# Abstraction levels found in robot social-interaction programming tools

Table 1 provides source data for the abstraction levels found in different social-interaction programming tools.

**Table 1. Abstraction levels found in social-interaction programming tools.**

| Tool | Target audience evidence | Abstraction levels and supporting data | | | | |
|---|---|---|---|---|---|---|
| | | Hardware primitives | Algorithm primitives | Social primitives | Emergent primitives | Methods for controlling primitives |
| Choregraphe | Novice: "It is a way for non-expert developers to avoid the complexity of 'post' subtlety or 'subscribeOnData' functions" (Pot, Monceaux, Gelin, & Maisonnier, 2009, p. 50). | ✓ See Choregraphe's visual blocks: e.g. LED control, sonar sensors, and accelerometer. Also: "Technically Choregraphe is just a graphical representation of NaoQi's functions but practically it is much more" (Pot et al., 2009, p. 50). | ✓ See Choregraphe's visual blocks: e.g. Speech Reco, Face Reco and Sound tracker. | ✓ See Choregraphe's visual blocks e.g. Say, Stand up and Sit Down. | | ✓ Flow-based programming editor (Figure 5) and a timeline editor (Figure 6) (Pot et al., 2009, p. 50). |
| Interaction Blocks | Novice: "designers will need materials and tools that will enable them to explore and prototype a range of interactions that robots will offer in these settings" (Sauppé & Mutlu, 2014, p. 1439). | | | | ✓ See Figure 3: introductory monologue, question-answer, comment exchange, monologue-comment, instruction-action, closing comment, wait (Sauppé & Mutlu, 2014, p. 1443). | ✓ A timeline, see Figure 4 (Sauppé & Mutlu, 2014, p. 1444). |
| Interaction Composer | Novice & professional: "Roughly speaking, we can categorize the main developers of a robot application into 'programmers' | | ✓ Table I: lookForFace, isFaceDetected, isSpeechResult (Glas et al., 2012, p. 6). | ✓ Table I: talk (Glas et al., 2012, p. 6). | ✓ Table I: ask (Glas et al., 2012, p. 6). | ✓ Figure 2, a visual representation of imperative programming (Glas et al., 2012, p. 4). |

| | | Abstraction levels and supporting data | | | | |
|---|---|---|---|---|---|---|
| **Tool** | **Target audience evidence** | **Hardware primitives** | **Algorithm primitives** | **Social primitives** | **Emergent primitives** | **Methods for controlling primitives** |
| | and 'designers'" (Glas, Satake, Kanda, & Hagita, 2012, p. 2). | | | | | |
| TiViPE | Novice & professional: "allows a scenario designer to decide what blocks are needed and in collaboration with a developer to construct a set of useful graphical … robot behaviors" (Lourens & Barakova, 2011, p. 218) | ✓ Figure 2: ledto, ledset, move, movem, stiff, flush (Lourens & Barakova, 2011, p. 215). | ✓ Figure 2: walk, walks, walka, walkto, walkd (Lourens & Barakova, 2011, p. 215). | ✓ Figure 2: say (Lourens & Barakova, 2011, p. 215). | | ✓ For the textual language a \| b and d & e notation as shown in (Lourens & Barakova, 2011, p. 214). Visual interface in Figure 3 (Lourens & Barakova, 2011, p. 217). |
| AIML | Professional | | | ✓ "In its simplest form, the template consists of only plain, unmarked text." (Wallace, 2003, p. 12). But this needs to be hooked up to a text to speech synthesiser, e.g. (Ahmed & Singh, 2015) | | ✓ XML based dialogue management system (Wallace, 2003). |
| BML | Professional: targeted at "ECA researchers" (Kopp et al., 2006, p. 205). | | | ✓ Table 1: head, torso, face, body, legs, lips general actions: gaze, gesture & speech (Kopp et al., 2006, p. 213). | | ✓ Figure 5: XML based event system, e.g. event and wait elements (Kopp et al., 2006, p. 214). |
| BONSAI | Professional: "The focus of this work is to provide a framework for developers of | ✓ Table 1: sensors - laser, camera, odometry, position, map, speed; actuators: camera, screen (Lohse, | ✓ Table 1: actuators: navigation (Lohse et al., 2014, p. 128) | ✓ Table 1: sensors: Person, Object; actuators: Speech, Arm (Lohse et al., 2014, p. 128) | | ✓ Listing 5.6: SCXML based finite state machine markup language (Siepmann, 2013, p. 61) |

| Tool | Target audience evidence | Abstraction levels and supporting data | | | | |
|---|---|---|---|---|---|---|
| | | Hardware primitives | Algorithm primitives | Social primitives | Emergent primitives | Methods for controlling primitives |
| | interactive robot systems that perform in domestic environments" (Siepmann, 2013, p. 4) | Siepmann, & Wachsmuth, 2014, p. 128) | | | | |
| Robot Behaviour Toolkit | Professional: "The Toolkit offers … an open-source Robot Operating System (ROS) [24] module that integrates the behavioral specifications … into an interaction model that supports human activity" (Huang & Mutlu, 2012, p. 26) | | | ✓ Figure 3: participants, objects (Huang & Mutlu, 2012, p. 25). Figure 5: gaze and speech channels (Huang & Mutlu, 2012, p. 28). | | ✓ Figure 5: sequential timeline (Huang & Mutlu, 2012, p. 28). Activity model + cognitive system + behaviour system (Huang & Mutlu, 2012, pp. 27–28). |

# References:

Ahmed, I., & Singh, S. (2015). AIML Based Voice Enabled Artificial Intelligent Chatterbot. *International Journal of u-and e-Service, Science and Technology*, *8*(2), 375–384.

Glas, D., Satake, S., Kanda, T., & Hagita, N. (2012). An interaction design framework for social robots. *Robotics: Science and Systems* (Vol. 7, p. 89).

Huang, C.-M., & Mutlu, B. (2012). Robot behavior toolkit: generating effective social behaviors for robots. *Proceedings of the seventh annual ACM/IEEE international conference on Human-Robot Interaction* (pp. 25–32). ACM.

Kopp, S., Krenn, B., Marsella, S., Marshall, A. N., Pelachaud, C., Pirker, H., Thórisson, K. R., et al. (2006). Towards a Common Framework for Multimodal Generation: The Behavior Markup Language. *Intelligent Virtual Agents*, Lecture Notes in Computer Science (pp. 205–217). Springer. Retrieved from http://link.springer.com.ezproxy.auckland.ac.nz/chapter/10.1007/11821830_17

Lohse, M., Siepmann, F., & Wachsmuth, S. (2014). A modeling framework for user-driven iterative design of autonomous systems. *International journal of social robotics*, *6*(1), 121–139.

Lourens, T., & Barakova, E. (2011). User-friendly robot environment for creation of social scenarios. *Foundations on Natural and Artificial Computation* (pp. 212–221). Springer.

Pot, E., Monceaux, J., Gelin, R., & Maisonnier, B. (2009). Choregraphe: a graphical tool for humanoid robot programming. *Robot and Human Interactive Communication, 2009. RO-MAN 2009. The 18th IEEE International Symposium on* (pp. 46–51). IEEE.

Sauppé, A., & Mutlu, B. (2014). Design patterns for exploring and prototyping human-robot interactions. *Proceedings of the 32nd annual ACM conference on Human factors in computing systems* (pp. 1439–1448). ACM.

Siepmann, F. (2013). *Behavior coordination for reusable system design in interactive robotics*. Universitätsbibliothek Bielefeld.

Wallace, R. (2003). The elements of AIML style. *Alice AI Foundation*.