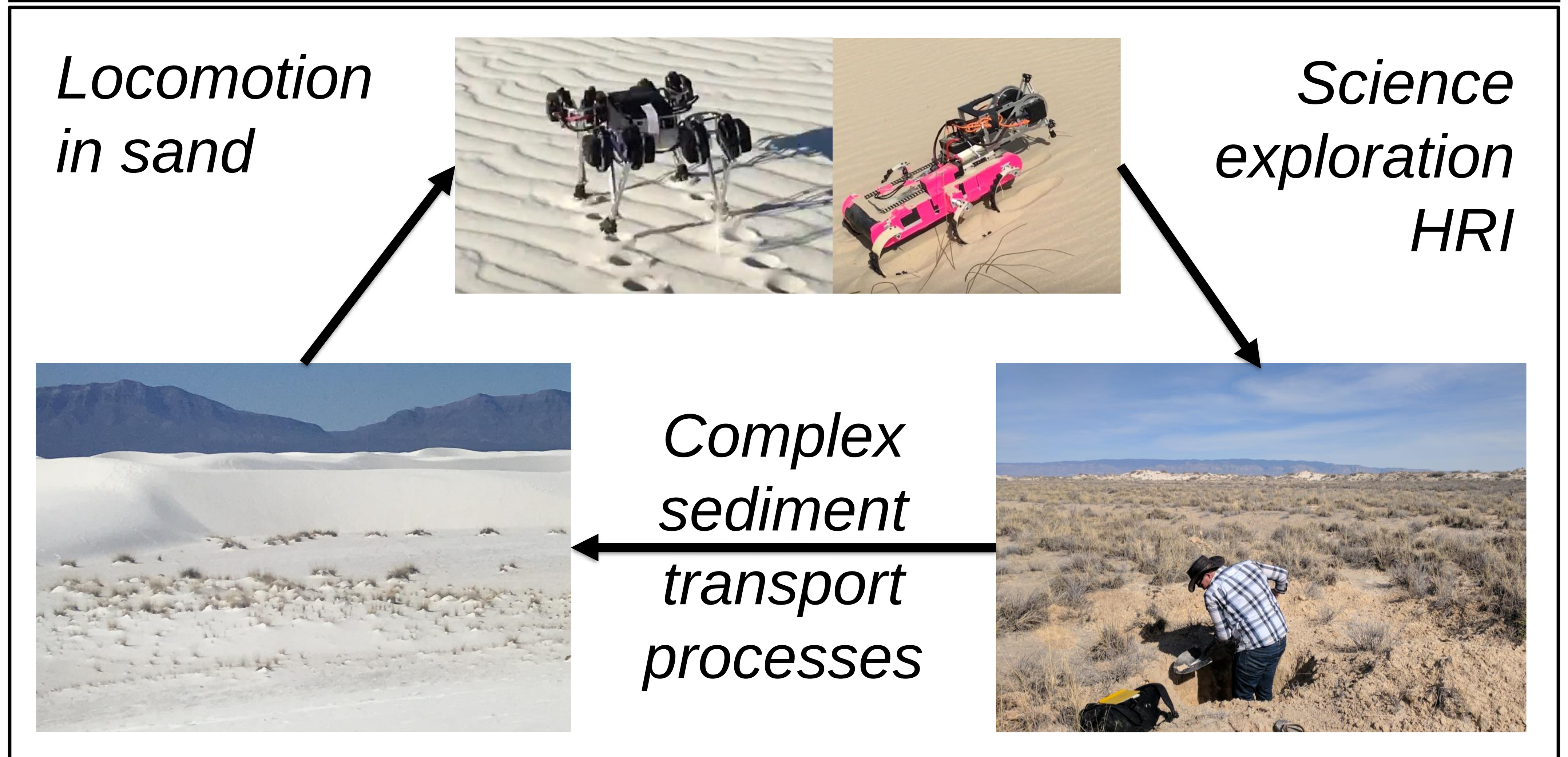
NRI: INT: COLLAB: Co-Robotic Systems for GeoSciences Field Research

Cristina Wilson[1], Thomas Shipley[2], Daniel Koditschek[1], Douglas Jerolmack[3]

[1]University of Pennsylvania, General Robotics, Automation, Sensing and Perception; [2]Temple University, Department of Psychology; [3]University of Pennsylvania, Earth and Environmental Science

This work anticipates a near future where humans and robots operate in coordination to explore, collect data, and test hypotheses on Earth, and other planets.

