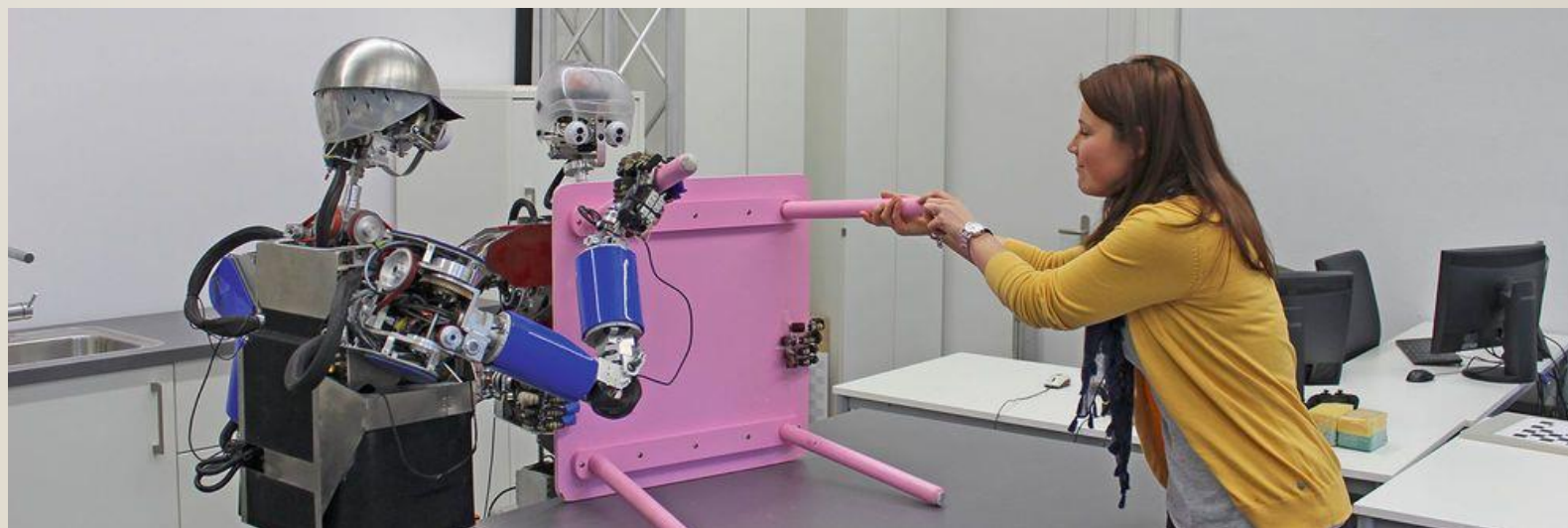




Kognitive Modellierung in dynamischen Mensch-Maschine Systemen

Prof. Dr.-Ing. Nele Rußwinkel
FG KModyS Institut für Psychologie und Arbeitswissenschaft
Technische Universität Berlin

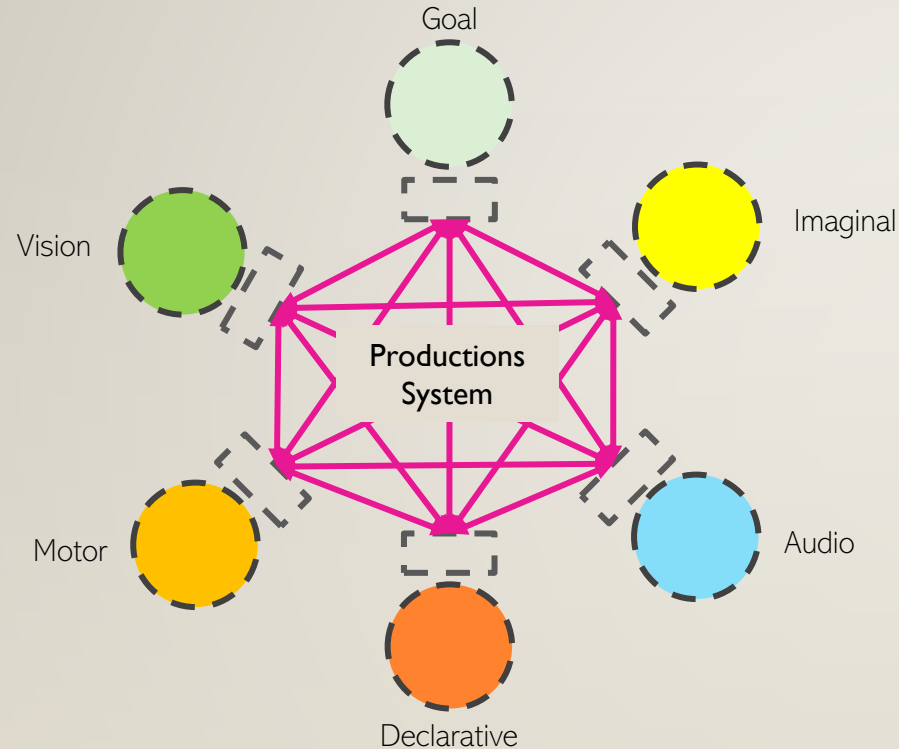


AUTOMATION VS. AUTONOMIE BZW. MENSCH-ZENTRIERTE KI



- Autonomy capitalizes on technology's ability to make intelligent decisions and adapt to **task**, **situation**, and **context**, [...] (Cox, 2013).
- Forschungsherausforderungen bei der Entwicklung **Human Aware AI-Systeme** (Kambhampati, 2020):
 - Modellierung der mentalen [kognitiven] Zuständen von Menschen in-the-loop
 - Erkennen der Wünsche und Intentionen,
 - proaktive Unterstützung bieten,
 - erklärbares Verhalten zeigen,
 - bei Bedarf stichhaltige Erklärungen abgeben und
 - Vertrauen schaffen.

KOGNITIVE ARCHITEKTUREN Z.B ACT-R (ANDERSON, 2002)



- Transparenz von Wissensrepräsentationen (Symbolische Repräsentationen) → flexible Strukturen Chunks & Prozedurale Regeln
- Eigenständig parallel arbeitende Module unterschiedlicher kognitiver Fähigkeiten.
- Buffer: Interface für den Informationsaustausch
- Bedeutung entsteht erst aus der Zusammenführung von Information

PHYSISCHES, KOGNITIVE ASPEKTE UND DYNAMISCHE INTEGRATION

1) Cockpit:

- Physisch: Interaktionen, surprise Reaktionen, Systemzustand
- Kognitiv: SA und Aufgabenwissen (Meta Ebene)
- Integration: Kognitiv + mental State ERP + Systemzustand

2) Hochautonomes Fahren

- Physisch: Interaktionen, Blickbewegung
- Kognitiv: Aufbau SA und flexibles Aufgabenwissen
- Integration: Umgebung + Eyetracking + Cognitive state

3) Human Robot Interaktion

- Physisch: Bewegungsmodelle + Eyetracking
- Kognitiv: SA und Aufgabenwissen (Meta Ebene)
- Integration: Kognitiv + physische Bewegung + Umgebung

A Neuroadaptive Cognitive Model in Tracing Pilots' Cognitive State



Oliver Klaproth

Weitere
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Prof. Thorsten Zander
(Brandenburg University of Technology)
Laurenz Kroll (TU Berlin)

Christoph Vernaleken
& Inge Wenzel (Airbus)



AIRBUS
Classic Cockpit Operations



AIRBUS CR&T

Inattentional Deafness (Dehains, Roy & Scanella, 2019)

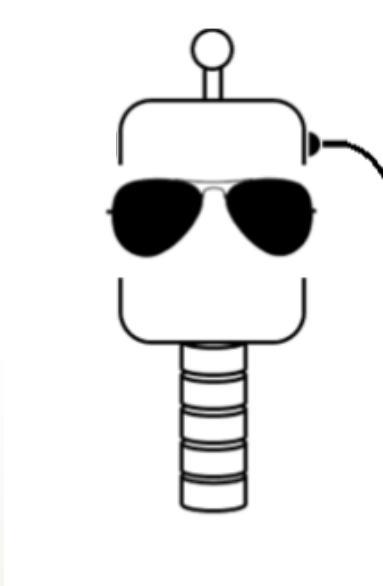
Der größte Anteil der Pilotenfehler ist auf falsche Wahrnehmung (70,3%) und falsches Verständnis der Situation (20,3%) zurückzuführen (Jones & Endsley, 1996).



