Humans in the Closed-Loop

- Closed-loop systems
  - Monitor – assess – decide – actuate – repeat
  - Goal: semi-autonomous control
  - Effective, stable, safe closed-loop control depends on high-fidelity system models
    - What is the state of the system?
    - What effect to we expect the actuation to have?
- In smart health systems, humans are typically somewhere in the loop
  - **Plant – i.e., that which we want to "control"**
  - Monitor: providing input (e.g., EMAs, surveys, etc.)
  - Actuate: perform decided action (e.g., take/dispense medication, alter environment, change/perform behavior, etc.)
- Humans and human dynamics pose significant modeling challenges
  - Physiology – getting better at this, but much work is needed for personalization and full-system
  - Psychology, behavior, interpersonal dynamics – critical work needed
  - Highly stochastic, dynamic, individualistic, …
- Humans in the closed-loop challenges:
  - Inputs and actions and be unreliable/unpredictable (monitor, actuate)
  - Actuation may not have desired impact (plant)

Safety Assurance

- Closed-loop control has heightened safety risks and requires strong safety assurances
- System safety assurance challenges (all interrelated)
  - Humans in the closed-loop
    - What assumptions must be made about human plants, monitors, actuators?
  - Use “in the wild”
    - What assumptions must be made about environment, context?
  - System-of-systems
    - What must be known about components?
    - What must component manufacturers know about system requirements?
  - Modeling
    - What models can be developed to strengthen safety assurance?
  - Experimentation
    - What experimentation is necessary/sufficient for safety assurance?