THE CHALLENGE



SCIENTIFIC & BROADER IMPACTS

- Direct-drive robotic leg to allow precise measure of soil strength and environment-aided locomotion
- Multi robot team to help human scientists isolate and model dependence of soil strength on different environment controls
- Simulated field scenario to explore data collection behavior and objectives amongst disciplinary experts
- Computational models translating abstract human objectives into quantitative actions, rendered as scripts executed by mobile robot field assistants to aid in real-time data collection

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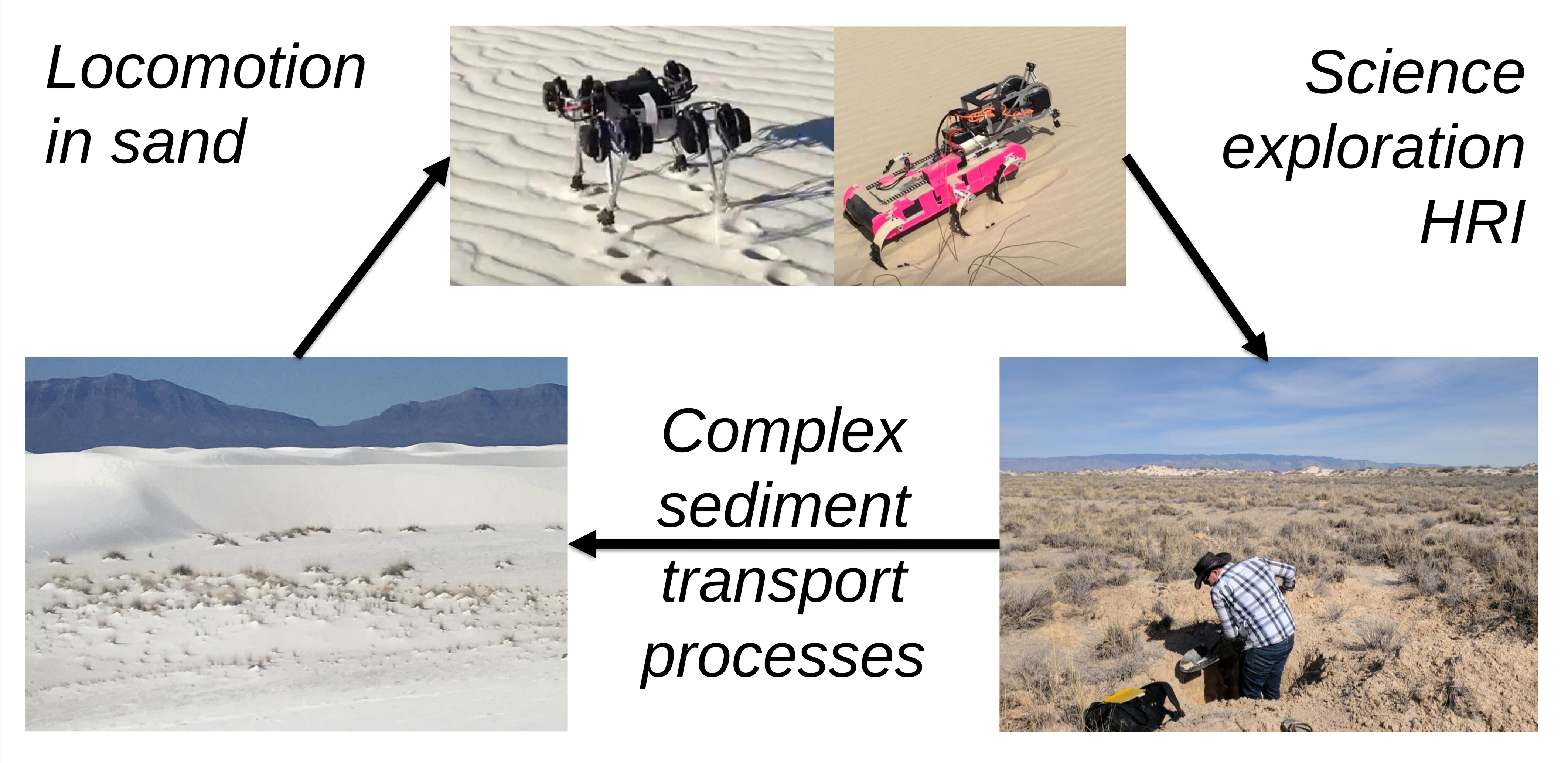