Flight simulator example

ZIELE

1. Abweichendes Pilotenverhalten detektieren
2. Wahrnehmung akustische Signale identifizieren
3. Out of the Loop Ereignisse erkennen

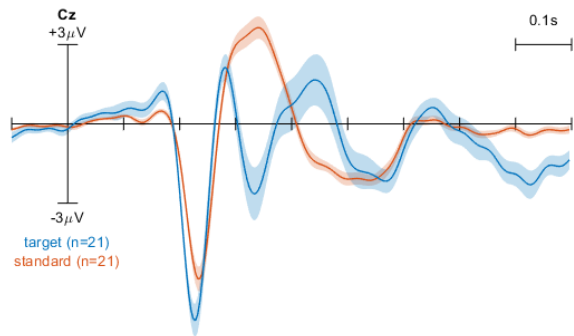


Hierarchical Task Analysis						
Layer 1	Layer 2	Layer 3	Layer 4	Layer 5	Layer 6	Layer 7
Fly scenario	0. Manage speed during climb and cruise					
	0.1. Monitor selected speed					
	0.2. Monitor ground speed					
	0.3. Monitor altitude					
1. Handle fuel pump alert	0.4. Adjust thrust lever accordingly					
	1.1. Hear alert					
	1.2. Read warning					
	1.3. Press master caution/master warning					
	1.4. Go through pump failure checklist					
	1.4.1. Right main fuel pump OFF					
	1.4.2. X-Feed-Valve ON					
	1.4.3. Gravity X-Flow AS REQ.					
	1.5. Validate by checking fuel display					
2. Handle TCAS	2.1. Hear Callout "Traffic Traffic"					
	2.2. Prepare for manual maneuver					
	2.2.1. Grab throttle					
	2.2.2. Grab Sidestick					
	2.3. Spot orange dot on NavMinNav					
	2.4. See dot turn white					
	2.5. Take hands off of sidestick and throttle					
3. Handle engine failure	3.1. Hear warning					
	3.2. Press master caution/master warning					
	3.3. Go through engine fire checklist					
	3.3.1. Right thrust lever to IDLE					
	3.3.2. Right engine master switch to OFF					
	3.3.3. Engine fire push button to off					
	3.3.3.1. Open switch guard					
	3.3.3.2. PNESS button					
	3.3.4. Wait for 10 seconds					
	3.3.5. DISCHARGE fire extinguishing agent #1					
	3.3.6. Wait for 30 seconds					
	3.3.7. DISCHARGE fire extinguishing agent #2					
	3.4. Go through follow-up checklist opens					
	3.4.1. Rudder trim					
	3.4.2. Engine mode to grtison					
	3.4.3. Open crossfeed valve (overhead)					
	3.4.4. Shut down right generator					
	3.4.5. TCAS Mode change					
4. Handle fuel imbalance	4.1. Notice fuel imbalance early on					
	4.2. Use fuel warning					

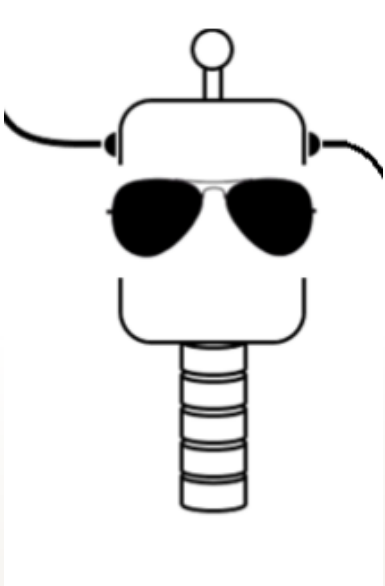
Cognitive model



A	B	C	D	E	F	G	H	I	J	K	L	
Task	grt	thrust	thrust	thrust	speed	altitude	heading	selected	altitude	maneuver	maneuver	
228	11.430	2017-12-08T08:10:10	0.8278018	0.8480234	0.9216	200	20000	340	201.555517	2408.2272	TRUE	FALSE
229	11.530	2017-12-08T08:10:10	0.8278018	0.8480234	0.9216	200	20000	340	201.447154	2408.1702	TRUE	FALSE
230	11.580	2017-12-08T08:10:10	0.8278018	0.8480234	0.9216	200	20000	340	201.427584	2478.0311	TRUE	FALSE
231	11.630	2017-12-08T08:10:10	0.8278018	0.8480234	0.9216	200	20000	340	201.806360	2471.8245	TRUE	FALSE
232	11.680	2017-12-08T08:10:10	0.8278018	0.8480234	0.9216	200	20000	340	201.960777	2495.8554	TRUE	FALSE
233	11.730	2017-12-08T08:10:10	0.8278018	0.8480234	0.9216	200	20000	340	202.10275	2498.7828	TRUE	FALSE
234	11.760	2017-12-08T08:10:10	0.8278018	0.8480234	0.9216	200	20000	340	202.338447	2493.7523	TRUE	FALSE
235	11.830	2017-12-08T08:10:10	0.8278018	0.8480234	0.9216	200	20000	340	202.516032	2547.7006	TRUE	FALSE
236	11.860	2017-12-08T08:10:10	0.8278018	0.8480234	0.9216	200	20000	340	202.694642	2491.8893	TRUE	FALSE
237	11.900	2017-12-08T08:10:10	0.8278018	0.8480234	0.9216	200	20000	340	202.869889	2493.7487	TRUE	FALSE
238	11.930	2017-12-08T08:10:10	0.8278018	0.8480234	0.9216	200	20000	340	203.041168	2452.8857	TRUE	FALSE
239	11.960	2017-12-08T08:10:10	0.8278018	0.8480234	0.9216	200	20000	340	203.216811	2457.8762	TRUE	FALSE
240	12.000	2017-12-08T08:10:10	0.8278018	0.8480234	0.9216	200	20000	340	203.388811	2457.8667	TRUE	FALSE
241	12.100	2017-12-08T08:10:10	0.8278018	0.8480234	0.9216	200	20000	340	203.564455	2467.8667	TRUE	FALSE
242	12.300	2017-12-08T08:10:10	0.8278018	0.8480234	0.9216	200	20000	340	203.73233	2498.0786	TRUE	FALSE
243	12.390	2017-12-08T08:10:10	0.8278018	0.8480234	0.9216	200	20000	340	203.92626	2498.3087	TRUE	FALSE
244	12.390	2017-12-08T08:10:10	0.8278018	0.8480234	0.9216	200	20000	340	204.079844	2498.3425	TRUE	FALSE
245	12.390	2017-12-08T08:10:10	0.8278018	0.8480234	0.9216	200	20000	340	204.244711	2498.4514	TRUE	FALSE
246	12.430	2017-12-08T08:10:10	0.8278018	0.8480234	0.9216	200	20000	340	204.419480	2482.8567	TRUE	FALSE
247	12.430	2017-12-08T08:10:10	0.8278018	0.8480234	0.9216	200	20000	340	204.583636	2479.8584	TRUE	FALSE
248	12.500	2017-12-08T08:10:11	0.8278018	0.8480234	0.9216	200	20000	340	204.751110	2467.0559	TRUE	FALSE
249	12.530	2017-12-08T08:10:11	0.8278018	0.8480234	0.9216	200	20000	340	204.919251	2465.2659	TRUE	FALSE
250	12.590	2017-12-08T08:10:11	0.8278018	0.8480234	0.9216	200	20000	340	205.088752	2493.4890	TRUE	FALSE
251	12.600	2017-12-08T08:10:11	0.8278018	0.8480234	0.9216	200	20000	340	205.255754	2463.7524	TRUE	FALSE
252	12.650	2017-12-08T08:10:11	0.8278018	0.8480234	0.9216	200	20000	340	205.420227	2447.9862	TRUE	FALSE
253	12.700	2017-12-08T08:10:11	0.8278018	0.8480234	0.9216	200	20000	340	205.587336	2462.2819	TRUE	FALSE
254	12.730	2017-12-08T08:10:11	0.8278018	0.8480234	0.9216	200	20000	340	205.754403	2462.2819	TRUE	FALSE
255	12.800	2017-12-08T08:10:11	0.8278018	0.8480234	0.9216	200	20000	340	205.920268	2463.8553	TRUE	FALSE
256	12.850	2017-12-08T08:10:11	0.8278018	0.8480234	0.9216	200	20000	340	206.085391	2452.8902	TRUE	FALSE
257	12.860	2017-12-08T08:10:11	0.8278018	0.8480234	0.9216	200	20000	340	206.251783	2419.4082	TRUE	FALSE
258	12.900	2017-12-08T08:10:11	0.8278018	0.8480234	0.9216	200	20000	340	206.421615	2411.7122	TRUE	FALSE
259	13.000	2017-12-08T08:10:11	0.8278018	0.8480234	0.9216	200	20000	340	206.586874	2408.0321	TRUE	FALSE
260	13.000	2017-12-08T08:10:11	0.8278018	0.8480234	0.9216	200	20000	340	206.753137	2403.5252	TRUE	FALSE
261	13.100	2017-12-08T08:10:11	0.8278018	0.8480234	0.9216	200	20000	340	206.920319	2436.8887	TRUE	FALSE
262	13.120	2017-12-08T08:10:11	0.8278018	0.8480234	0.9216	200	20000	340	207.086981	2436.0562	TRUE	FALSE
263	13.200	2017-12-08T08:10:11	0.8278018	0.8480234	0.9216	200	20000	340	207.248685	2438.3750	TRUE	FALSE
264	13.300	2017-12-08T08:10:11	0.8278018	0.8480234	0.9216	200	20000	340	207.410359	2473.7242	TRUE	FALSE
265	13.380	2017-12-08T08:10:11	0.8278018	0.8480234	0.9216	200	20000	340	207.571411	2474.0874	TRUE	FALSE
266	13.390	2017-12-08T08:10:11	0.8278018	0.8480234	0.9216	200	20000	340	207.736603	2498.4026	TRUE	FALSE
267	13.430	2017-12-08T08:10:11	0.8278018	0.8480234	0.9216	200	20000	340	207.903435	2492.8018	TRUE	FALSE
268	13.450	2017-12-08T08:10:12	0.8278018	0.8480234	0.9216	200	20000	340	208.064789	2497.1712	TRUE	FALSE
269	13.530	2017-12-08T08:10:12	0.8278018	0.8480234	0.9216	200	20000	340	208.223101	2493.5415	TRUE	FALSE
270	13.600	2017-12-08T08:10:12	0.8278018	0.8480234	0.9216	200	20000	340	208.386784	2496.8756	TRUE	FALSE
271	13.690	2017-12-08T08:10:12	0.8278018	0.8480234	0.9216	200	20000	340	208.550476	2496.2847	TRUE	FALSE
272	13.690	2017-12-08T08:10:12	0.8278018	0.8480234	0.9216	200	20000	340	208.713506	2498.8756	TRUE	FALSE
273	13.760	2017-12-08T08:10:12	0.8278018	0.8480234	0.9216	200	20000	340	208.877467	2493.8942	TRUE	FALSE
274	13.790	2017-12-08T08:10:12	0.8278018	0.8480234	0.9216	200	20000	340	209.040827	2492.4205	TRUE	FALSE
275	13.790	2017-12-08T08:10:12	0.8278018	0.8480234	0.9216	200	20000	340	209.204605	2491.8057	TRUE	FALSE
276	13.850	2017-12-08T08:10:12	0.8278018	0.8480234	0.9216	200	20000	340	209.368225	2492.1601	TRUE	FALSE
277	13.900	2017-12-08T08:10:12	0.8278018	0.8480234	0.9216	200	20000	340	209.531472	2496.8198	TRUE	FALSE
278	13.950	2017-12-08T08:10:12	0.8278018	0.8480234	0.9216	200	20000	340	209.697659	2498.9465	TRUE	FALSE
279	14.000	2017-12-08T08:10:12	0.8278018	0.8480234	0.9216	200	20000	340	209.862754	2498.9195	TRUE	FALSE
280	14.050	2017-12-08T08:10:12	0.8278018	0.8480234	0.9216	200	20000	340	209.996331	2498.0884	TRUE	FALSE
281	14.100	2017-12-08T08:10:12	0.8278018	0.8480234	0.9216	200	20000	340	210.154816	2498.0662	TRUE	FALSE
282	14.150	2017-12-08T08:10:12	0.8278018	0.8480234	0.9216	200	20000	340	210.312721	2497.4194	TRUE	FALSE
283	14.300	2017-12-08T08:10:12	0.8278018	0.8480234	0.9216	200	20000	340	210.471111	2497.8162	TRUE	FALSE
284	14.350	2017-12-08T08:10:12	0.8278018	0.8480234	0.9216	200	20000	340	210.629101	2497.0584	TRUE	FALSE
285	14.390	2017-12-08T08:10:12	0.8278018	0.8480234	0.9216	200	20000	340	210.786774	2496.2847	TRUE	FALSE
286	14.430	2017-12-08T08:10:12	0.8278018	0.8480234	0.9216	200	20000	340	210.944447	2495.5109	TRUE	FALSE
287	14.430	2017-12-08T08:10:12	0.8278018	0.8480234	0.9216	200	20000	340	211.102120	2494.7370	TRUE	FALSE
288	14.430	2017-12-08T08:10:12	0.8278018	0.8480234	0.9216	200	20000	340	211.259793	2493.9631	TRUE	FALSE
289	14.430	2017-12-08T08:10:12	0.8278018	0.8480234	0.9216	200	20000	340	211.417466	2493.1892	TRUE	FALSE
290	14.430	2017-12-08T08:10:12	0.8278018	0.8480234	0.9216	200	20000	340	211.575139	2492.4153	TRUE	FALSE



