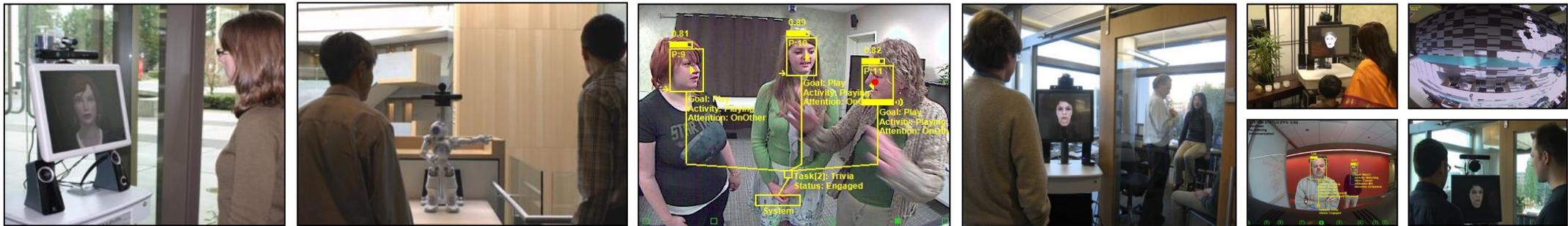


Microsoft Research
Faculty
Summit
2016

Integrative-AI challenges in physically situated interactive systems



Dan Bohus

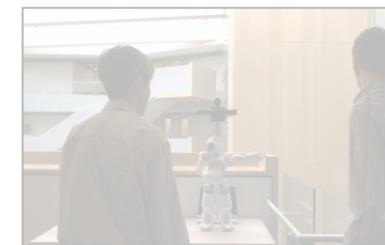
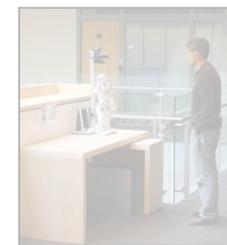
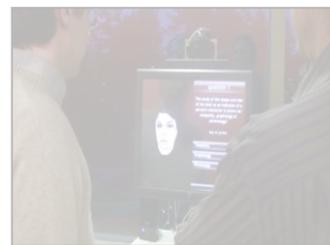
dbohus@microsoft.com

Senior Researcher

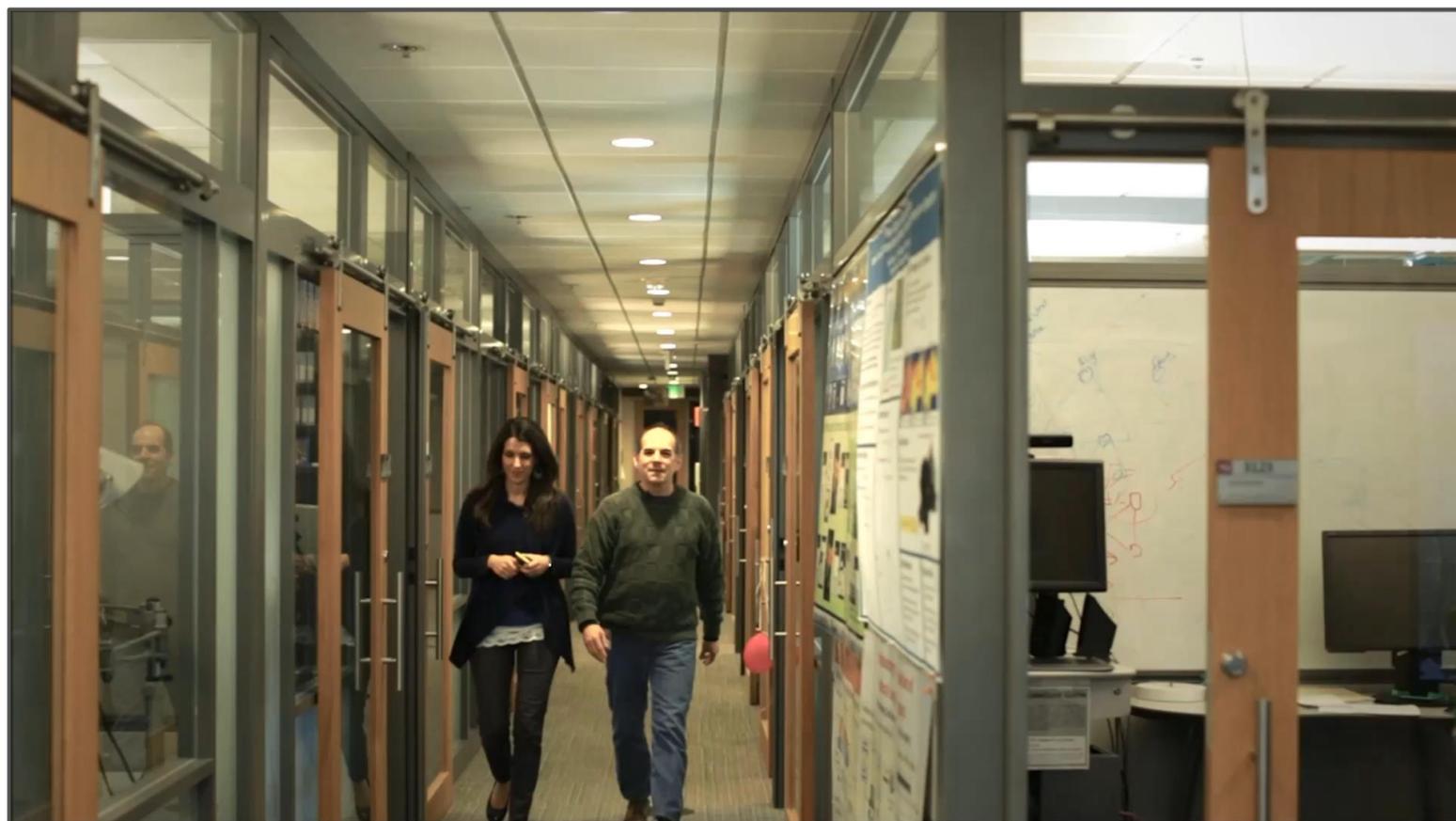
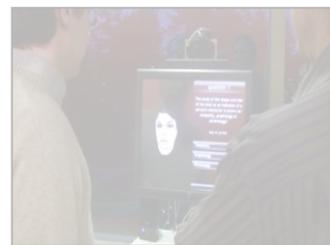
Adaptive Systems and Interaction

