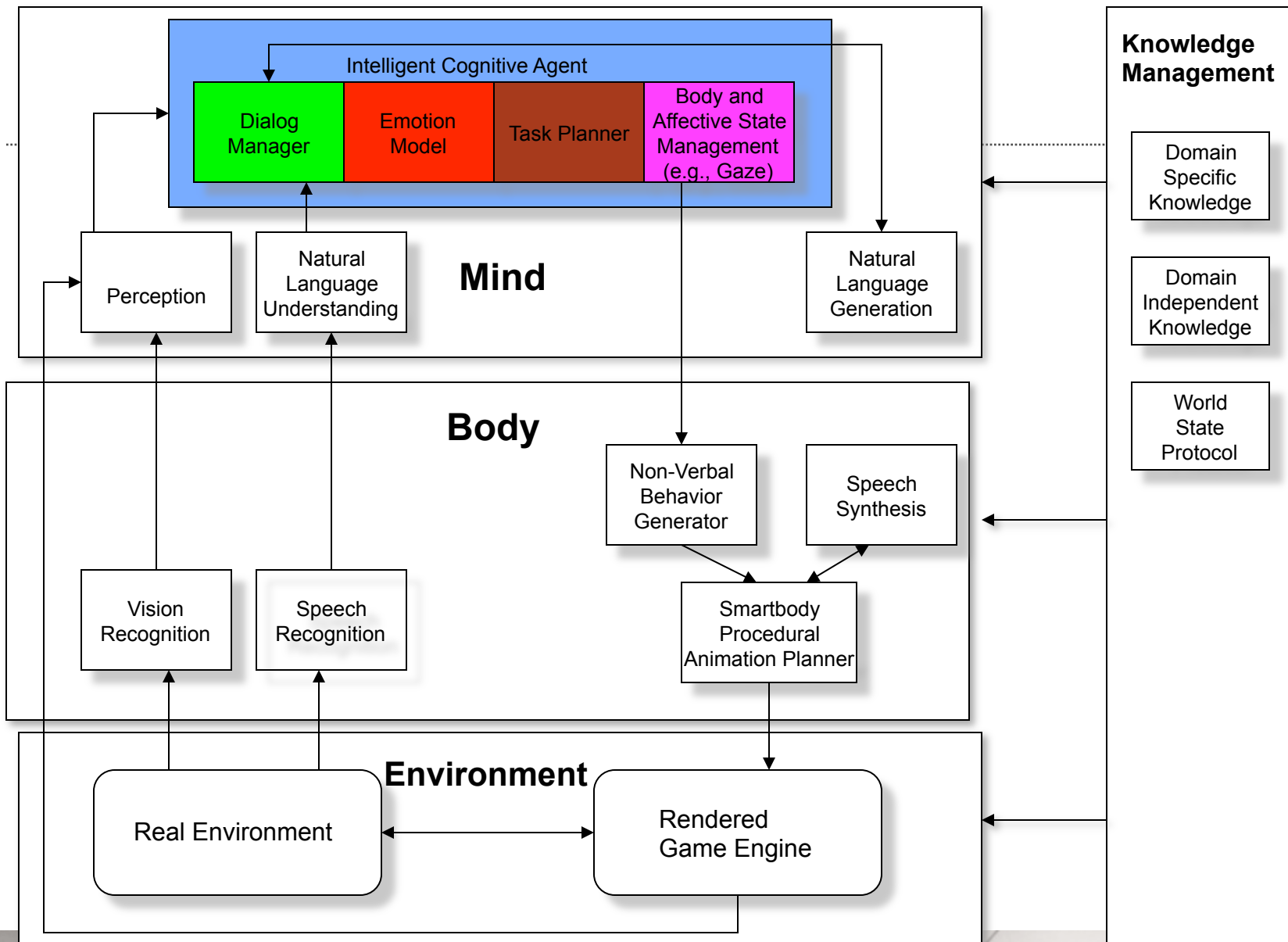
Add Utterance

Evaluation

- **Two characters have been built by non-experts within a few weeks (Amani & Assad)**
- **Amani domain size :**
 - Amani 89 DAs linked to 98 utterances
 - Player 113 DAs linked to 681 utterances
- **Preliminary evaluation of DA schema (Artstein et al, 2009)**
 - A total of unique 224 player's utterances were linked to most appropriate DA
 - Initially 50% coverage (improved to 80%)
- **West Point Sessions**
 - Surveys (one student:
“Felt like the most realistic exercise in class, first time interacting with locals”)
 - Domain expansion
 - Evaluation of expanded domain (in progress)

