Automated Scenario Generation
Toward Tailored and Optimized Military Training in Virtual Environments

Alex Zook

Stephen Lee-Urban, Mark Riedl,
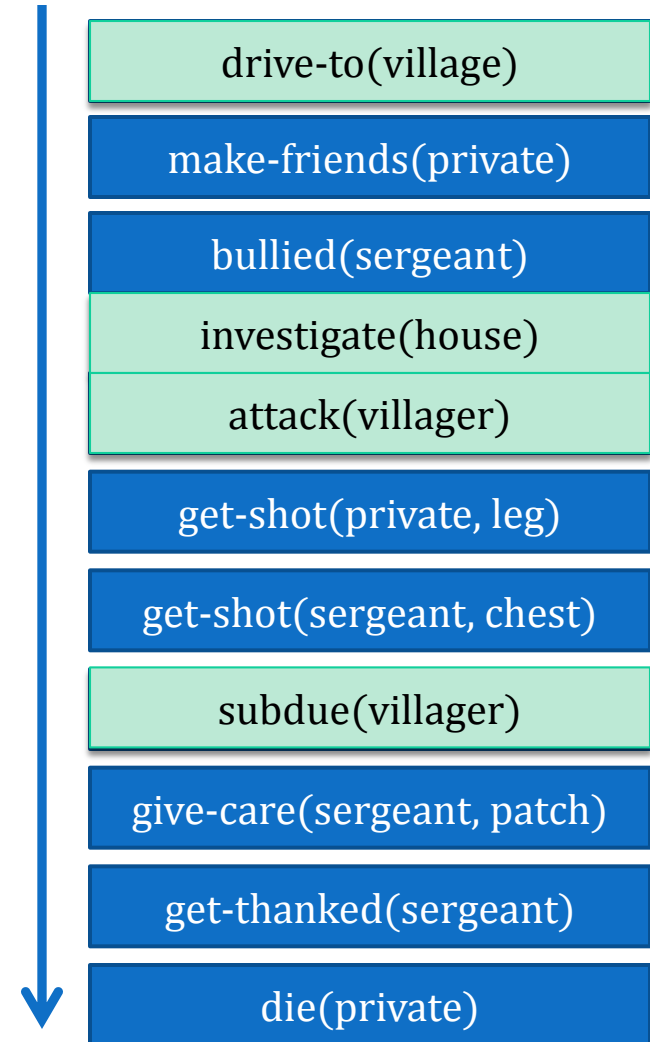Heather Holden, Robert Sottilare,
Keith Brawner

Scenario-based Training

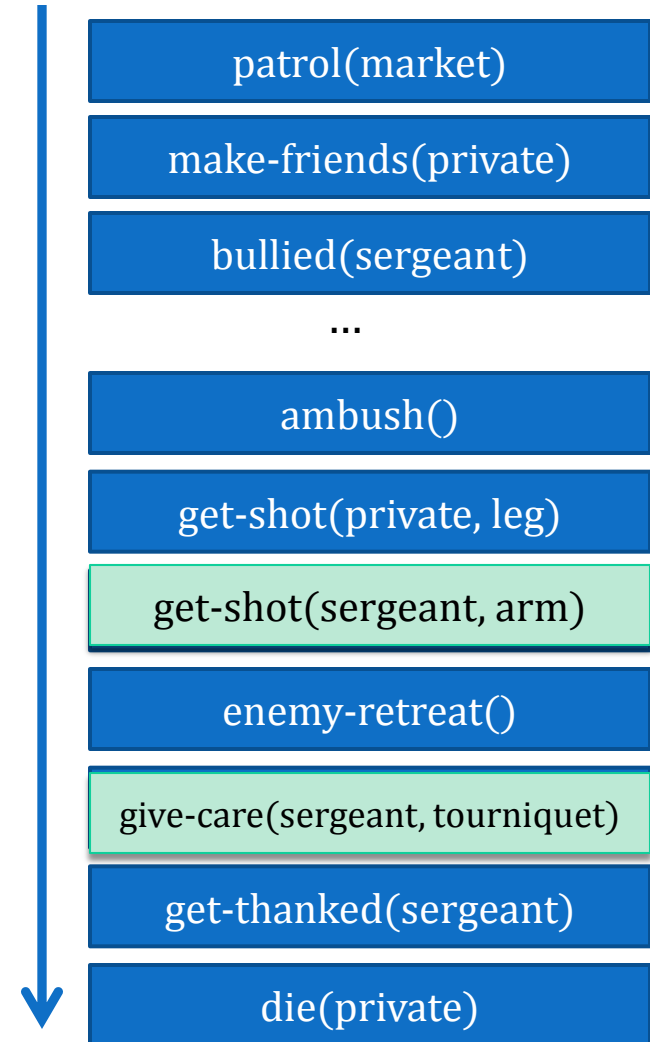- Scenario – script of events for training purposes