Microsoft Research

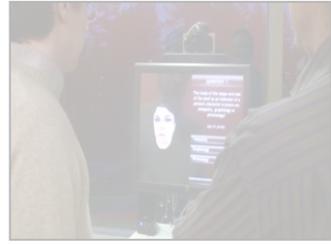
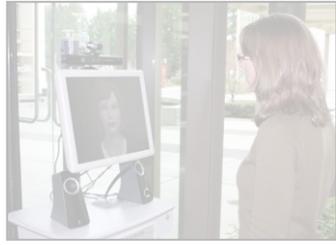
Situated interaction @ MSR



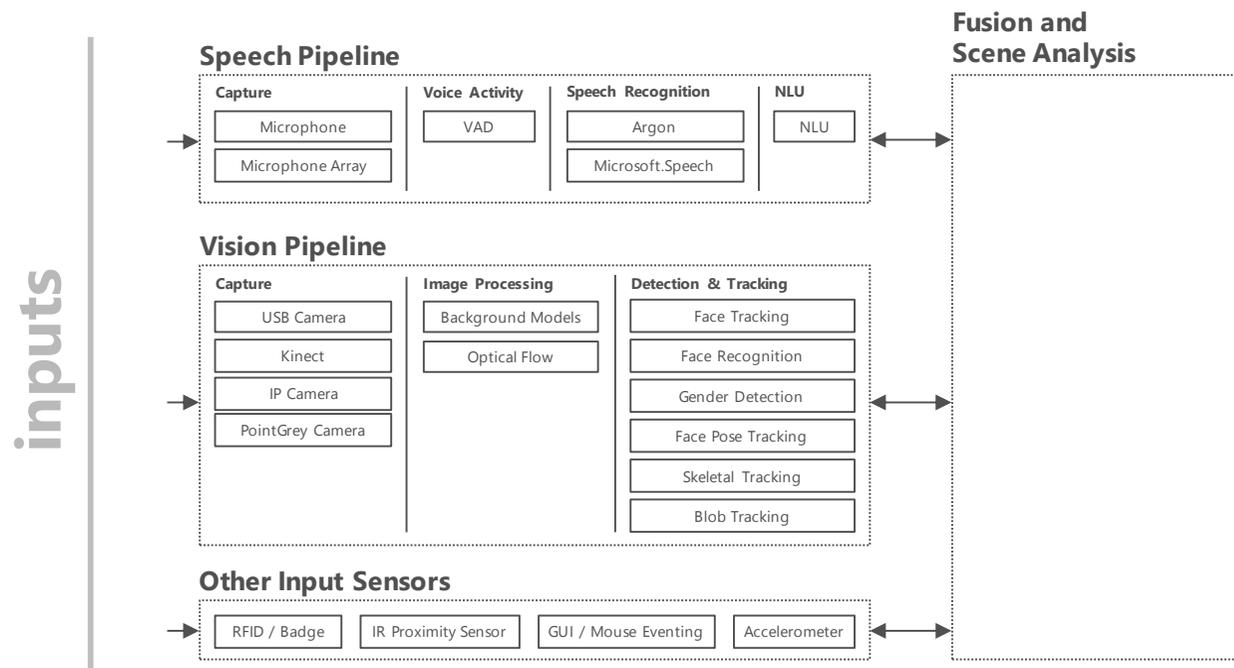
Situated interaction @ MSR



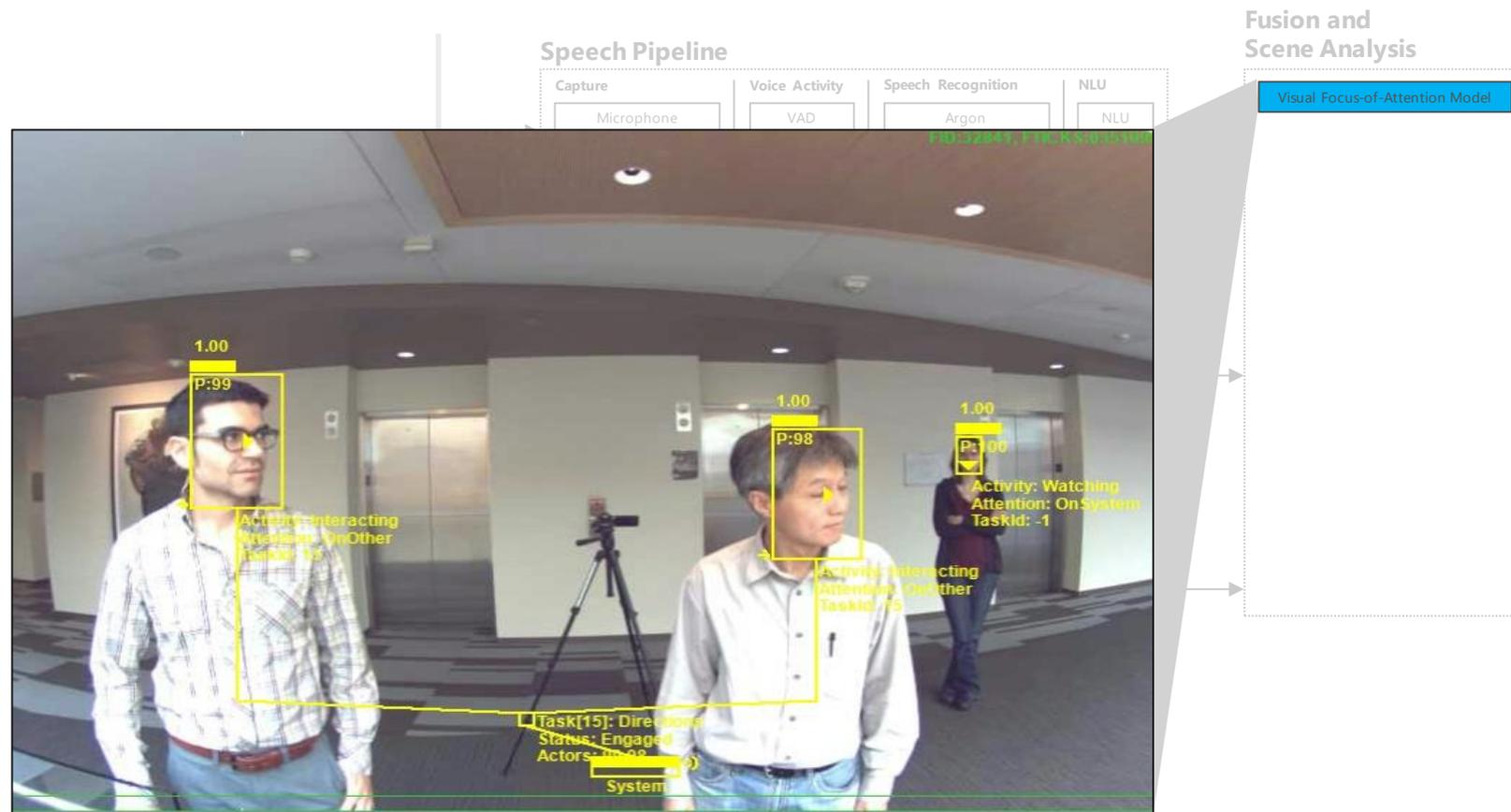
Situated interaction @ MSR



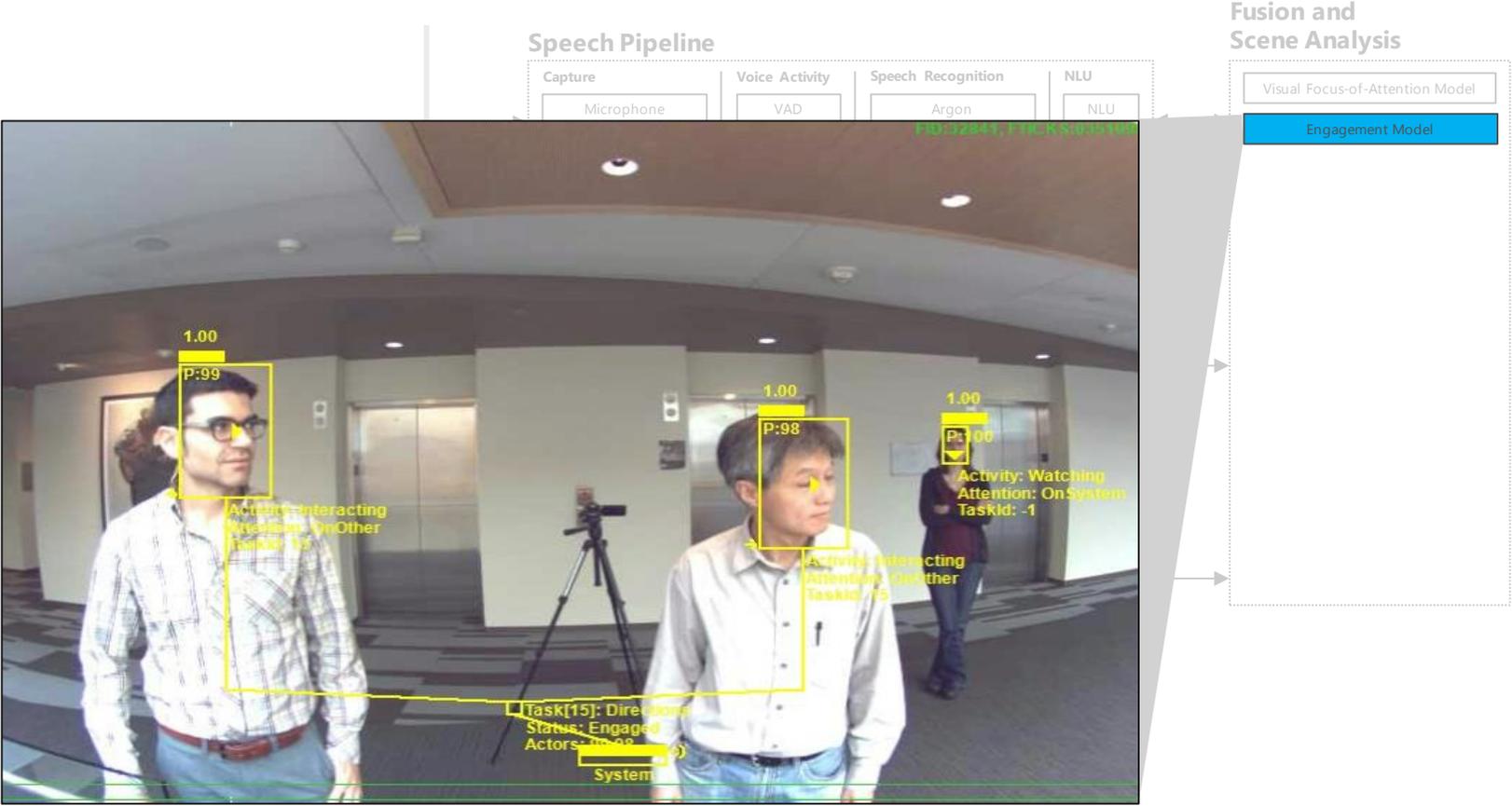
Challenges with integrative-AI



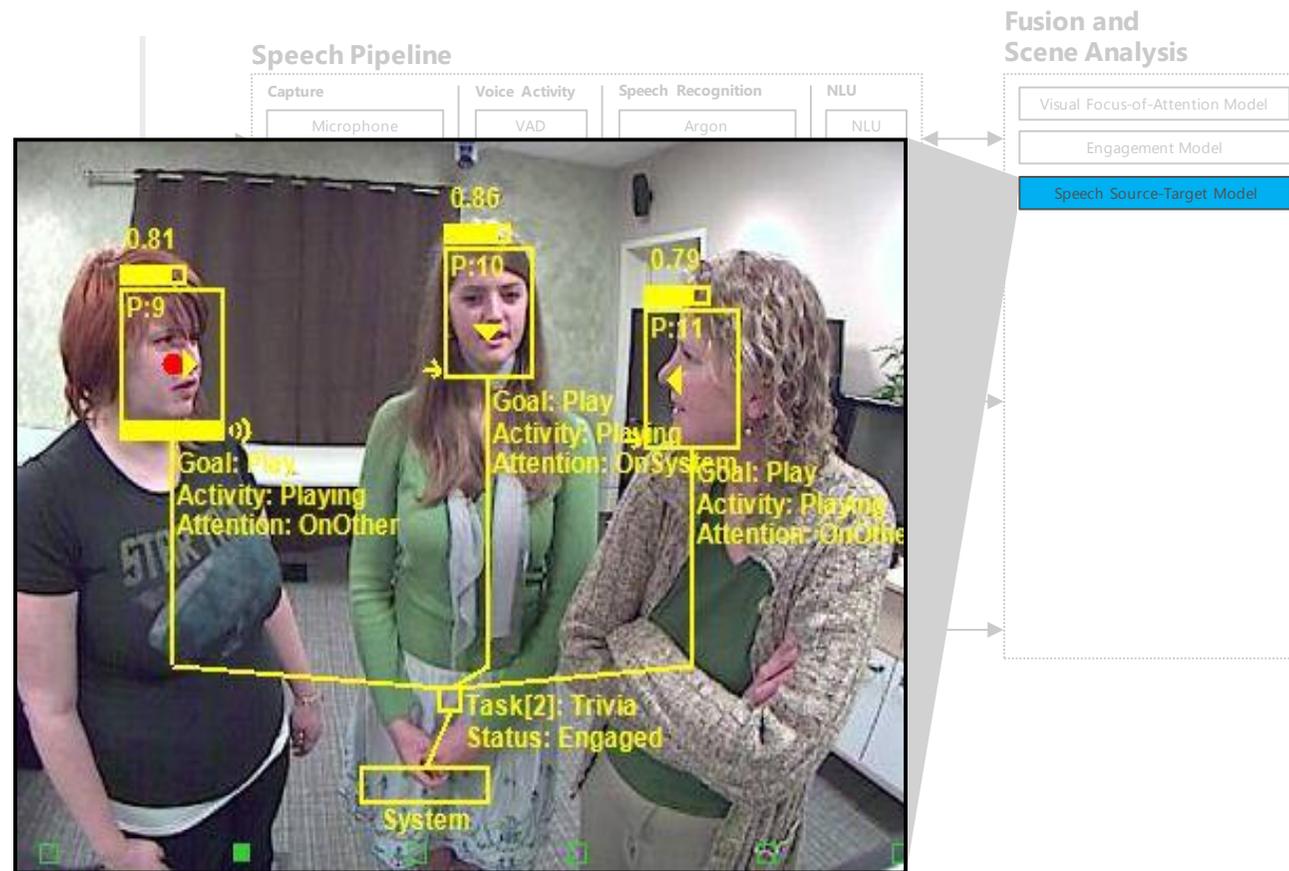
Challenges with integrative-AI



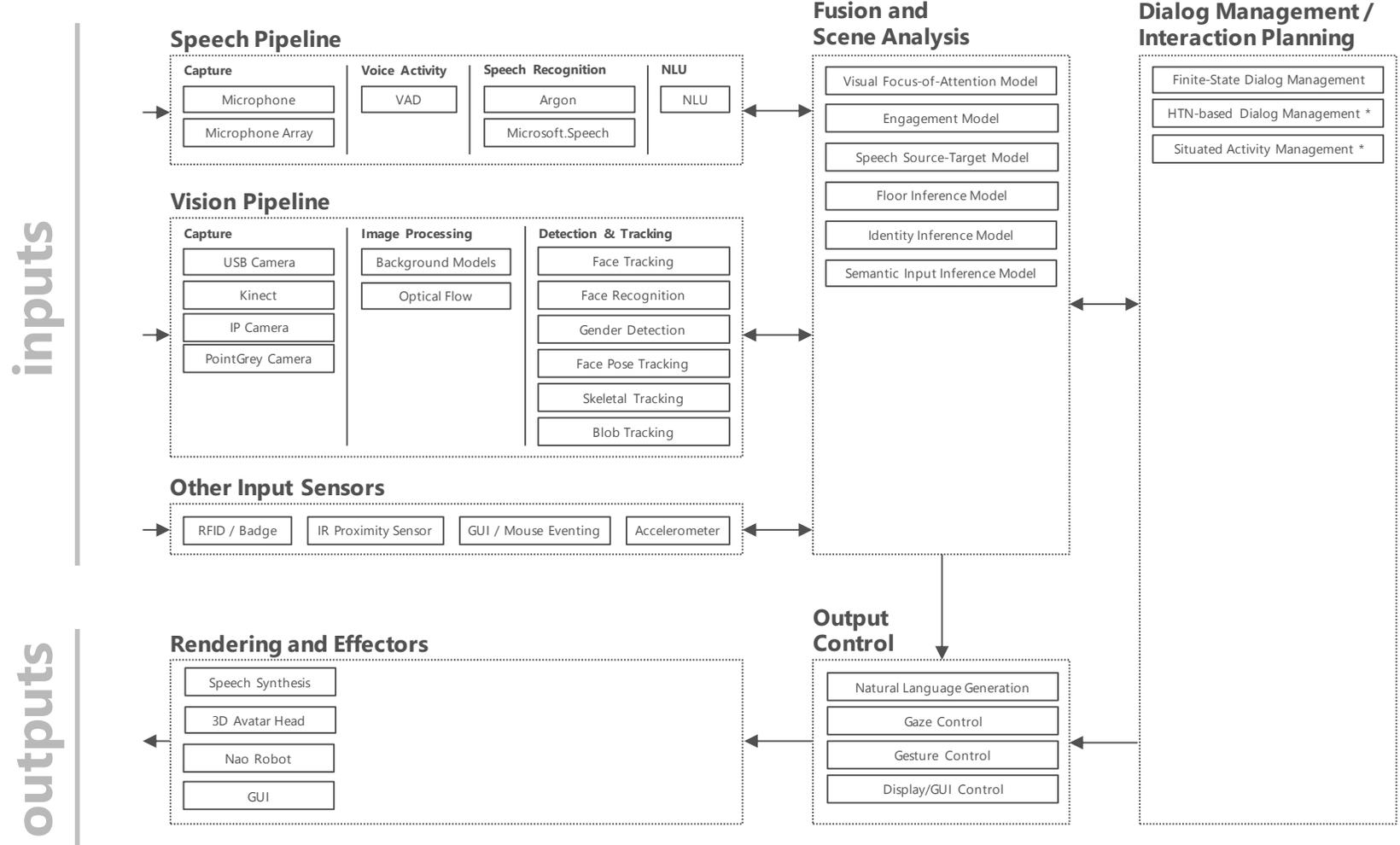