Negotiation Characters: Increasing Capabilities





Virtual Human Task Model

(Traum et al AAMAS 2003)

- **Basic Types**

- States

- Object-id
 - Attribute
 - Value
 - Polarity
 - Concerns
 - Belief

E.g.: :object-id clinic :attribute location
 :value market :polarity positive

- Tasks

- Pre, Add , Delete (states)
 - Case roles (event, agent, theme, location, source, destination,instrument, path)
 - E.g.: move-clinic { :agent captain :theme clinic :source market
 :event move :instrument locals :destination camp
 :pre {clinic-at-market}
 :add {clinic-at-camp}
 :del {clinic-at-market}

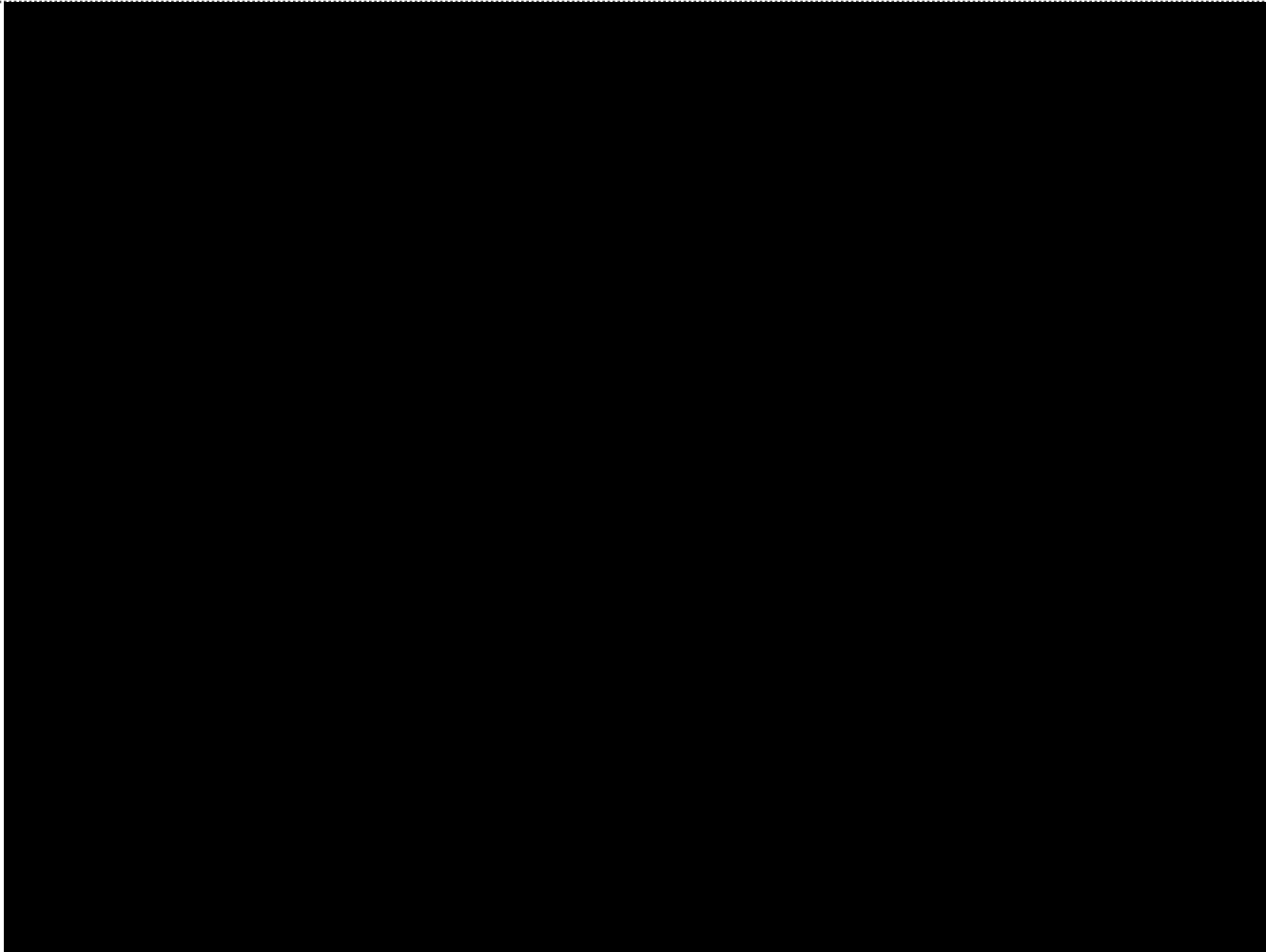
- **Reasoning**

- Goals
 - Plans
 - Intentions
 - Alternative Courses of Action

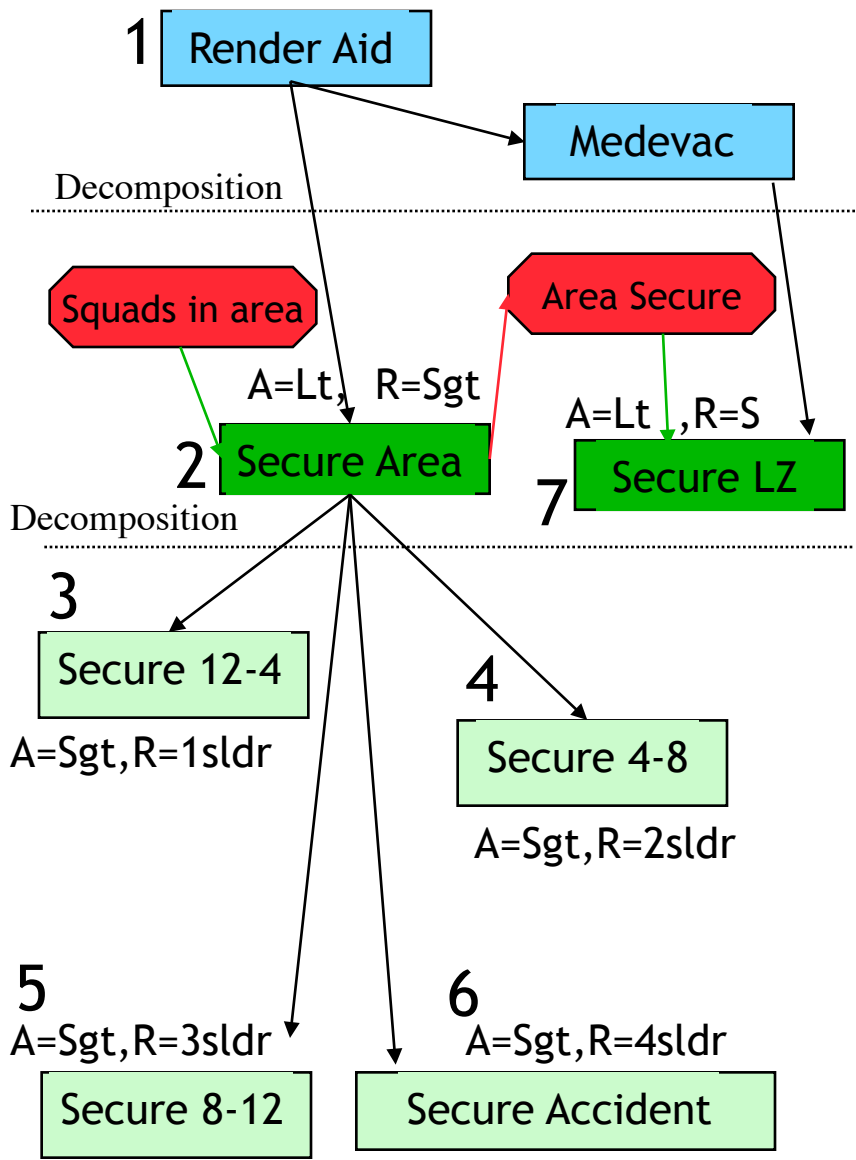
Dialogue Model: Interaction Layers & Dialogue Acts (Traum et al 2008 book chapter)

- **Contact (make, break)**
- **Attention (show, request, accept)**
- **Conversation (begin, join, leave, end)**
 - Turn-taking (take, hold, release, assign)
 - Initiative (take, assign, release)
 - Utterance
 - Main Function (assert, request, suggest, order, offer, promise, info-request,...)
 - Relational (answer, accept, reject, avoid, hold,...)
 - Features: speaker, addressee, overhearer, referent, content
 - Polarity (positive, negative)
 - Grounding (initiate, continue, acknowledge, repair, request repair...)
 - Topic (set topic, set subtopic, close topic)
- **Social**
 - Obligations & Commitments
 - Relationships
 - Social Roles