BCI

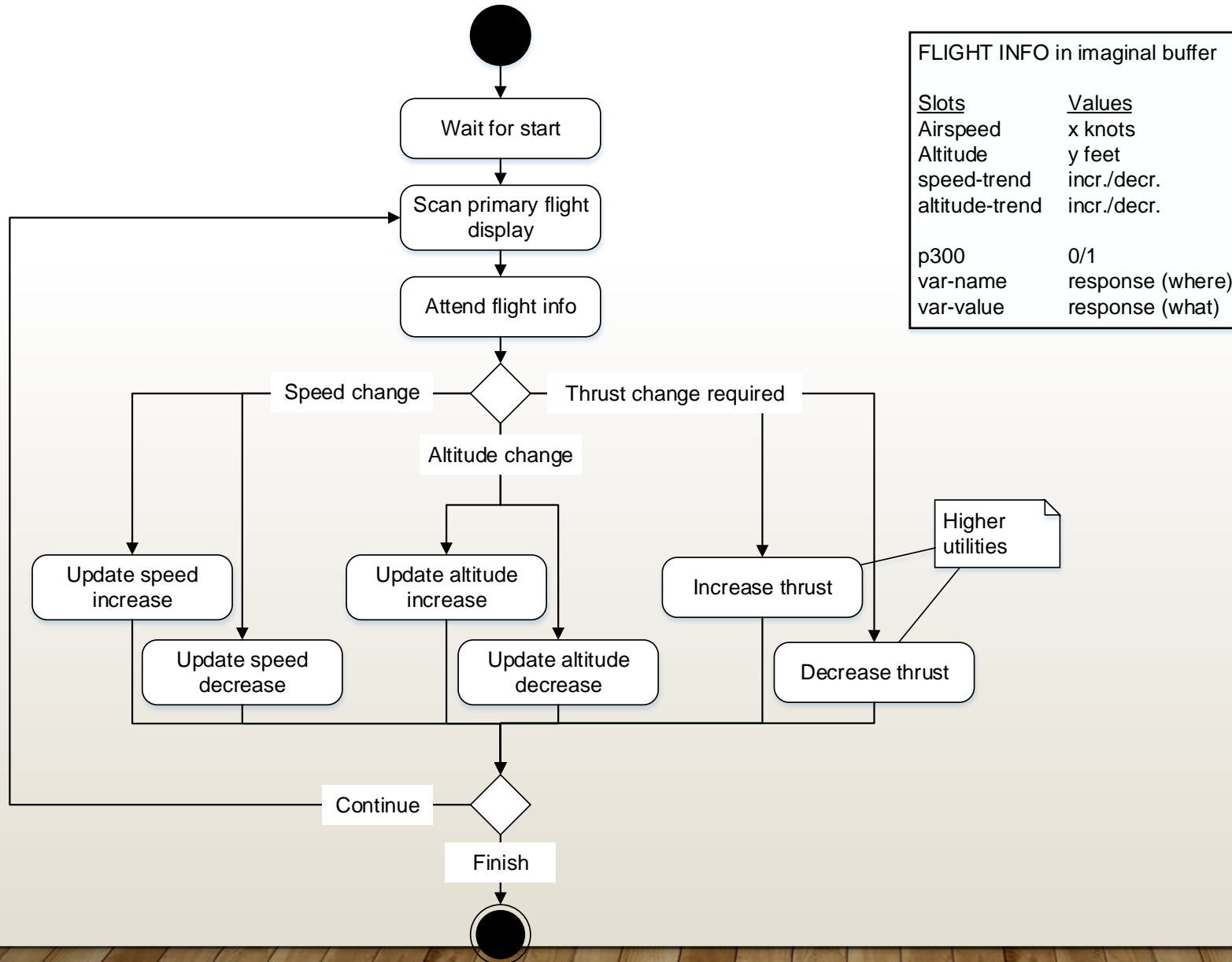


Hierarchical Task Analysis						
Layer 1	Layer 2	Layer 3	Layer 4	Layer 5	Layer 6	Layer 7
Fly scenario						
0. Manage speed during climb and cruise						
0.1. Monitor selected speed						
0.2. Monitor ground speed						
0.3. Monitor altitude						
0.4. Adjust thrust lever accordingly						
1. Handle fuel pump alert						
1.1. Hear alert						
1.2. Read warning						
1.3. Press master caution/master warning						
1.4. Go through pump failure checklist						
1.4.1. Right main fuel pump OFF						
1.4.2. X-Feed Valve ON						
1.4.3. Gravity X-Flow AS REQ.						
1.5. Validate by checking fuel display						
2. Handle TCAS						
2.1. Hear Callout "Traffic Traffic"						
2.2. Prepare for manual maneuver						
2.2.1. Grab throttle						
2.2.2. Grab Sidestick						
2.3. Spot orange dot on NavMinNav						
2.4. See dot turn white						
2.5. Take hands off of sidekick and throttle						
3. Handle engine failure						
3.1. Hear warning						
3.2. Press master caution/master warning						
3.3. Go through engine fire checklist						
3.3.1. Right thrust lever to IDLE						
3.3.2. Right engine master switch to OFF						
3.3.3. Engine fire push button to OFF						
3.3.3.1. Open switch guard						
3.3.3.2. P/RESS button						
3.3.4. Wait for 10 seconds						
3.3.5. DISCHARGE fire extinguishing agent #1						
3.3.6. Wait for 30 seconds						
3.3.7. DISCHARGE fire extinguishing agent #2						
3.4. Go through follow-up checklist opens						
3.4.1. Rudder trim						
3.4.2. Engine mode to ignition						
3.4.3. Open crossfeed valve (overhead)						
3.4.4. Shut down right generator						
3.4.5. TCAS Mode change						
4. Handle fuel imbalance						
4.1. Notice fuel imbalance early on						
4.2. Wait for warning						

Cognitive model



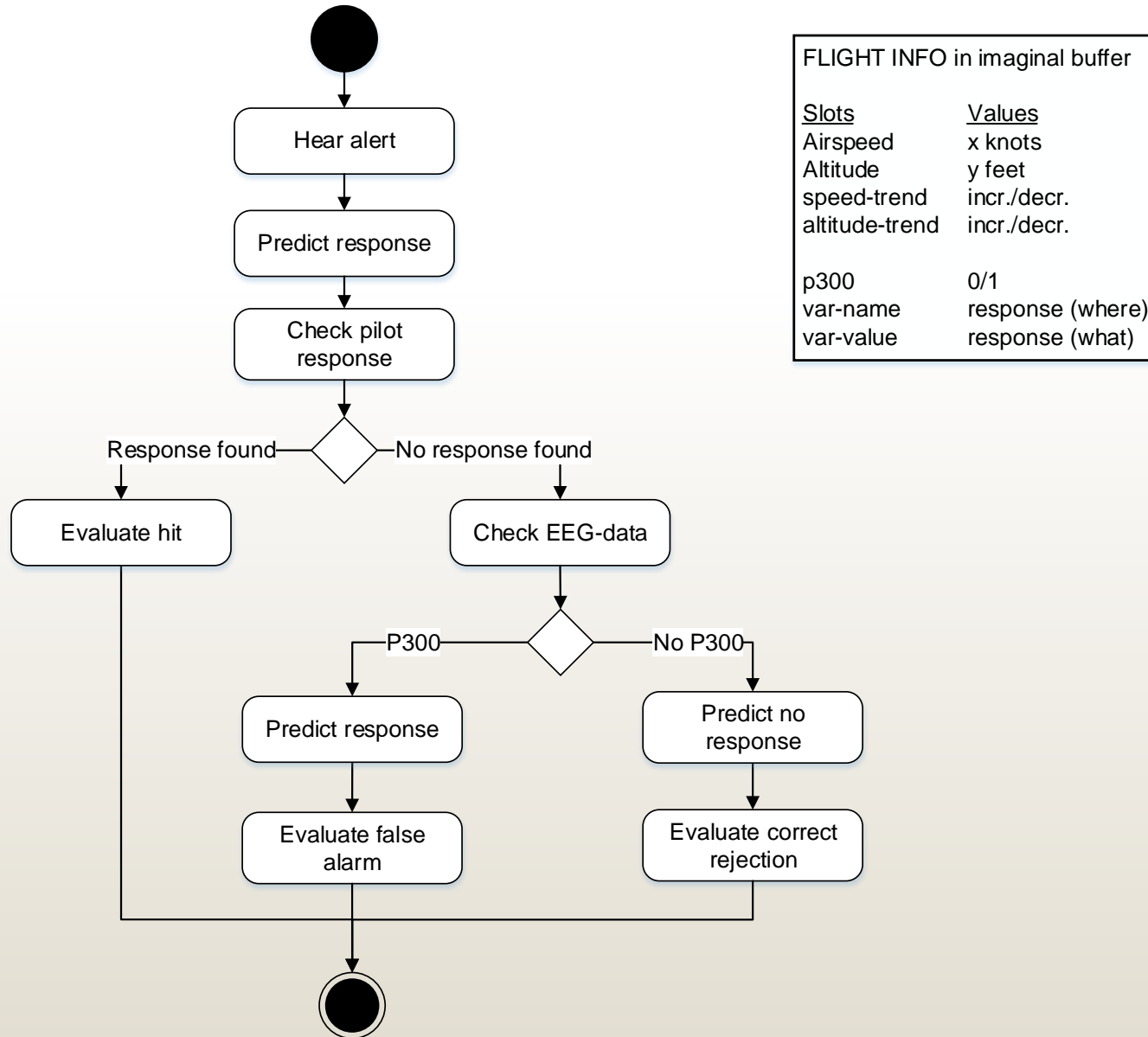
Task	A	R	C	D	E	F	G	H	I	J	K	L
Task	grt	thr	thr	thr	thr	thr	thr	thr	thr	thr	thr	thr
228	11.430	2017-12-08T08:10:10	0.82570018	0.84802354	0.82570018	200	20000	340	201.550537	24506.3272	TRUE	FALSE
229	11.530	2017-12-08T08:10:10	0.82570018	0.84802354	0.82570018	200	20000	340	201.447154	24504.1700	TRUE	FALSE
230	11.530	2017-12-08T08:10:10	0.82570018	0.84802354	0.82570018	200	20000	340	201.427584	24510.0311	TRUE	FALSE
231	11.630	2017-12-08T08:10:10	0.82570018	0.84802354	0.82570018	200	20000	340	201.800360	24511.8245	TRUE	FALSE
232	11.630	2017-12-08T08:10:10	0.82570018	0.84802354	0.82570018	200	20000	340	201.960277	24505.8554	TRUE	FALSE
233	11.730	2017-12-08T08:10:10	0.82570018	0.84802354	0.82570018	200	20000	340	202.14075	24509.7820	TRUE	FALSE
