

Meta-Modelling Methodology for Craniofacial Growth: Toward a Digital Twin for Paediatrics Surgery

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BACKGROUND & MOTIVATION

The Challenge: Congenital craniofacial malformations are highly complex, requiring a deep understanding of craniofacial growth to treat them.

The Current State: Models are fragmented, ignoring anatomical interdependency.

The Need: A unified framework to reconcile these theories into a single, predictive tool.

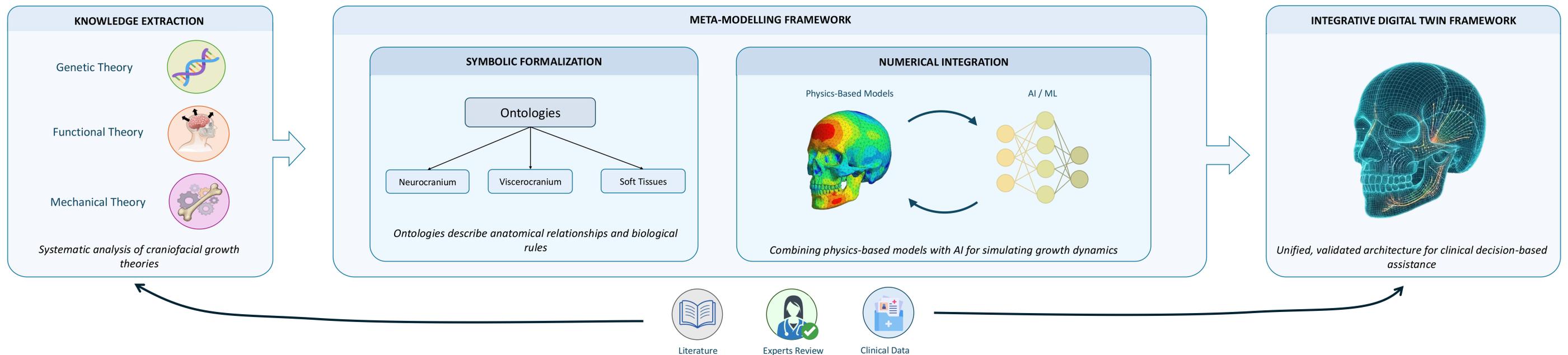
RESEARCH OBJECTIVES

- To introduce a meta-modelling methodology to unify this fragmented knowledge.
- Create the theoretical and technical roadmap required to build a multimodal Digital Twin.
- Provide clinicians with a predictive tool to personalize paediatric surgical decision-making and optimize long-term outcomes.

EXPECTED OUTCOMES & IMPACT

- **Unified Meta-Modelling Framework:** A validated methodology reconciling genetic, mechanical, and functional theories via symbolic (ontologies) and numerical (AI, physics) formalisms.
- **Digital Twin Foundations:** The technical architecture and roadmap premise for a future multimodal digital twin.
- **Improved Growth Prediction:** Improved accuracy in forecasting complex craniofacial evolution.
- **Personalized Surgical Support:** A clear roadmap toward patient-specific surgery planning tools for congenital deformities.
- **Optimized Paediatric Care:** Provide decision support for paediatric surgeons.

PROPOSED METHODOLOGY



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