Specifying Drone Teleoperation Skill for Adaptive Curriculum Generation

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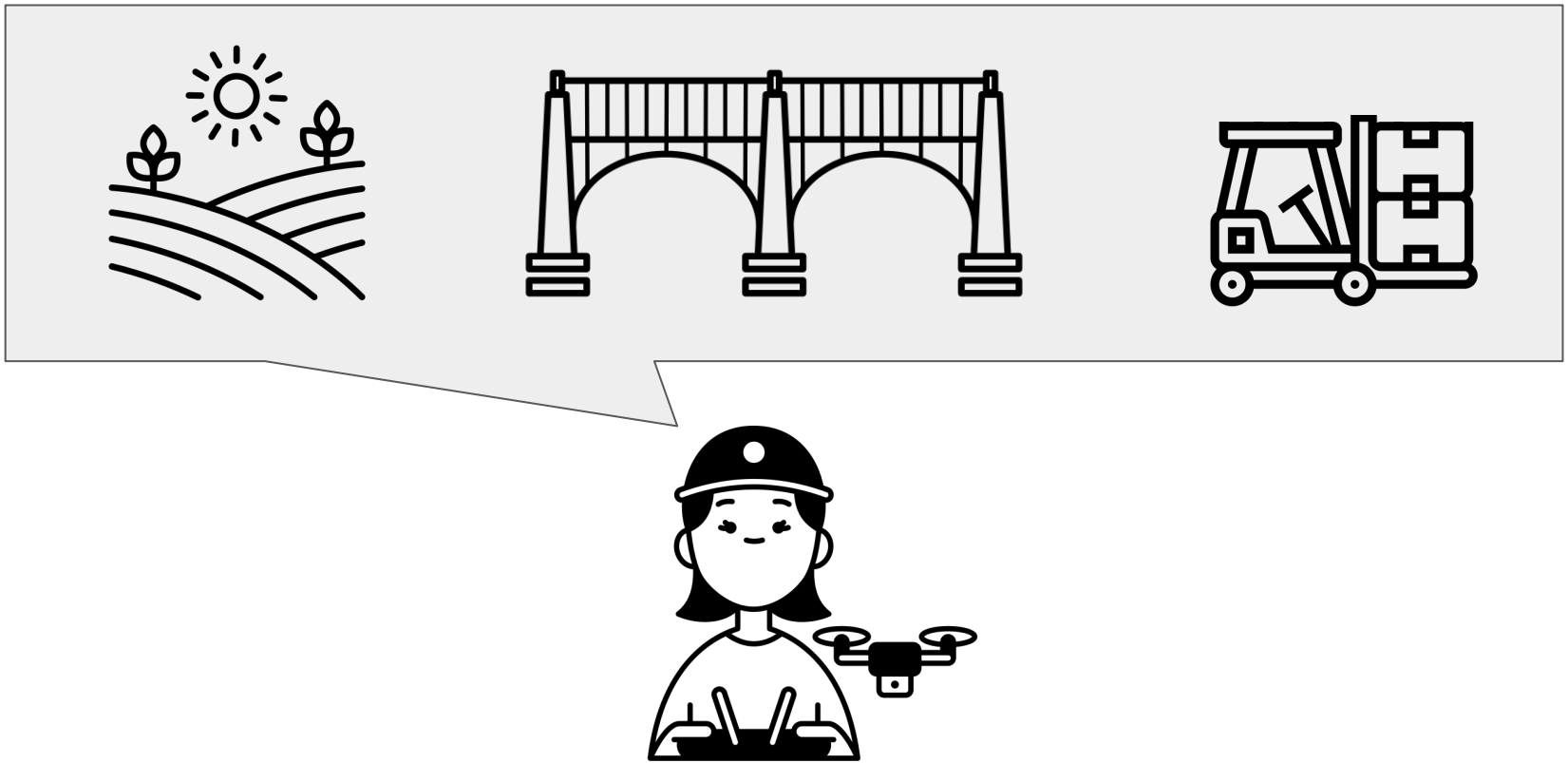
Motivation: rapid retooling



How do you teach yourself?

What You Will Learn In This Guide

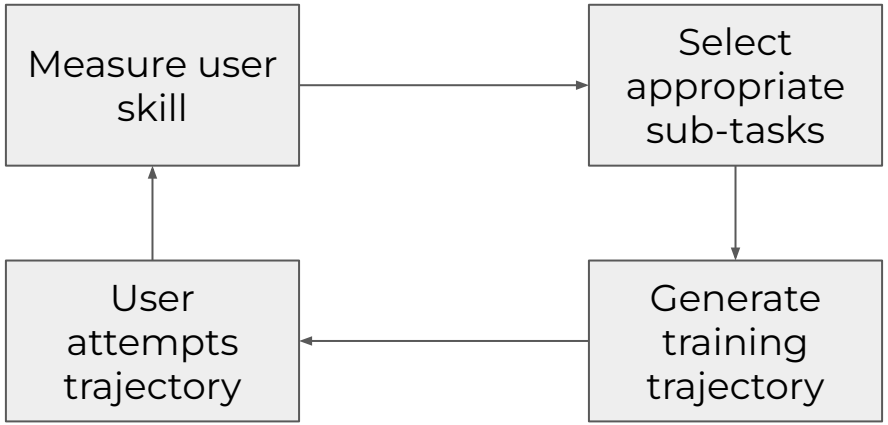
We know that not all aspiring commercial pilots or hobbyists are on the same level.

To help you work on specific skills, we've put together an interactive table of contents. Click each link to be transported to different sections.

(Or, you can scroll down and start from the beginning.)