234	11.830	2017-12-08T08:10:10	0.82570018	0.84802354	0.82570018	200	20000	340	202.330447	24513.7521	TRUE	FALSE
235	11.830	2017-12-08T08:10:10	0.82570018	0.84802354	0.82570018	200	20000	340	202.51002	24547.7006	TRUE	FALSE
236	11.930	2017-12-08T08:10:10	0.82570018	0.84802354	0.82570018	200	20000	340	202.68962	24541.8891	TRUE	FALSE
237	11.930	2017-12-08T08:10:10	0.82570018	0.84802354	0.82570018	200	20000	340	202.869209	24535.7487	TRUE	FALSE
238	12.030	2017-12-08T08:10:10	0.82570018	0.84802354	0.82570018	200	20000	340	203.048796	24529.7077	TRUE	FALSE
239	12.030	2017-12-08T08:10:10	0.82570018	0.84802354	0.82570018	200	20000	340	203.228381	24523.6671	TRUE	FALSE
240	12.130	2017-12-08T08:10:10	0.82570018	0.84802354	0.82570018	200	20000	340	203.407966	24517.6262	TRUE	FALSE
241	12.130	2017-12-08T08:10:10	0.82570018	0.84802354	0.82570018	200	20000	340	203.587551	24511.5853	TRUE	FALSE
242	12.230	2017-12-08T08:10:10	0.82570018	0.84802354	0.82570018	200	20000	340	203.767135	24505.5448	TRUE	FALSE
243	12.230	2017-12-08T08:10:10	0.82570018	0.84802354	0.82570018	200	20000	340	203.946720	24499.5043	TRUE	FALSE
244	12.330	2017-12-08T08:10:10	0.82570018	0.84802354	0.82570018	200	20000	340	204.126304	24493.4638	TRUE	FALSE
245	12.330	2017-12-08T08:10:10	0.82570018	0.84802354	0.82570018	200	20000	340	204.305889	24487.4233	TRUE	FALSE
246	12.430	2017-12-08T08:10:10	0.82570018	0.84802354	0.82570018	200	20000	340	204.485474	24481.3828	TRUE	FALSE
247	12.430	2017-12-08T08:10:10	0.82570018	0.84802354	0.82570018	200	20000	340	204.665059	24475.3423	TRUE	FALSE
248	12.530	2017-12-08T08:10:10	0.82570018	0.84802354	0.82570018	200	20000	340	205.024229	24469.3018	TRUE	FALSE
249	12.530	2017-12-08T08:10:10	0.82570018	0.84802354	0.82570018	200	20000	340	205.203814	24463.2613	TRUE	FALSE
250	12.630	2017-12-08T08:10:10	0.82570018	0.84802354	0.82570018	200	20000	340	205.383399	24457.2208	TRUE	FALSE
251	12.630	2017-12-08T08:10:10	0.82570018	0.84802354	0.82570018	200	20000	340	205.562984	24451.1803	TRUE	FALSE
252	12.730	2017-12-08T08:10:10	0.82570018	0.84802354	0.82570018	200	20000	340	205.742569	24445.1398	TRUE	FALSE
253	12.730	2017-12-08T08:10:10	0.82570018	0.84802354	0.82570018	200	20000	340	205.922154	24439.0993	TRUE	FALSE
254	12.830	2017-12-08T08:10:10	0.82570018	0.84802354	0.82570018	200	20000	340	206.101739	24433.0588	TRUE	FALSE
255	12.830	2017-12-08T08:10:10	0.82570018	0.84802354	0.82570018	200	20000	340	206.281324	24427.0183	TRUE	FALSE
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299	15.030	2017-12-08T08:10:10	0.82570018	0.84802354	0.82570018	200	20000	340	214.184014	24162.2363	TRUE	FALSE
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COGNITIVE PILOT MODEL