patrol(market)
make-friends(private)
bullied(sergeant)
…
ambush()
get-shot(private, leg)
get-shot(sergeant, chest)
enemy-retreat()
give-care(sergeant, patch)
get-thanked(sergeant)
die(private)

Scenario-based Training Challenges

- Repeat to learn
  - Many contexts for same skill

| drive-to(village) |
| make-friends(private) |
| bullied(sergeant) |
| investigate(house) |
| attack(villager) |
| get-shot(private, leg) |
| get-shot(sergeant, chest) |
| subdue(villager) |
| give-care(sergeant, patch) |
| get-thanked(sergeant) |
| die(private) |

Scenario-based Training

- Repeat to learn
  - Many contexts for same skill

- Varying learner needs
  - Tailoring to user abilities

patrol(market)
make-friends(private)
bullied(sergeant)
...
ambush()
get-shot(private, leg)
get-shot(sergeant, arm)
enemy-retreat()
give-care(sergeant, tourniquet)
get-thanked(sergeant)
die(private)

Scenario-based Training

- Repeat to learn
  - Many contexts for same skill

- Varying learner needs
  - Tailoring to user abilities

- Changing deployment contexts
  - Reauthoring content

| patrol(jungle) |
| make-friends(private) |
| bullied(sergeant) |
| ... |
| ambush() |
| get-shot(private, leg) |
| get-shot(sergeant, chest) |
| enemy-retreat() |
| give-care(sergeant, patch) |
| get-thanked(sergeant) |
| die(private) |

