

On-line appendix 2: GIS in DBCIs

This appendix provides a brief overview of key geographic concepts and GIS functionalities, acknowledging the complexity and interdisciplinary challenges of integrating spatial context into DBCI and LLM technologies.

Central to this integration are frameworks from Time Geography and Health Geography [A1], which offer theoretical grounding for understanding individuals' spatial routines and environmental constraints.

From an operational perspective, integration is enabled through data collection via Location-Aware Technologies (LAT), such as GNSS (Global Navigation Satellite System) modules, embedded in smartphones or wearables [A2]. Combined with GIS, these technologies support the application of methods like Geographic Momentary Assessment (GMA) and Geographically Explicit Ecological Momentary Assessment (GEMA) [A3], which support real-time, spatially specific monitoring and can be integrated into systems that deliver context-aware feedback.

Simultaneously, LBS personalizes content delivery based on the user's current location, drawing on geographic databases such as OpenStreetMap to provide contextual data (e.g., nearby amenities), which enhances personalization and relevance within DBCIs [A4].

Table A1 outlines the key GIS-based concepts and functionalities applied in the DigiWELL LLM-driven DBCI pilot to support context-aware behavior change.

Table A1 *Overview of the key GIS-based concepts and functionalities*

Geographic Feature in DBCI	Description (in overall DBCI context)	Description (in DigiWELL LLM-driven DBCI)	Example of context-aware message
Geo-fencing and Location-based triggering	Geofencing and location-based triggering use user location to activate context-aware functions in DBCIs. [A5, A6]	Used to deliver context-aware DBCI elements when participants enter, leave, or remain in defined locations for a certain duration.	Still at your workplace? A quick stretch could boost your energy and concentration.
Geographic Context / Environment	Incorporates static geographic features (e.g., parks, school zones) and dynamic environmental conditions (e.g., weather, air quality) to tailor timing and	LLM-generated suggestions are tailored to the location type and current environmental conditions (e.g., promoting indoor activities during poor	Rain is expected in your area today. An indoor activity might be the best way to stay on track.

	content of DBCI messages. [A7]	weather or low air quality)	
Point of Interest (POI)	Integrates known landmarks or venues into DBCIs to tailor suggestions based on local opportunities, such as parks, fitness centers, or culturally significant sites. [A4]	LLM-generated messages recommend nearby POIs to promote behavior change, such as walking to a park or visiting a calming spot.	There's a remarkable heritage tree 300 meters from your current location. It could be a peaceful destination for a short walk today.
Semantic Location Mapping / Semantic Enrichment	Transforms raw location measurements data into natural language (e.g., 'home', 'gym', 'store'), enabling more relevant and interpretable DBCI logic. [A8, A9]	Provides LLMs with semantically enriched location labels, allowing the model to understand where the participant is and generate context-appropriate messages.	Looks like you spent most of yesterday at home. Today could be a good opportunity to get some fresh air around Brno.
Spatiotemporal Clustering	Identifies patterns by grouping locations and times that share similar behavioral characteristics, such as recurring physical activity in specific areas during certain times of day. [A10]	Supports time-and-location-based suggestions by allowing the LLM to reference habitual patterns in the participant's behavior.	Since you regularly ride public transport, getting off at Antonínská instead of Pionýrská could be an easy and effective way to add a few more active minutes to your day.

Appendix References

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