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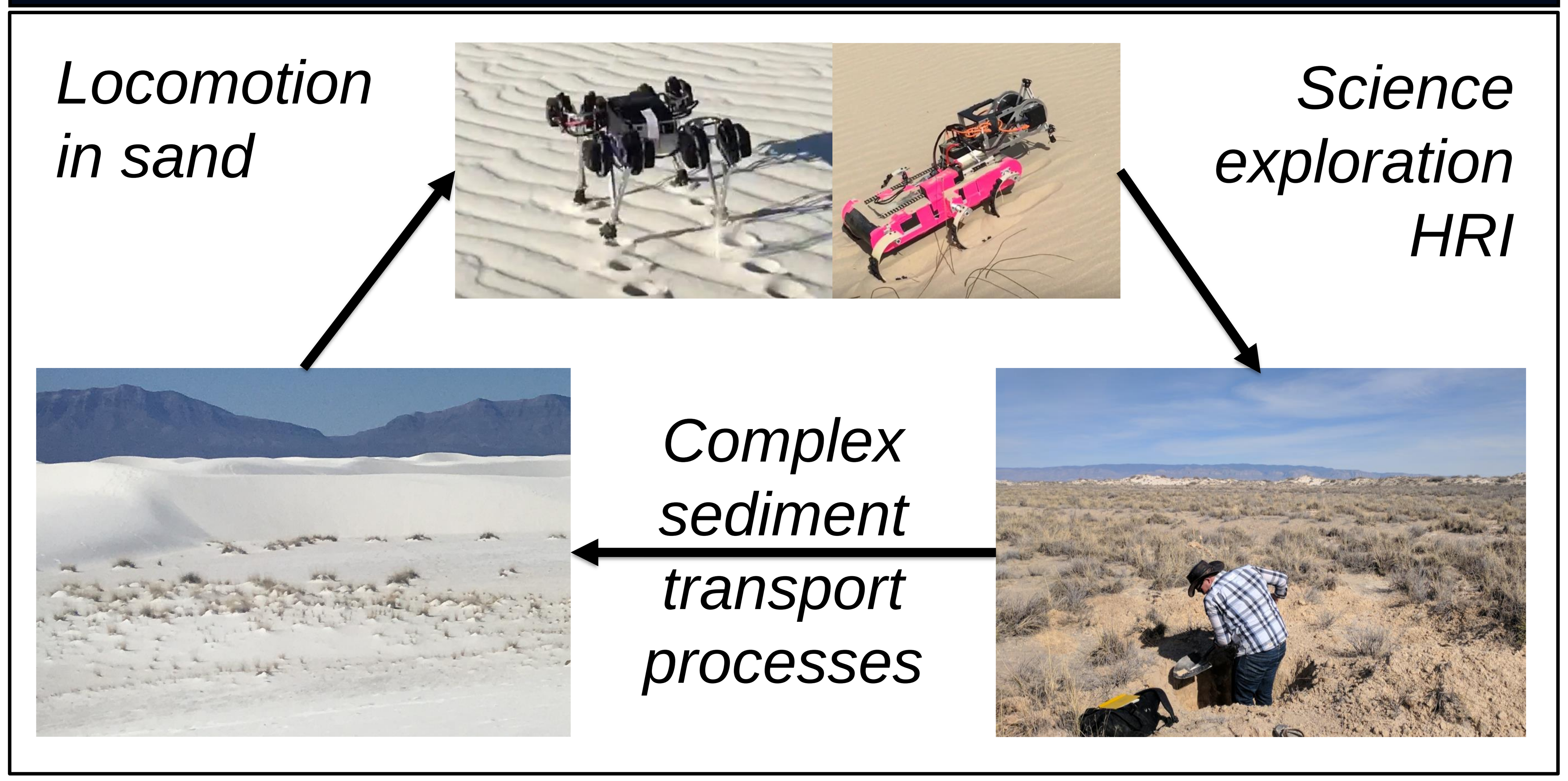