Scenario Generation Goals

1. **Augment** authoring volume with automated generation

2. **Tailor** scenarios to individual differences

3. Generate content **on-demand**

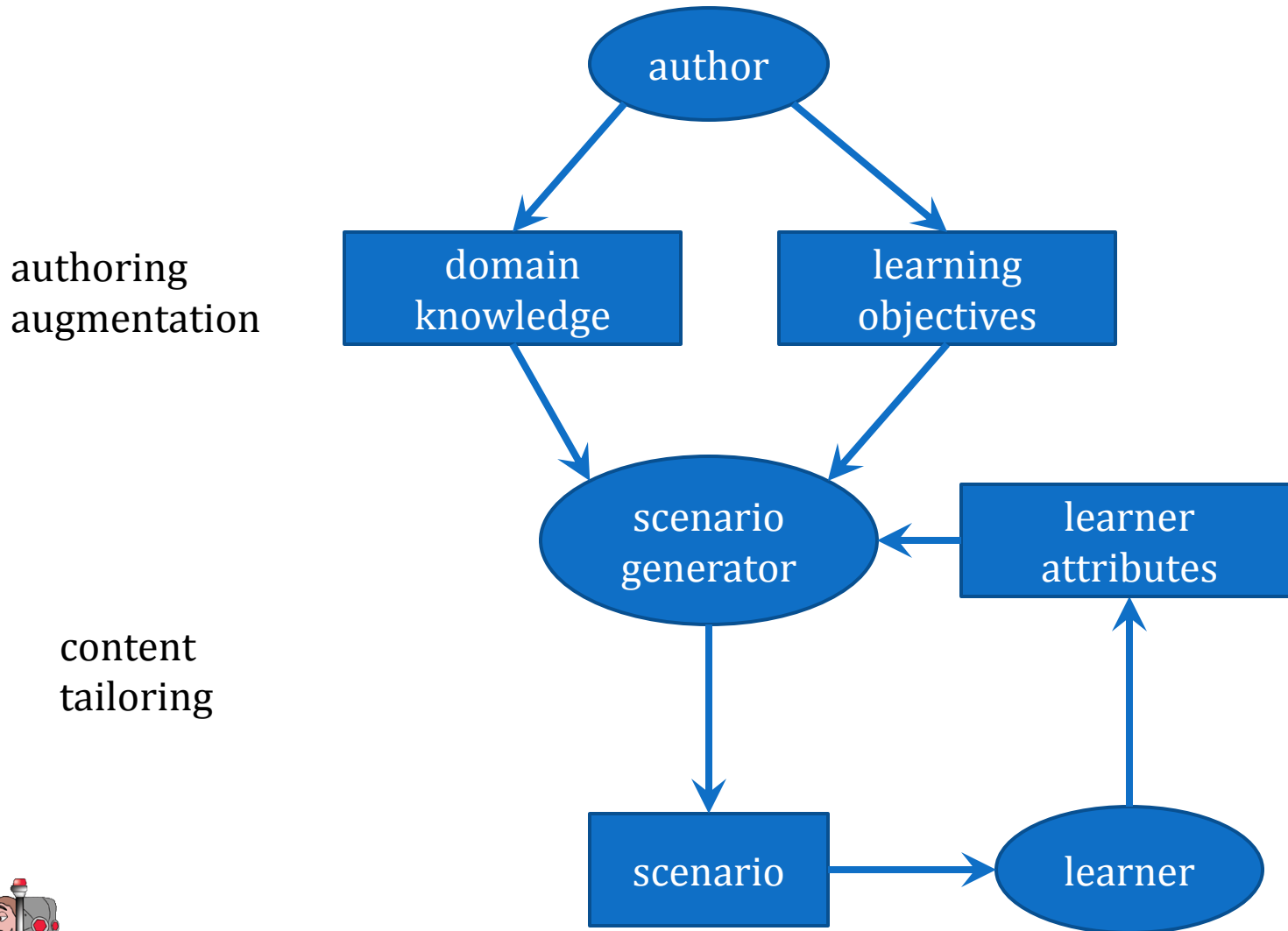# Automated Scenario Generation

- Automated generation of training scenarios given knowledge of:
  - learning objectives
  - learner attributes
  - domain knowledge
    - domain content
    - scenario quality evaluation