MRE Team-Negotiation Example



Sgt's Negotiation Behavior



Focus=1

Lt: U9 "secure a landing zone"

Committed(lt,7,sgt), 7 authorized, Obl(sgt,U9)

Sgt: U10 "first we should secure the assembly area"

Disparaged(sgt, 7,lt), endorsed(sgt,2.lt), grounded(U9)

Lt: U11 "secure the area"

Committed(lt,2,sgt), 2 authorized, Obl(sgt,U11),grounded(U10)

Sgt: U12 "yes sir"

Committed(sgt,2,lt), grounded(U11), Push(2,focus)

Goal7: Announce(2, {1sldr, 2sldr, 3sldr, 4sldr})

Goal8: Start-conversation(sgt, , {1sldr, 2sldr, ...}, 2)

Goal8 -> Sgt: U21 "Squad leaders listen up!"

Goal7 -> Sgt: U22 "I want 360 degree security"

Committed(sgt, 2, {1sldr, 2sldr, 3sldr, 4sldr})

Push(3, focus)

Goal9: authorize 3

Goal9 -> Sgt: U23 "1st squad take 12-4"

Committed(sgt, 3, {1sldr, 2sldr, 3sldr, 4sldr}), 3 authorized

Pop(3), Push(4)

Goal10: authorize 4

Goal10 -> Sgt: U24 "2nd squad take 4-8"

Committed(sgt, 4, {1sldr, 2sldr, 3sldr, 4sldr}), 4 authorized

Pop(4)

...

A10: Squads move

Grounded(U21-U26)

ends conversation about 2, Happened(2)

Push(7, Focus)

Selecting Acts to Perform

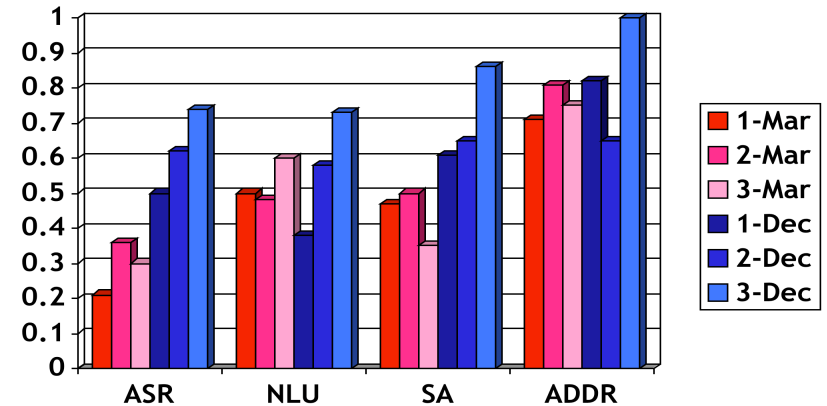
- **Considerations:**

- Current Topic, orientation and strategy
- The turn
- Initiative level
- Obligations to ground
- Obligations to repair
- Degree of understanding of prior utterances
- (potential) obligations to address info-request
- Beliefs about true answers
- Agent Goals

Evaluations (MRE): Mar vs Dec 2003 (Traum et al LREC 2004)

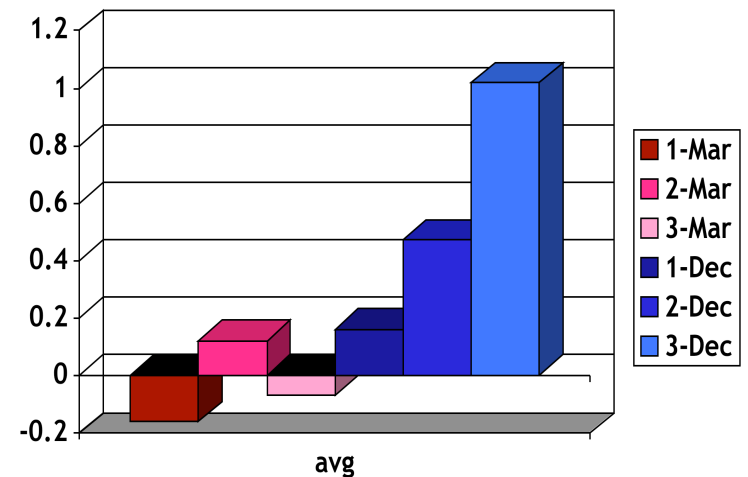
- Recognition: how well did system 'understand':

- Speech recognition
- Language understanding
- Speech Act
- Addressee



- Appropriateness: how correct was system response?