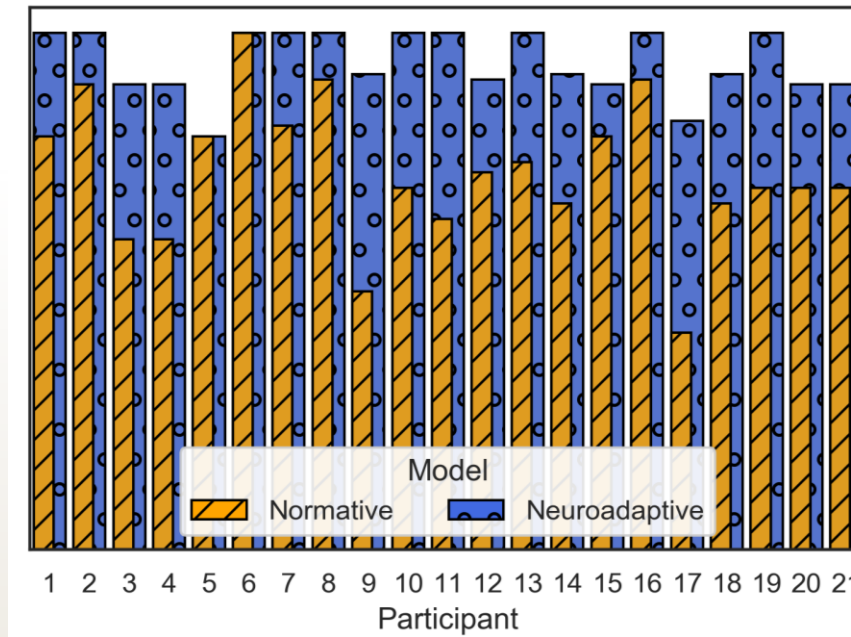
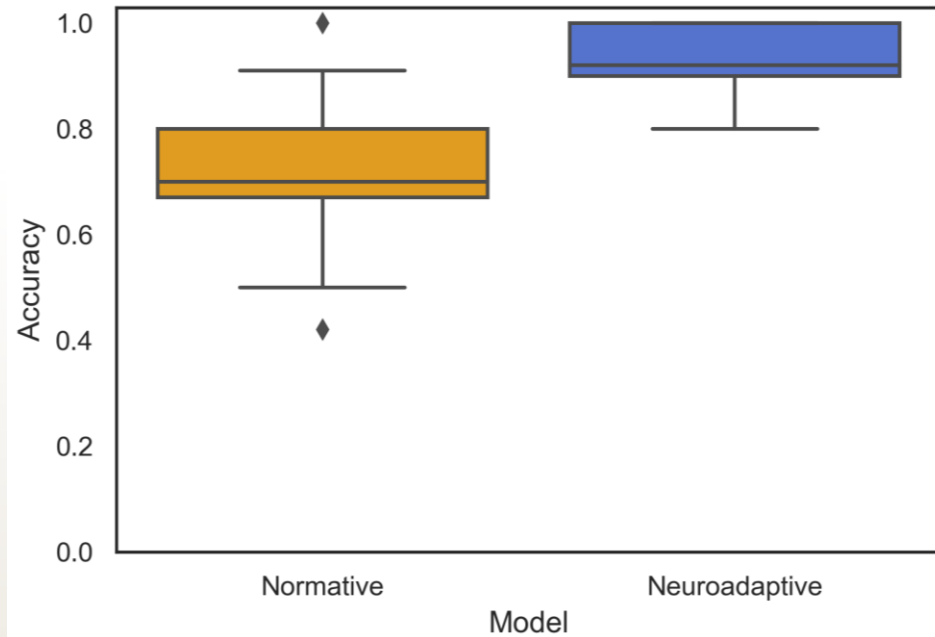
Das Pilotmodell besteht aus einer routinemäßigen Überwachungsschleife

...



COGNITIVE PILOT MODEL

...und einem Alarmreaktionsprozess.



$Mdn_{Norm.} = 0.73$ ($IQR = 0.8 - 0.67$)

$Mdn_{Neuro.} = 0.92$ ($IQR = 1.0 - 0.9$)

MODEL RESULTS

Signifikant höhere Genauigkeit des neuroadaptiven Modells

ANTIZIPATION VON TAKEOVER SITUATIONEN IM HOCHAUTONOMEN FAHREN (SUBJECTIVE UND OBJEKTIVE KOMPLEXITÄT)