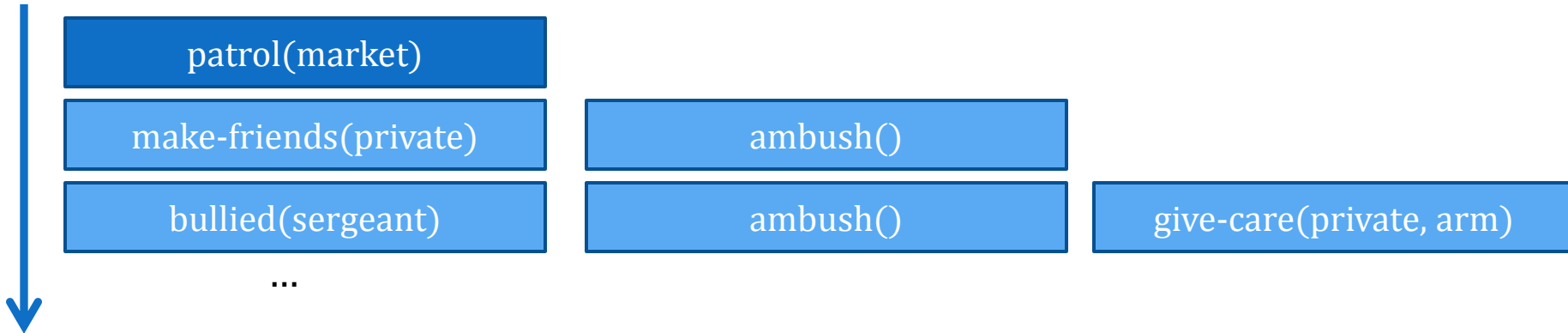# Automated Scenario Generation
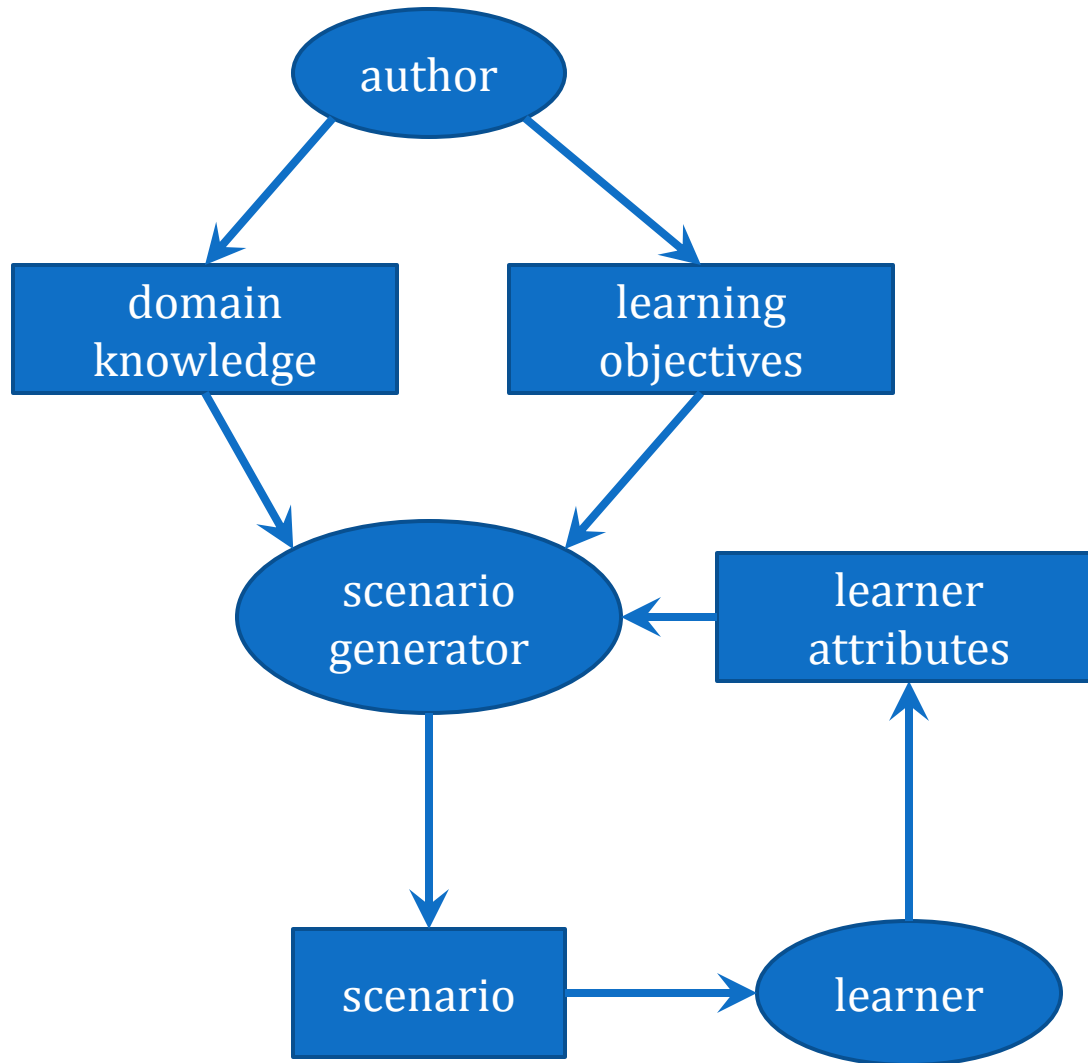
Automated Scenario Generation