- High Inter-rater reliability: 0.9K (for 4 raters)



SASO-EN Virtual Humans



SASO-EN Multiparty Negotiation

(Traum et al IVA 2008)

- **Set of Strategies**
- **Multiparty**
 - Each agent has strategy
 - Trust toward each party
- **Multi-issue**
 - Appraisal for each alternative
 - Potential strategy for each
 - Topic tracking
 - Strategy for current topic is active
- **Negotiation Considerations**
 - Trust
 - If too low, disengage
 - Plan Assessment
 - Appraisal variables
 - Flaws
 - Relative utility
 - Dialogue Assessment
 - Topic
 - Control
 - Commitments

3-party negotiation Dialogue: Not very cooperative

C: hello gentlemen

D: hello captain

E: hello captain

C: thank you for meeting me

E: how may I help you?

C: i have orders to move this clinic to a camp near the us base

D: we need to help the victims of this conflict you started

C: i understand but it is imperative that we move the clinic out of this area

D: do you see that girl over there her mother was killed by american gunfire today

C: it is not safe here

D: look at these people they are injured because of your operations

C: i have my orders to move you to the camp

D: elder i think staying at the market would be best

E: we have many matters to attend to

C: i understand

E: captain you would do better to protect the town

C: we cannot protect you here

E: we must stop this killing insanity

E: i must refuse

D: i would have to refuse this decision

E: i must leave thank you

D: i must go now

SASO-EN: More Cooperative Interaction



SASO-EN Multiparty Negotiation

(Traum et al IVA 2008)

- **Set of Strategies**
- **Multiparty**
 - Each agent has strategy
 - Trust toward each party
- **Multi-issue**
 - Appraisal for each alternative
 - Potential strategy for each
 - Topic tracking
 - Strategy for current topic is active
- **Negotiation Considerations**
 - Trust
 - If too low, disengage
 - Plan Assessment
 - Appraisal variables
 - Flaws
 - Relative utility

SASO Vhuman Trust Model

(Traum et al, IVA 2005)

- **Trust as function of multiple factors:**
 - Familiarity - (part of cognitive consideration) can I expect someone to behave properly
 - Solidarity - (joint purpose) to what extent does other have shared purpose with self
 - Credibility - (part of ethical consideration) does agent make (only) claims that are
 - Believable
 - Verifiably true
 - Turn out to be true
- **Trust dynamically computed**
 - Displays of solidarity/opposed goals
 - Credible/incredible statements
 - Show empathy, polite behavior, behave according to conventions
- **Use of trust**
 - accept assertions as truth (e.g., Perrault, Cohen & Allen)
 - Negotiate in good faith
 - Continue engagement
 - Acceptance of empathy

Implementing Negotiation Strategies

- **Orientations result from appraisal of negotiation**
 - Reified negotiation “task”
 - Interactions with goals and plans
- **Strategies chosen as part of coping**
 - Entry & exit conditions
- **Strategies associated with communicative behavior**
 - Base posture and gesture set
 - Choice of dialogue moves
 - Speech act and realization
 - Initiative, topic selection, and type of grounding feedback
 - Affective tone
 - Aspects of interpretation
 - Charitability of interpretation
 - Assumptions vs clarification

Negotiation Strategies: Appraising the topic

	topic	Control	Utility	Potential	Trust	Commitment
Find issue	--				some	
Avoid		+	--		some	
Attack	+	--	--	--	some	
Negotiate	+	--	--	+	some	
Advocate	+		+		some	
Success	+				moderate	Mutual
Failure	+				Very low	Negative