Automated methods for personalized education

Task Specifications + Learning Analytics = Intelligent Tutoring System



Automated methods for personalized education

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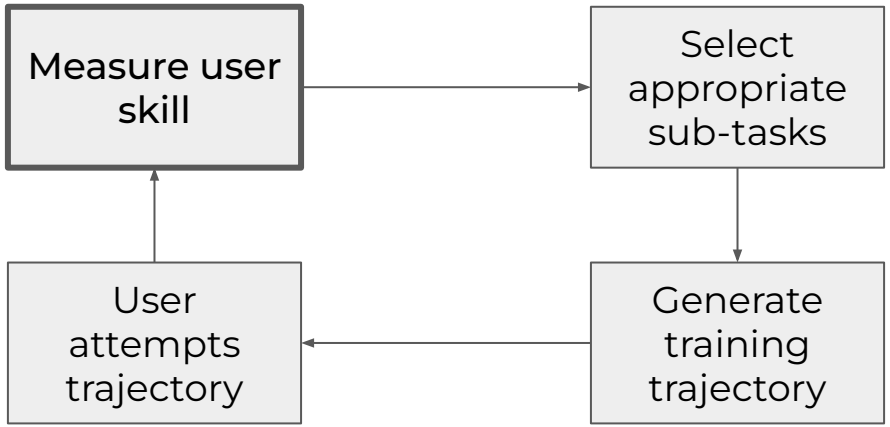


Skill framework

Complex Task

Inspect the garden.
Take pictures and mark
the locations of any plants
that look unhealthy.

Skill framework

Complex Task	Primitive Sub-tasks
Inspect the garden. Take pictures and mark the locations of any plants that look unhealthy.	Take off to a height of 2 m. Move forward to the end of the path. Turn right. Hover in front of the unhealthy plant for 5 s.

Skill framework

Complex Task	Primitive Sub-tasks	Formal Specifications
Inspect the garden. Take pictures and mark the locations of any plants that look unhealthy.	Take off to a height of 2 m.	$(v_y \geq 0)\ \text{UNTIL}_{[0,T]}\ (\lvert y-H \rvert \leq \epsilon \wedge \lvert v_y \rvert \leq \delta)$
	Move forward to the end of the path.	
	Turn right.	
	Hover in front of the unhealthy plant for 5 s.	$\text{EVENTUALLY}\Big(\text{Always}_{[0,T]}\big(y \in [y_{\min}, y_{\max}] \wedge \lvert v_y \rvert \leq \epsilon\big)\Big)$

Assessing skill

Formal Specifications

Take-off

$$(v_y \geq 0)\ \text{UNTIL}_{[0,T]}\ \left(|y - H| \leq \epsilon \wedge |v_y| \leq \delta\right)$$

Hover

$$\text{EVENTUALLY}\left(\text{Always}_{[0,T]}\left(y \in [y_{\min}, y_{\max}] \wedge |v_y| \leq \epsilon\right)\right)$$

Robustness Metric

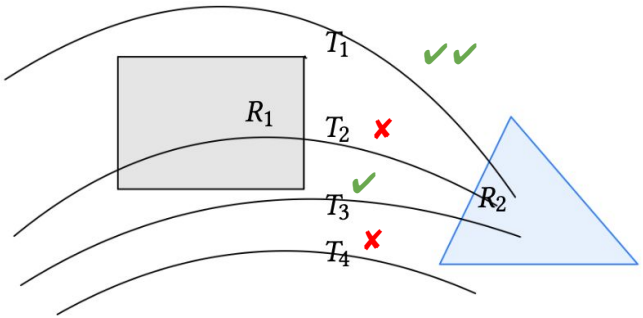


Figure 1: Illustration of robustness for various trajectories $T_1 - T_4$ for a drone. The desired task specification is to avoid the shaded region R_1 and reach region R_2.

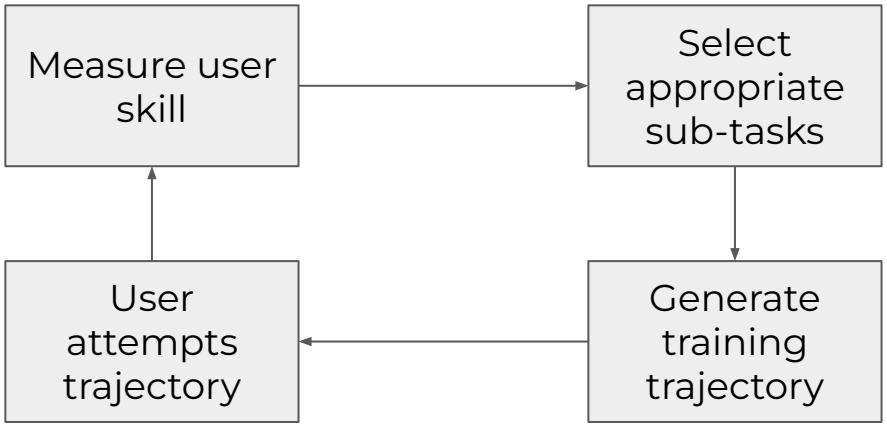
Adaptive curriculum generation

Create training tasks according to user's current skill level

- Need an ordering in which tasks need to be mastered
- Generate trajectories for users to follow based on selected subtasks

Room to experiment with different pedagogical strategies

- Format and timing of feedback
- Scheduling review of mastered tasks



Future questions

What is the role of the expert in specifying skills?

- Latent skill discovery
- Translating from natural language descriptions to formal specifications

What is the user perspective of using the system?

- Trade-offs between efficiency and self confidence
- Desire to have control over the learning process

Thank you!

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