Generation Methods

- planning vs genetic algorithms
  - causal coherence vs evaluation optimality
  - result construction vs iterative modification
  - construction knowledge vs result evaluation knowledge
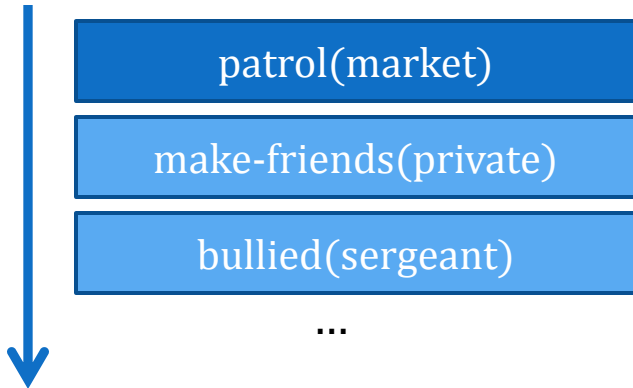   - incremental vs final result criteria
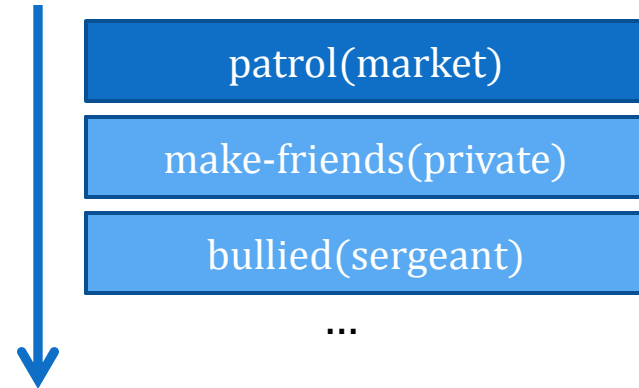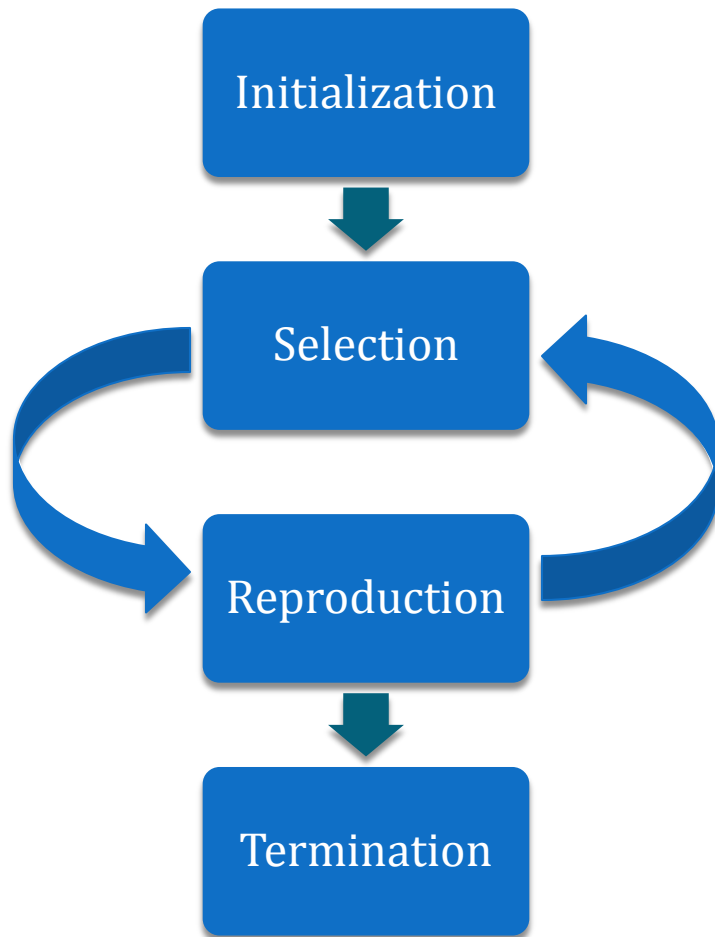
Generation Methods

PLANNING

patrol(market)

make-friends(private)   ambush()

bullied(sergeant)   ambush()   give-care(private, arm)

...

Generation Methods

PLANNING

patrol(market)

make-friends(private)

bullied(sergeant)

...

GENETIC ALGORITHM

patrol(market)

make-friends(private)

bullied(sergeant)

...