Challenges with integrative-AI



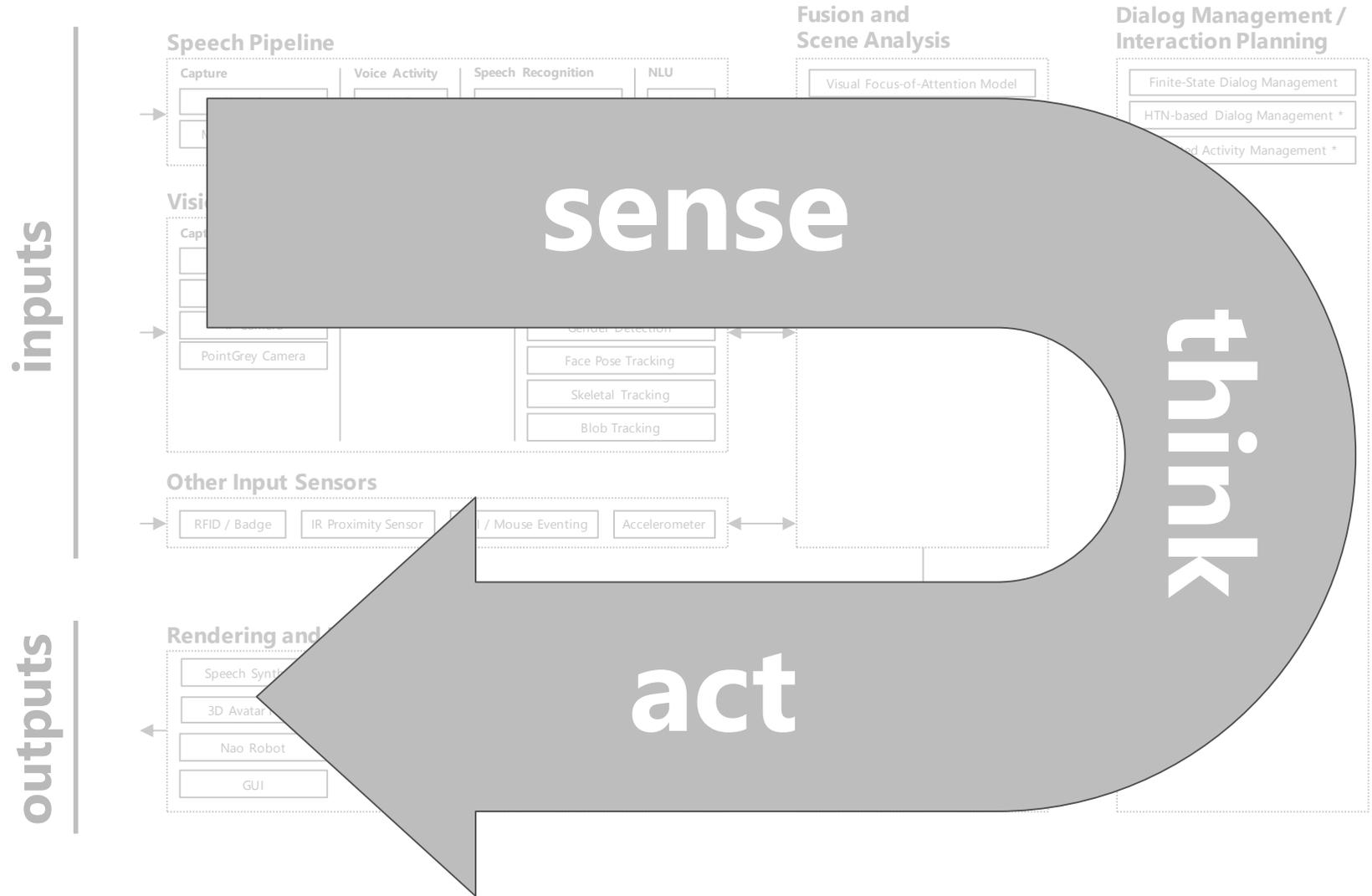
Challenges with integrative-AI



Challenges with integrative-AI



Challenges with integrative-AI

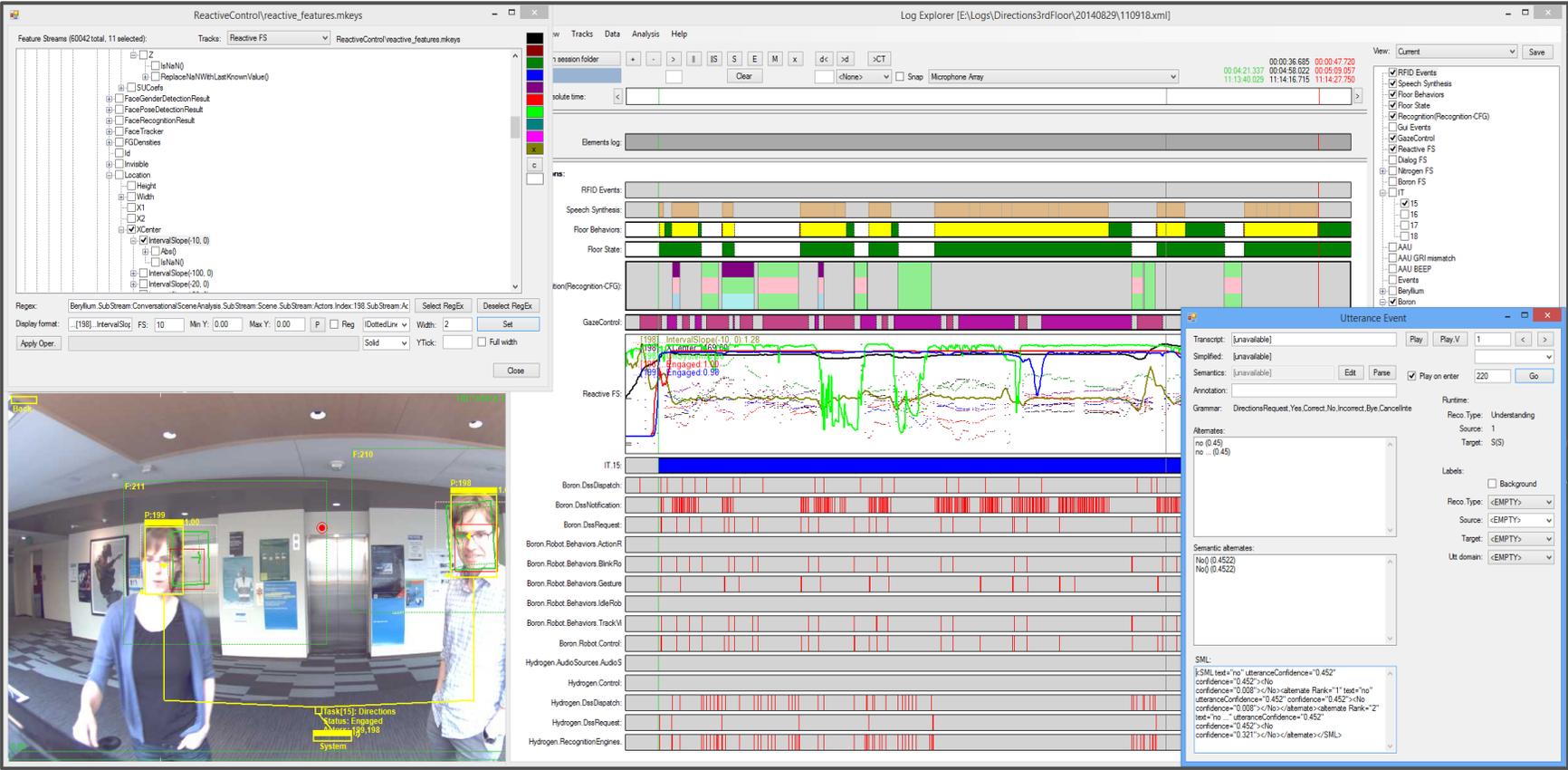


Challenges with integrative-AI

Managing complexity

programming models for parallel, coordinated computation

Time
Uncertainty & ML



Time

The screenshot displays a complex software interface for analyzing reactive control systems. The main window is titled "ReactiveControl/reactive_features.mkeys" and "Log Explorer [E:\Logs\Directions3rdFloor\20140829\110918.xml]".

Feature Streams (60042 total, 11 selected):

- Tracks: Reactive FS
- ReactiveControl/reactive_features.mkeys
- Feature Streams (60042 total, 11 selected):
 - 2
 - [NaN]
 - ReplaceNaNWithLastKnownValue
 - SUConfs
 - FaceGenderDetectionResult
 - FacePoseDetectionResult
 - FaceRecognitionResult
 - FaceTracker
 - FGDenialies
 - Id
 - Invisible
 - Location
 - Height
 - Width
 - X1
 - X2
 - XCenter
 - IntervalSlope(10, 0)
 - [NaN]
 - IntervalSlope(100, 0)
 - IntervalSlope(20, 0)

Reactive FS Timeline:

- RFID Events
- Speech Synthesis
- Floor Behaviors
- Floor State
- Boron(Recognition CFG)
- GazeControl
- Reactive FS
- IT.15
- Boron DesDispatch
- Boron DesNotification
- Boron DesRequest
- Boron Robot Behaviors Action-R
- Boron Robot Behaviors Blink-Po
- Boron Robot Behaviors Gesture
- Boron Robot Behaviors Idle-Pob
- Boron Robot Behaviors Track-VI
- Boron Robot Control
- Hydrogen_AudioSources_AudioS
- Hydrogen Control
- Hydrogen DesDispatch
- Hydrogen DesRequest
- Hydrogen RecognitionEngines

Utterance Event Panel:

- Transcript: [unavailable]
- Simplified: [unavailable]
- Semantics: [unavailable]
- Annotation: [unavailable]
- Grammar: DirectionsRequest.YesCorrect.No.Incorrect.Bye.CancelIrite
- Runtime: Understanding
- Reco Type: 1
- Source: SIS
- Target: SIS
- Labels: Background
- Reco Type: <EMPTY>
- Source: <EMPTY>
- Target: <EMPTY>
- Ut domain: <EMPTY>
- SML: [SML text="no" utteranceConfidence="0.452" confidence="0.452">no confidence="0.002">no</alternate> alternate Rank="2" test="no" ... utteranceConfidence="0.452" confidence="0.452">no confidence="0.452">no</alternate></SML>

Video Feed:

- Shows two people in a hallway.
- Yellow bounding boxes track faces.
- Labels: P:199, P:211, P:198.
- Bottom text: L:110918: Directions, Status: Engaged, 11:09:18, System.