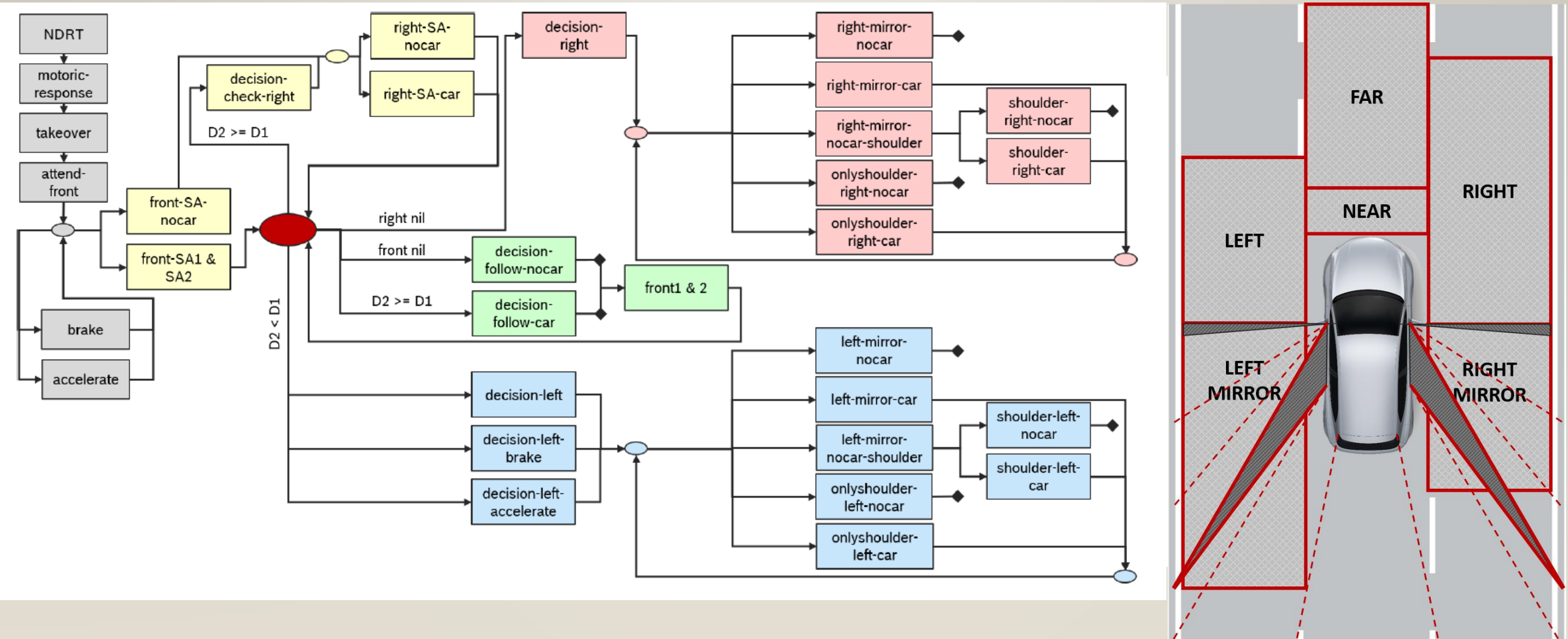


- Alexander Sternberg ehem. Lotz (Daimler AG)
 - LKW Studie Simulator und Realfahrt Übernahmeverhalten (Eyetracking und Cinect)
 - Maschinelles Lernen um Übernahmezeiten vorherzusagen
 - Adaptive assistance system for subjective critical driving situations (Lotz et al., 2020)



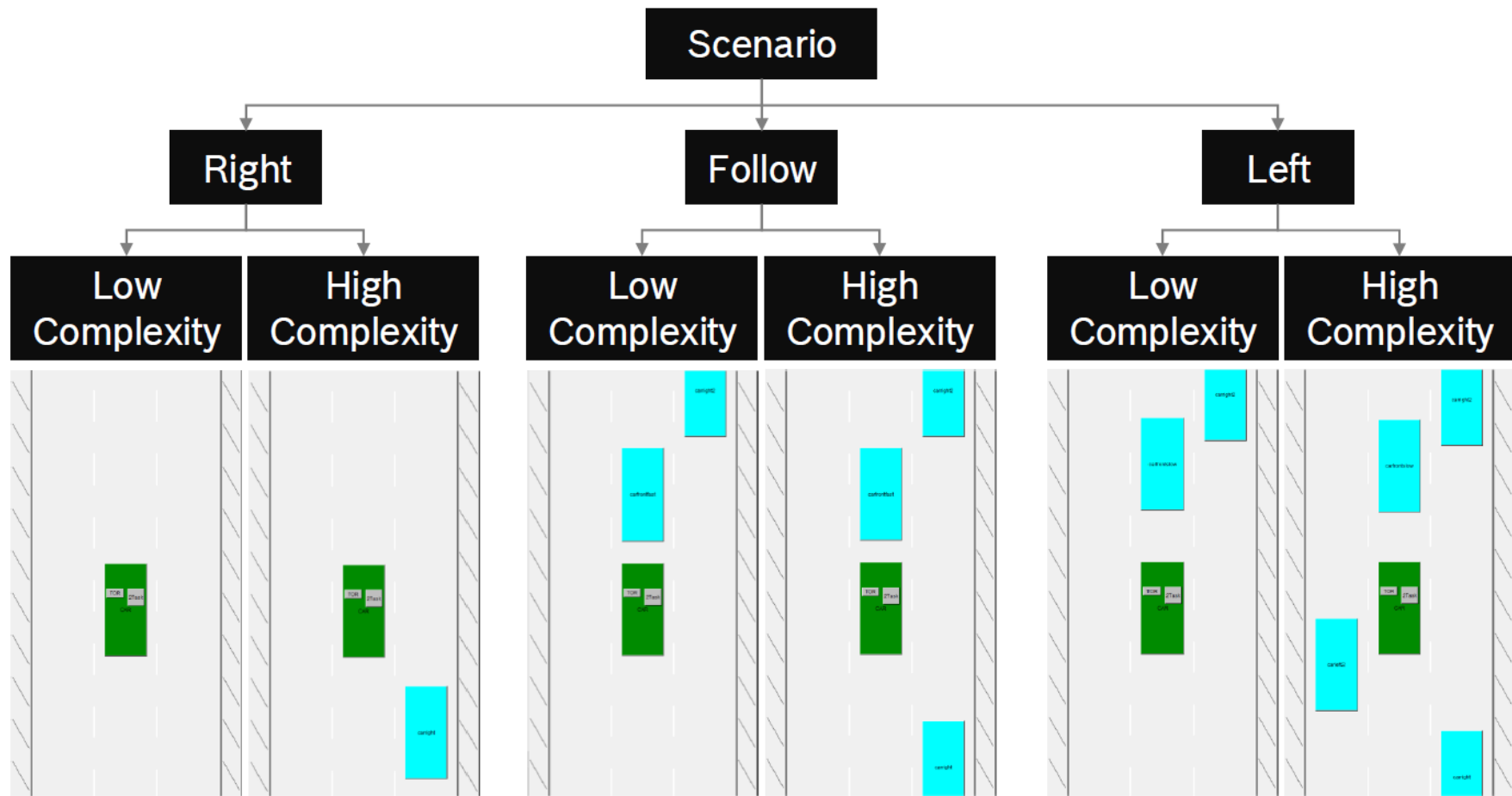
- Marlene Scharfe (Robert Bosch GmbH)
 - PKW Studie mit Eyetracking zu Vorhersage von Übernahmezeiten
 - Kognitive Modellierung zur Vorhersage der Zeiten einzelner Übernahmeschritte anhand der Komplexität einer Situation

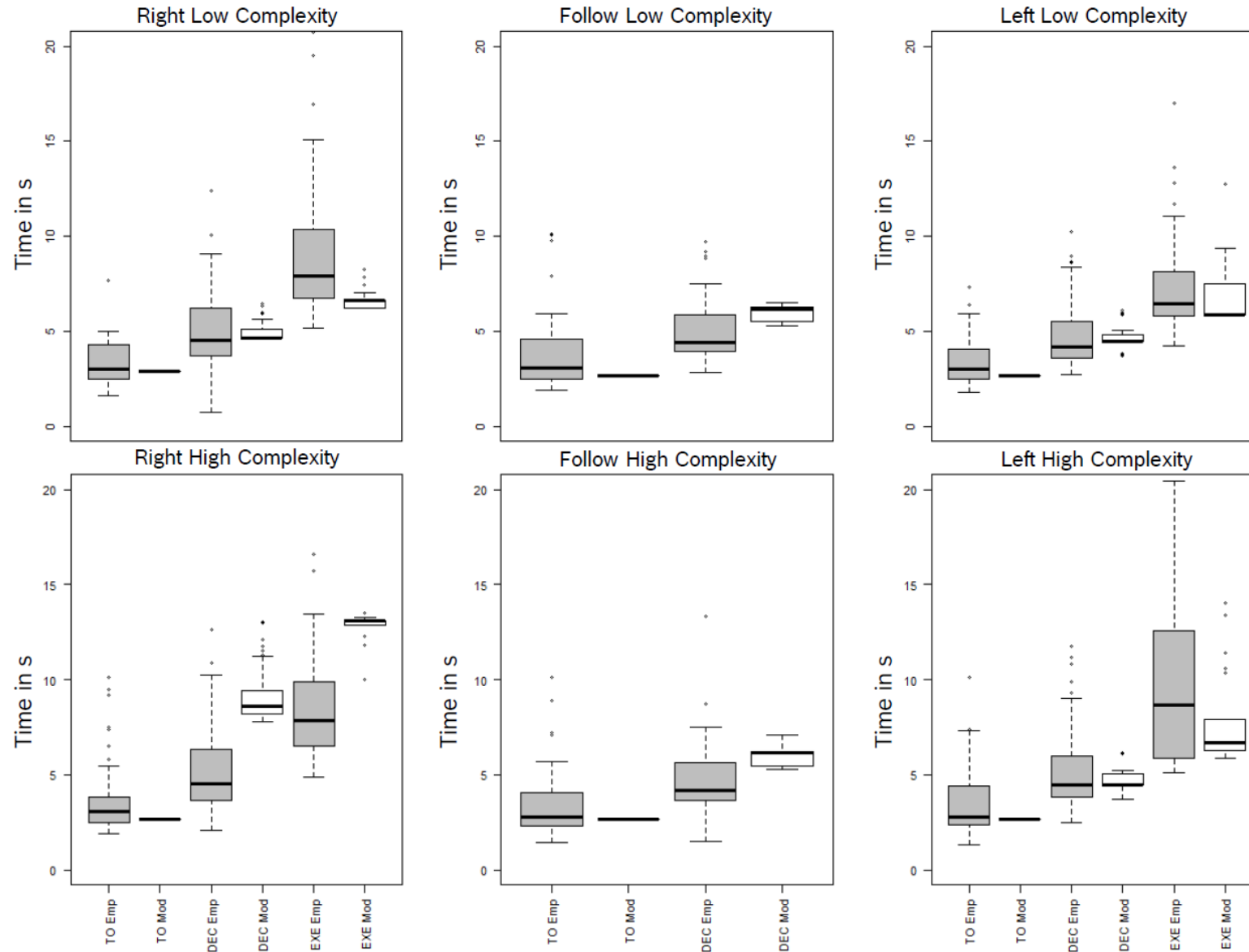
KOGNITIVES MODEL: SITUATIONSVERSTÄNDNIS BEI DER ÜBERNAHME



Scharfe, M., & Russwinkel, N. (2019). Towards a Cognitive Model of the Takeover in Highly Automated Driving for the Improvement of Human Machine Interaction. In Proceedings of the 17th International Conference on Cognitive Modelling, Montreal, Canada.