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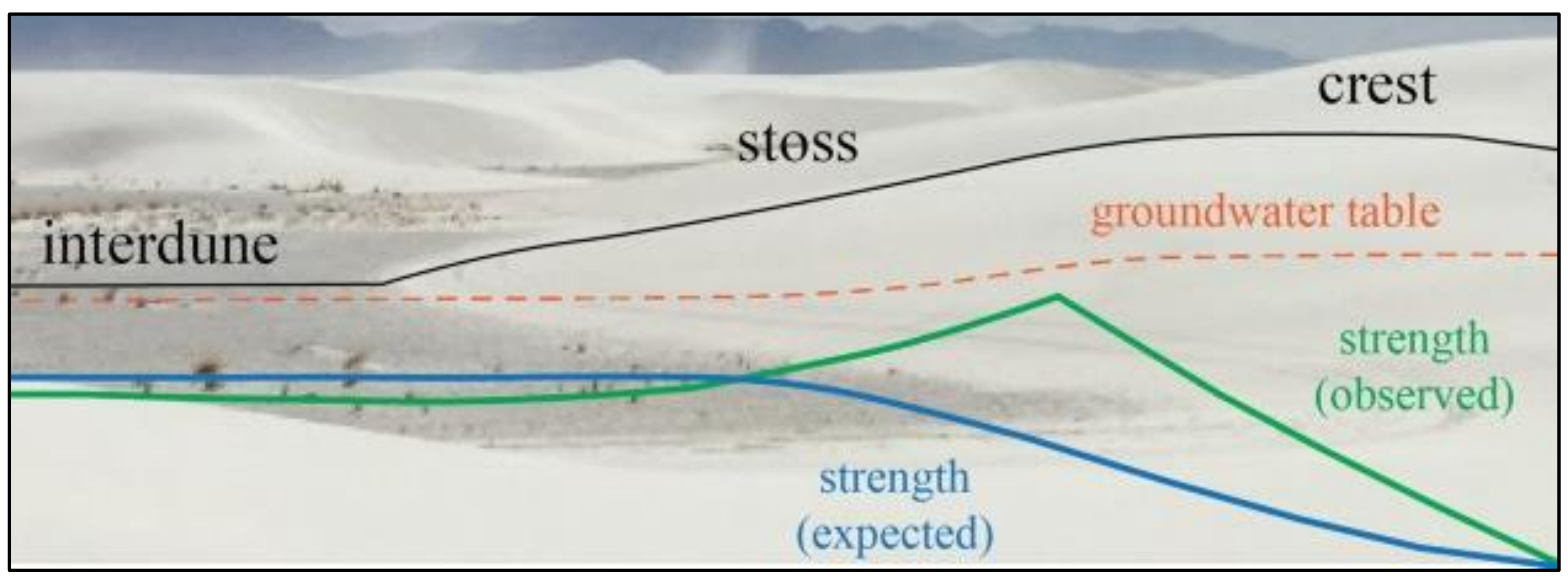