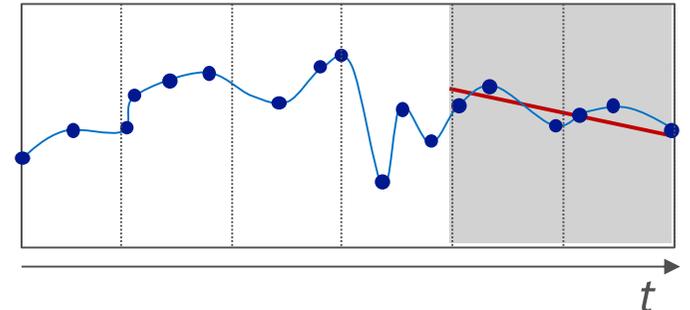
Time

Time and streams as 1st order citizens

```
stream double f;
```

```
f=3; f=x*f-y;
```

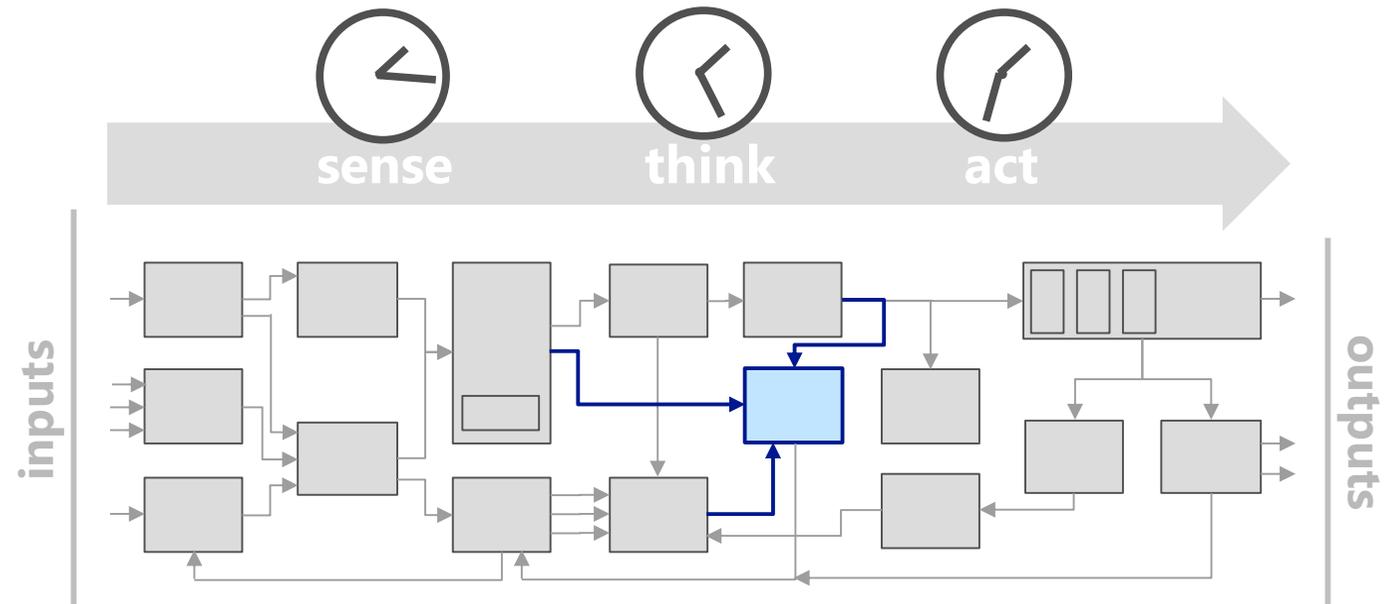
persistence w/ historical access (e.g. `f[-200ms]`), sampling, transforms (e.g. `f.Slope[-500ms:0ms]`)



Latency-awareness

synchronization and coordination primitives

meta-reasoning about time



Uncertainty & ML in integrative-AI systems

Software engineering & Uncertainty

composability

testing and maintenance

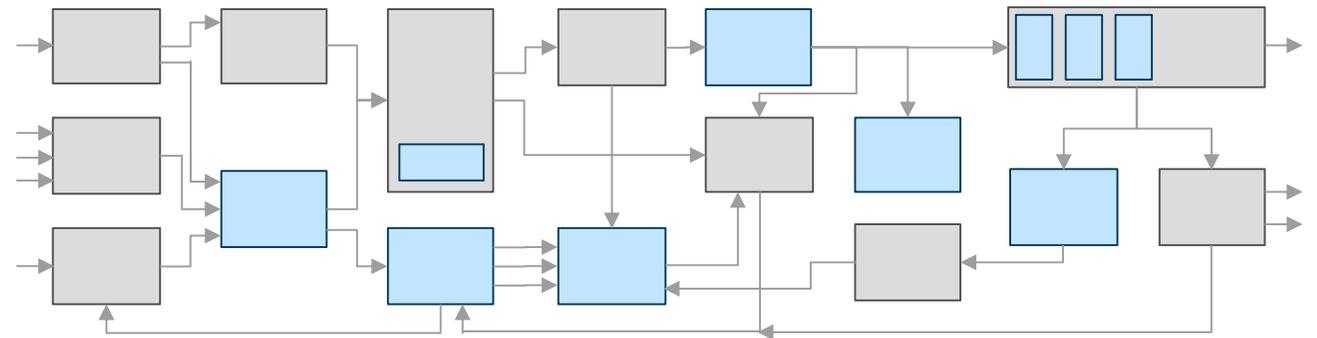
versioning

ML & integrative-AI systems

interactivity (with outside world or other components)

blame assignment

system-level optimization



Microphone array capture
Sound source localization
Speech recognition
Language understanding
Infrared proximity sensors
Badge sensors
Face detection and tracking
Head-pose tracking

Facial feature tracking
Face identity recognition
Gender detection
Attention models
Engagement models
Turn-taking models
Behavioral control

Dialog management
Natural language generation
Speech synthesis
Avatar synthesis
Robot motion control
Floor-plan models
User models

Integrative-AI