Genetic Algorithms

- Inputs:
  - Event templates
  - Event ordering constraints
  - Evaluation grammar
- Output:
  - Scenarios with fitness values

Generation

- Event templates

make-friends(?character)

get-shot(?character, ?injury type)

give-care(?character, ?care-type)

Evaluation

- Evaluation
  - evaluation functions
    - character use
    - event use
    - scenario length
    - ...
  - evaluation grammar
  - learner model

Evaluation Functions

- example: character use

   + few characters

   + character reuse across events

Evaluation Grammar

hurt-friend
- make-friends(?character)
- get-shot(?character, ?injury type)

injury-care
- get-shot(?character, ?injury type)
- give-care(?character, ?care-type)
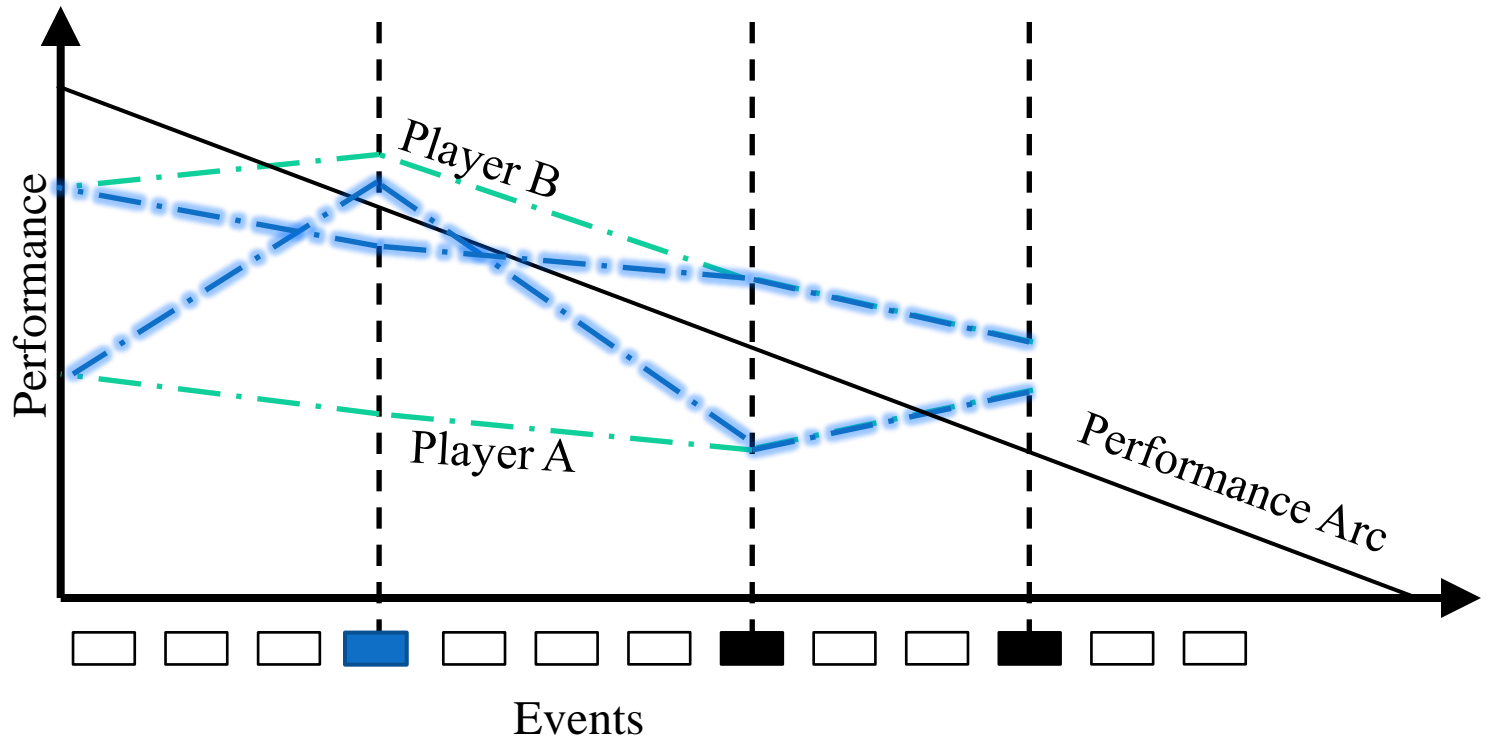
care-friend
- hurt-friend
- injury-care