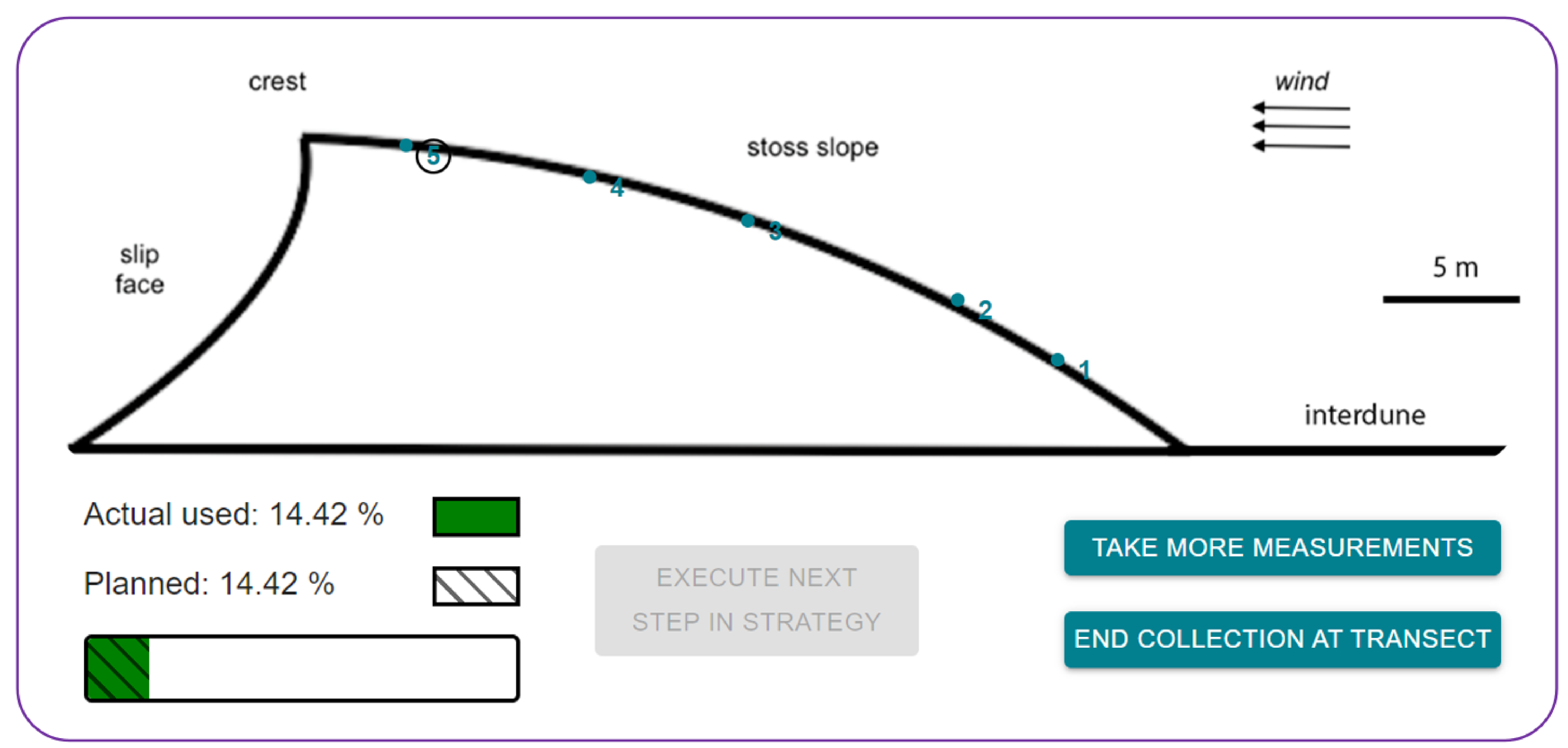

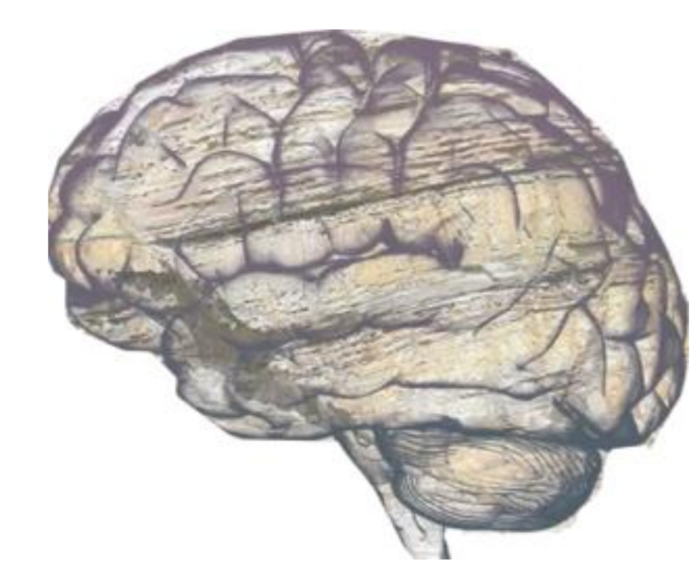