Scharfe, M., & Russwinkel, N. (2019). A Cognitive Model for Understanding the Takeover in Highly Automated Driving Depending on the Objective Complexity of Non-Driving Related Tasks and the Traffic Environment. In 41st Annual Meeting of the Cognitive Science Society Montreal, Canada.



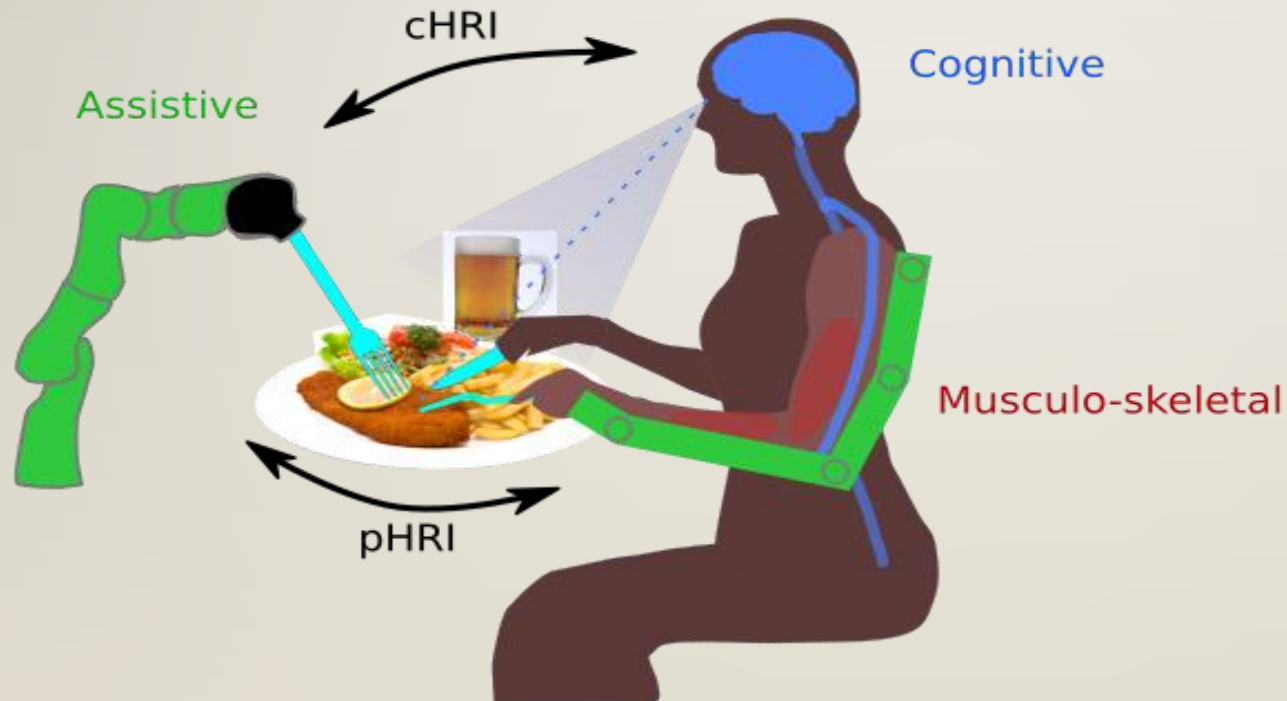


INTEGRATED MODELS OF COGNITIVE AND PHYSICAL HUMAN-ROBOT INTERACTION

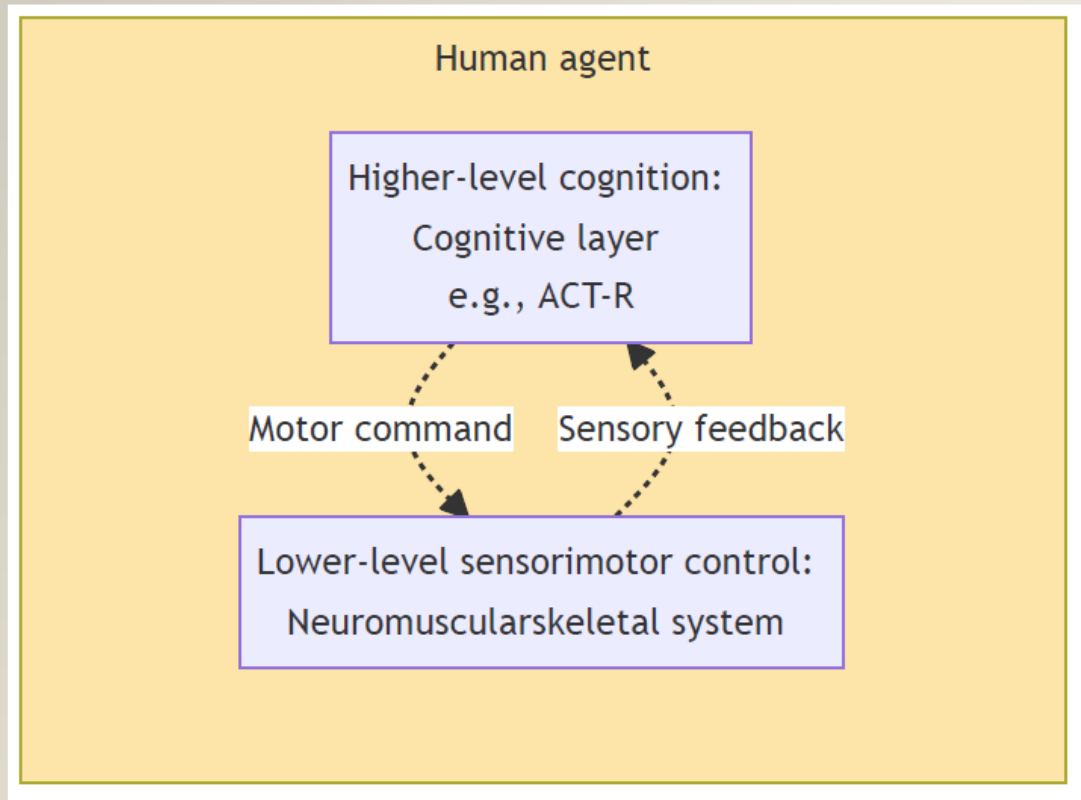
Philipp Beckerle & Stella Hao Chenxu (Uni Erlangen-Nürnberg),
Nele Rußwinkel (TU Berlin), Daniel Häufle (Uni Tübingen)

Anforderungen an das kognitiven Modell:

- Verstehen der Aufgabe und der nächsten Schritte in der Aufgabe
- Verfolgt Dynamik des Situationsbewusstsein
- Versteht Kontextinformationen
- Versteht Zustand des Menschen