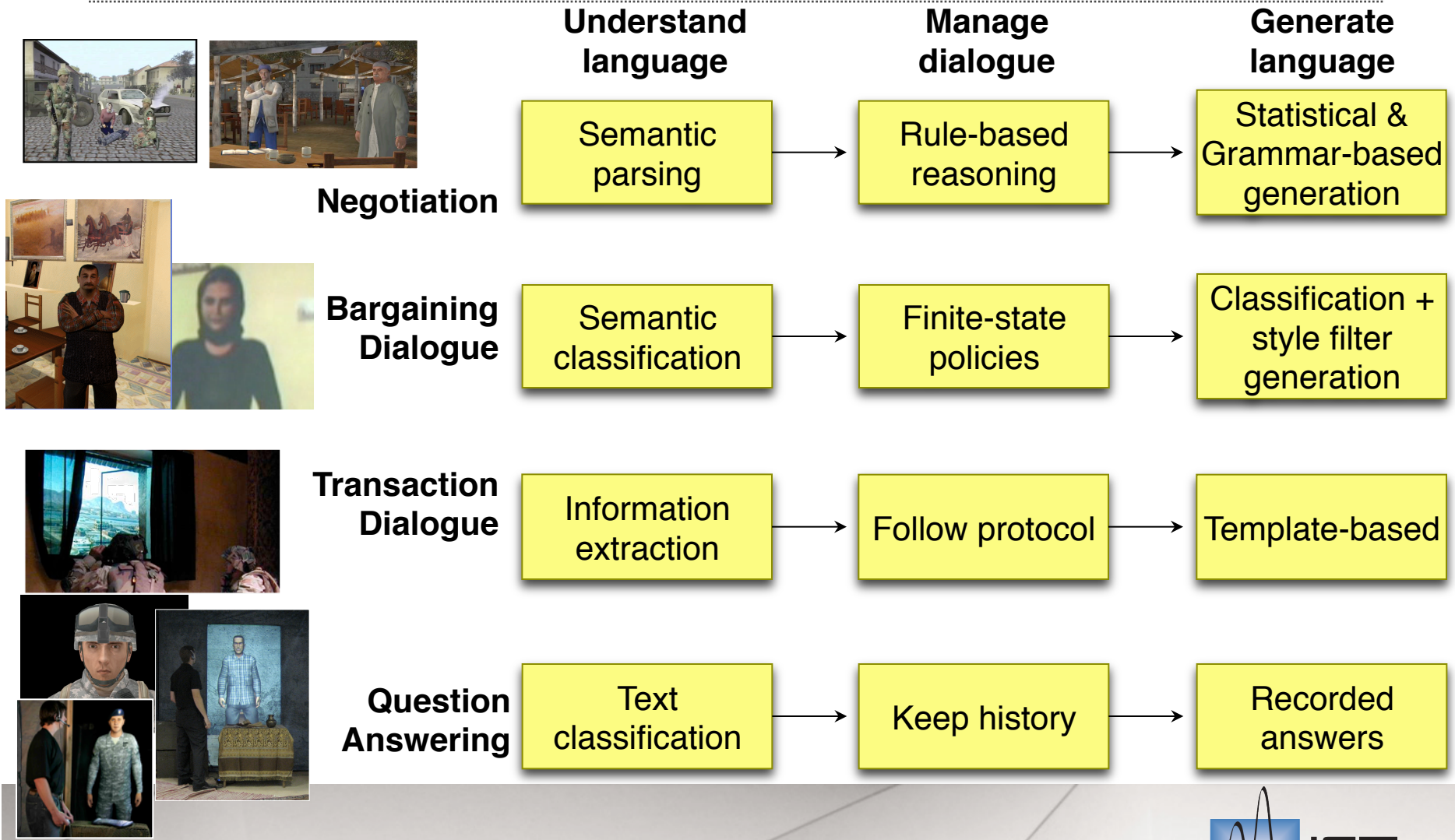
Behaving according to Strategies

- **No topic**
 - Find topic
- **Avoid**
 - Change topic
 - Try to leave
- **Attack**
 - State flaws
 - Propose better alternatives
 - Ad hominem
- **Negotiate**
 - State flaws
 - Propose solutions
 - Offer bargains
- **Advocate**
 - Propose actions
 - Address flaws
 - Offer commitment
- **Success**
 - Move on
- **Failure**
 - Move on

How to Win Friends and Influence Virtual People

- **Gain Trust**
 - Familiarity
 - Do the right things
 - Show you know how to behave
 - Credibility
 - Say believable things
 - Stand by your word
 - Solidarity
 - Want the right things
 - Show alignment in goals
- **Manage Interaction**
 - Don't lose control
 - Set the agenda
 - React to what they are saying
- **Solve Problems**
 - Offer resources
 - Commit to important actions
 - Remove obstacles
 - Consider alternatives
 - Win-win situations

NL Dialogue Processing: best techniques for genre & sub-task



Factors in Choosing the right architecture

- **Complexity of domain**
 - Type of task
 - Size of task
 - Requirements on understanding
- **Authorability of resources**
- **Robustness needed**
- **Depth of modeling**

Thank You

- **Questions?**