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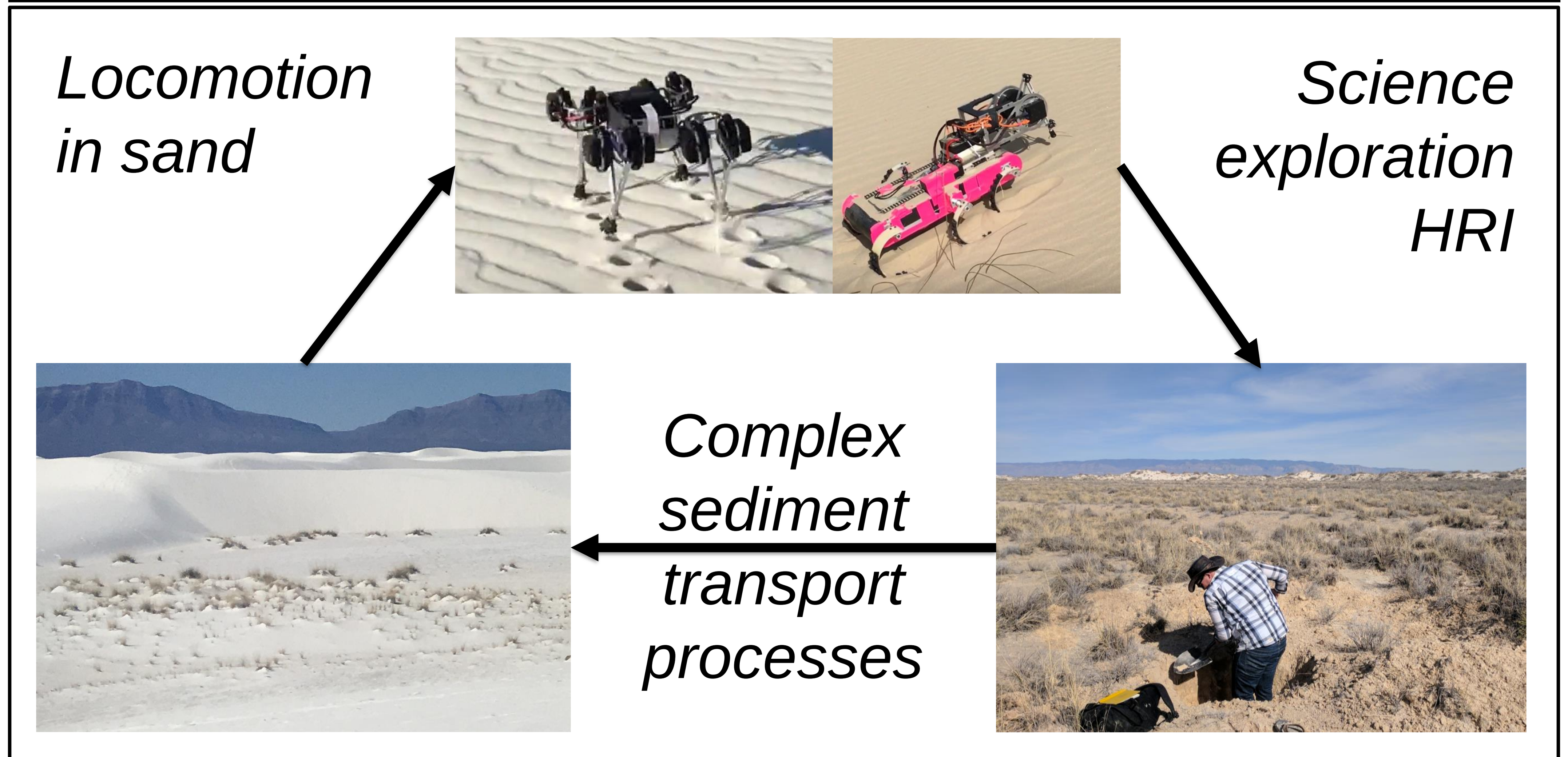