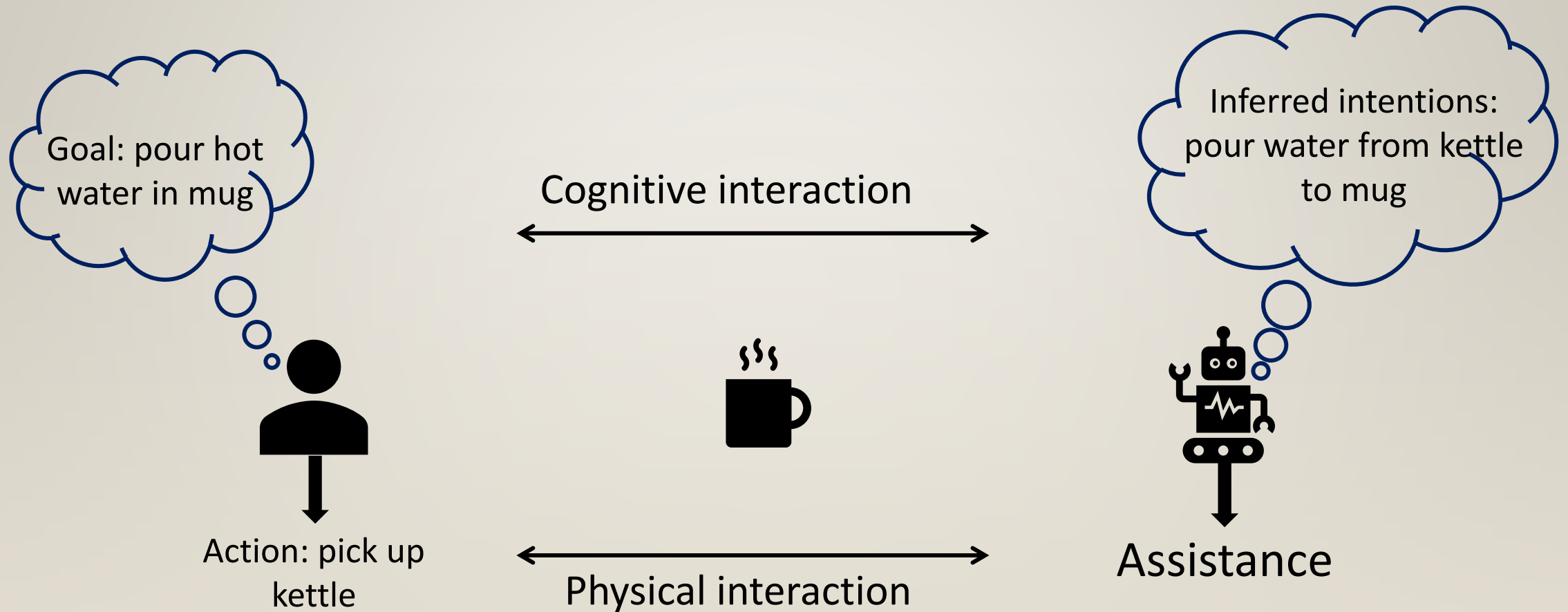


INTEGRATED MODELS OF COGNITIVE AND PHYSICAL HUMAN-ROBOT INTERACTION

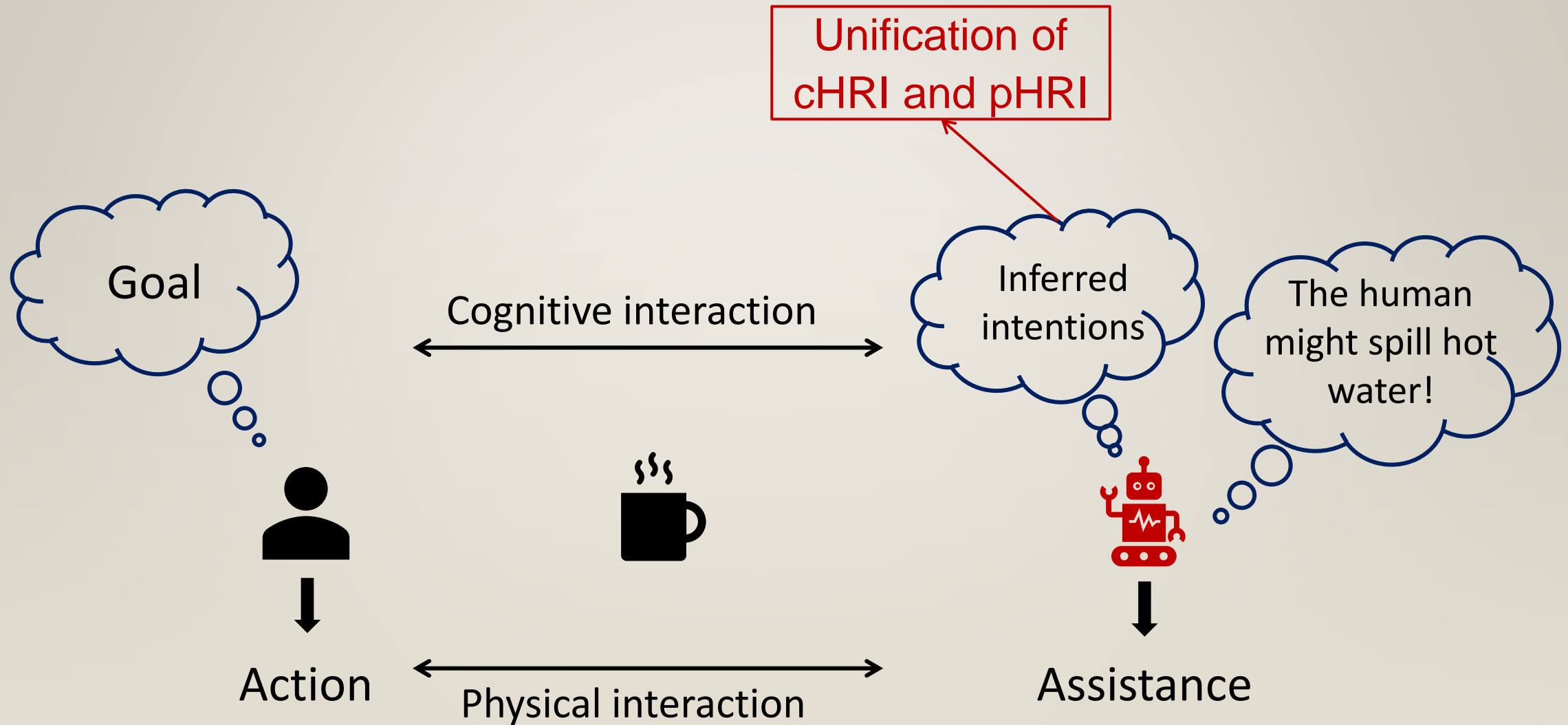


- Erforderlich: Ansatz, der die höhere kognitive Ebene mit der sensomotorischen Kontrolle verbindet. (Kahl et al., 2021)
- Unterschiedliche Unterstützungsebenen stellen unterschiedliche Anforderungen an das antizipatorische Modell.
- Gemeinsames Handeln?
- Vision: Beide Seiten sind gegenseitig anpassungsfähig

MOTIVATION: WHY INTEGRATION?

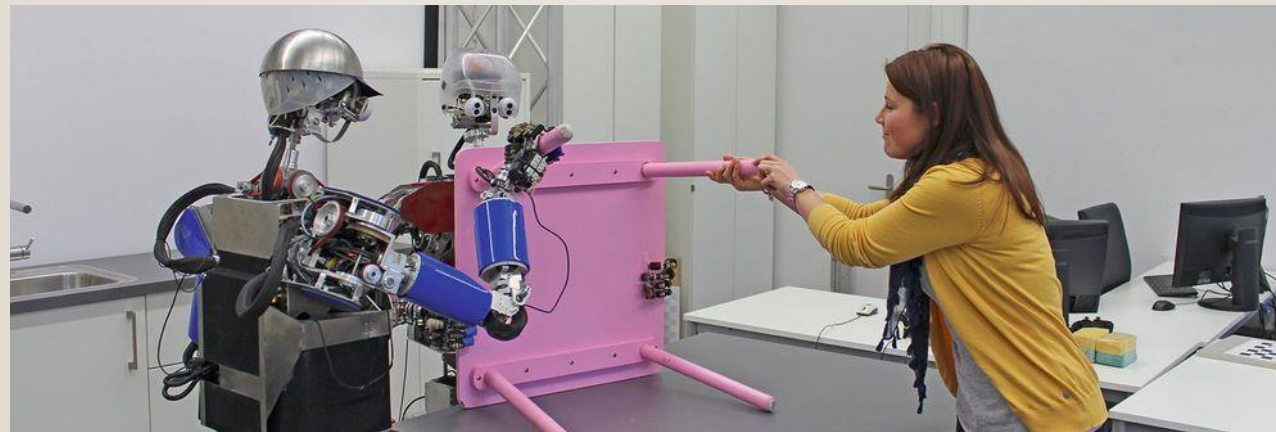


UNIFYING MODELS OF CHRI AND PHRI



FAZIT KOGNITIVE MODELLIERUNG

- Um neuen Technologie menschengerecht zu gestalten werden neue Ansätze benötigt
 - Die Dynamik und individuellen Aspekten von Aufgabenabläufen
 - Zusammenführung von physischen und kognitiven Aspekten bei der Aufgabenbearbeitung
 - Verbinden von Digitalen und kognitiven Menschmodellen wichtig
 - Die sinnvolle Integration von Informationen gerade bei Unsicherheit relevant.



VIELEN DANK!