Learner Model

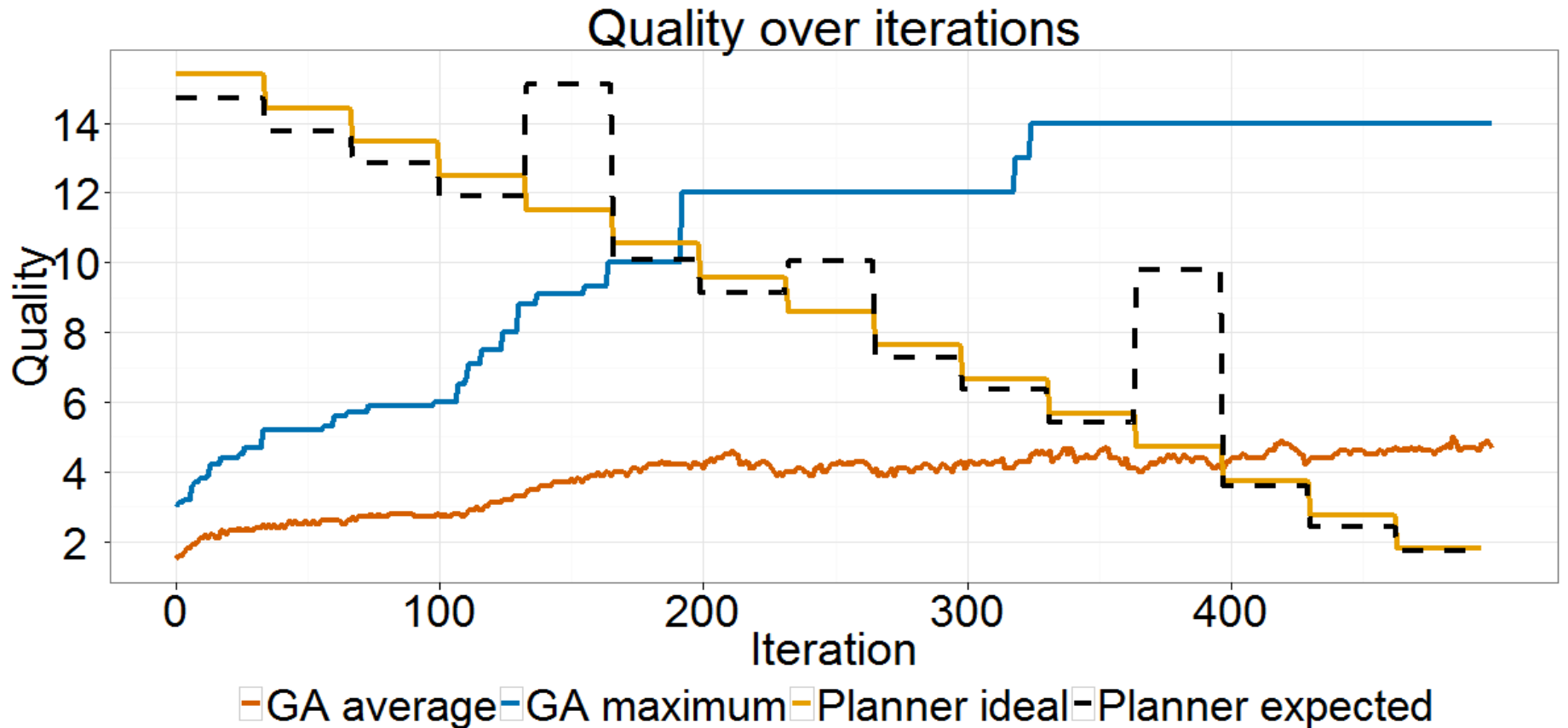- Match predicted to desired performance

Scenario Generator Evaluation

- How do you compare generation systems?
- System dynamics
  - Quality over time
  - Diversity over time
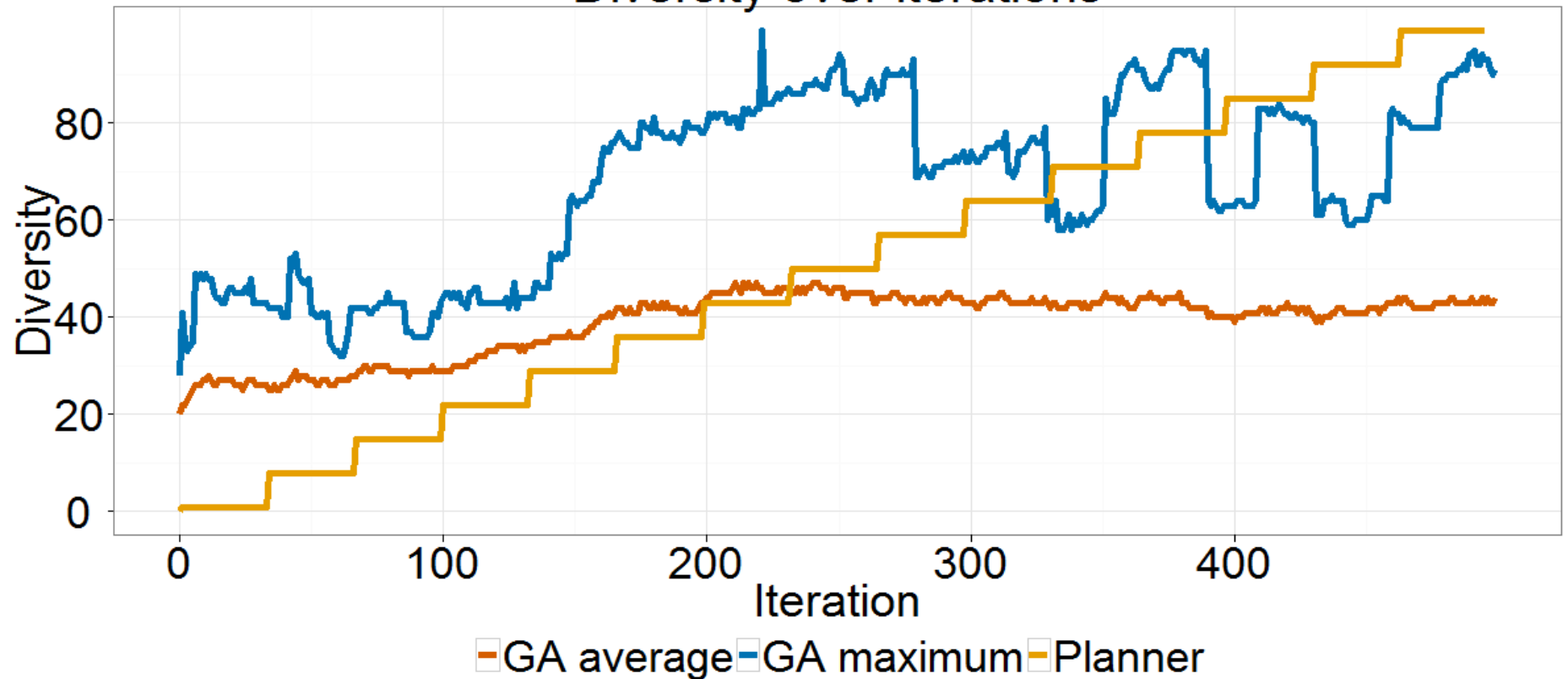- Human evaluation

System Dynamics

- ## Scenario Quality
  - evaluation functions + evaluation grammar

Quality over iterations

System Dynamics

- ## Scenario Diversity
  - – scenario population edit distance

Diversity over iterations

Legend: GA average, GA maximum, Planner

Human Evaluation

- Generator measures
  - actual vs predicted performance
- Subjective measures
  - difficulty
  - enjoyment
- Outside validation
  - paper test of learning
  - on-field performance

Thanks!

Questions?