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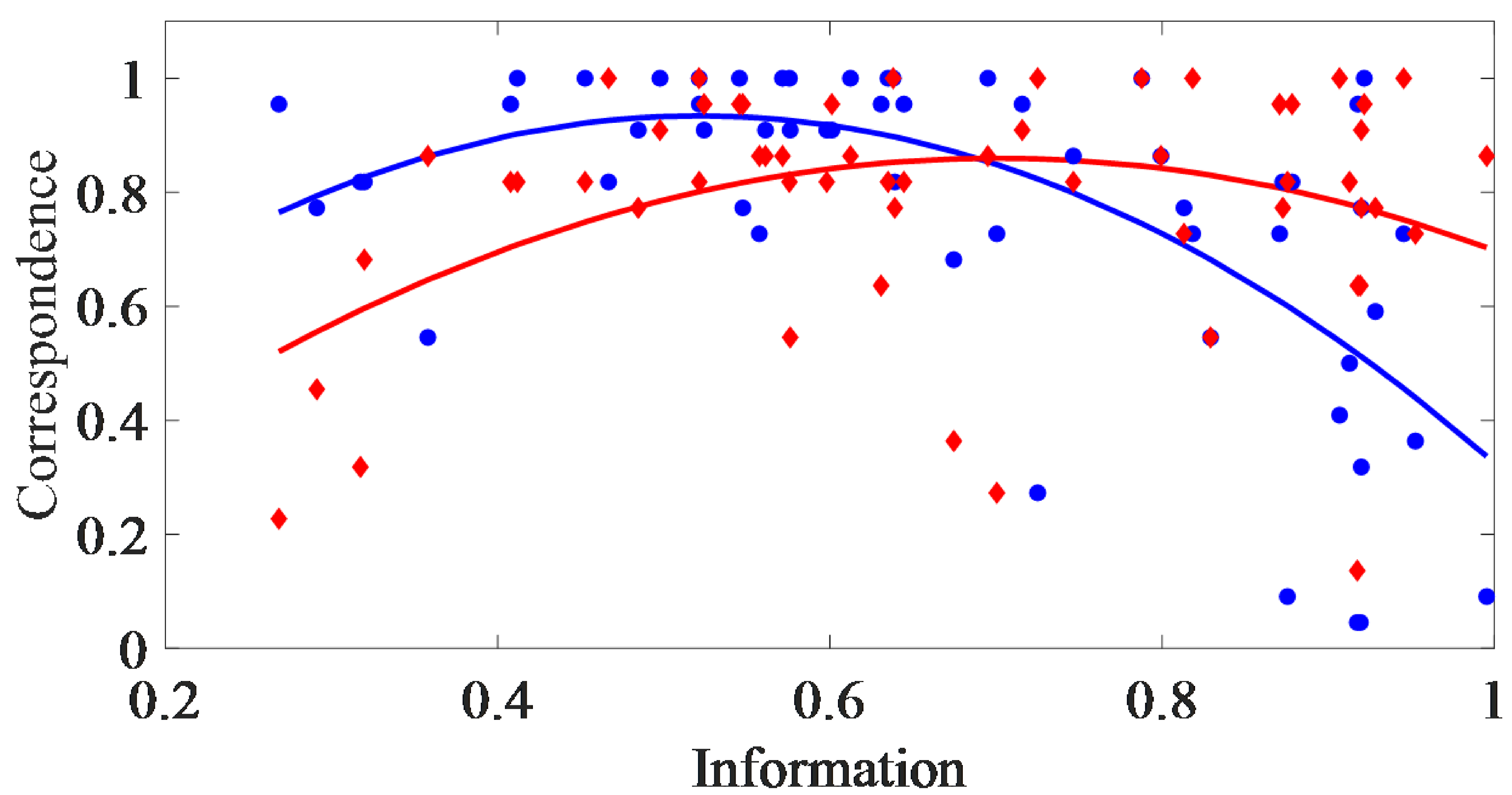
Correspondence of computational models at predicting expert data collection decisions in simulated field scenario



Maximize Spatial Information Reward

$$I_s(l_t) = \sum_{l \in l_s} e^{\frac{-(l-l_t)^2}{2\beta_1^2}} \times e^{\frac{-1}{2\sqrt{n}}}$$

Targeted Location (l_t); All Sampled Location (l_s); Indirect Information Inference; Diminished Information Gain

Maximize Discrepancy to Invalidate

$$R_d(l) = \int_{m=m_{min}}^{m_{max}} P_m(l) \int_{s=s_{min}}^{s_{max}} P_s(m) * D(m_c)$$

Targeted Location (l); Moisture Distribution Given Location ($P_m(l)$); Shear Strength Distribution Given Moisture ($P_s(m)$); Measured Discrepancy ($D(m_c)$)