

MECH 6326 - Optimal Control and Dynamic Programming
Final Project Working Doc

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Chapter 1

Simple System Model

1.1 System Definition

1.1.1 Assumptions:

- Movement: Single movement per turn
 - Deterministic
 - 1 square movement
 - move then action
- Actions: Single action per time step
 - Melee (hit check)(d6) - Short range
 - Ranged (hit check)(d8) - Longer range
 - Health Potion (d4 + 1)
 - Nothing
- Characters
 - 1 PC and 1 Monster
 - Identical Specs/modifiers
 - Same weapon (+2) (different between melee and ranged?)
- Monster
 - Monster move in standard pattern
 - Monster cannot heal
- Infinite Time Horizon
- Infinite Battlefield and no Obstacles

1.1.2 Environment Definition

States

Let each character be associated with position and HP states. For position, let

$$x_{pc,p}, x_{mn,p} \in \mathcal{X}_p \subseteq \mathbb{Z}^2$$

describe the position on an infinite 2-d grid. For HP, let

$$x_{pc,hp}, x_{mn,hp} \in \mathcal{X}_{hp} \subseteq \mathbb{Z}_+ = \{0, 1, 2, \dots\}$$

describe the HP for each character.

Inputs

The inputs to the system consist of movement and actions impacting the position and hp states respectively. For movement, a deterministic input of

$$u_{pc,m}, u_{mn,m} \in \mathcal{U}_m = \{(-1, 0), (+1, 0), (0, -1), (0, +1), (-1, -1), (-1, +1), (+1, -1), (+1, +1)\}$$

For actions, all the actions (except nothing) each are stochastic and can be represented as Markov chains or as a combination of input and noise term, $u_{pc,a}, u_{mn,a} \in \mathcal{U}_a = \{\text{Melee, Ranged, Heal, Nothing}\}$.

For Melee and Ranged attacks, the character acts upon another character's HP where the impact on HP is as follows:

1. Ensure in range for either melee or ranged attack - otherwise can't attack.
2. "Roll" for success/fail - if fail then self-loop on opponent HP
3. "Roll" for effectiveness - opponent HP decreased by Weapon/self Modifiers (2) + d6/d8

The PC is allowed to use a health potion which has a stochastic effect upon the player's health:

1. Ensure potion is available - otherwise can't heal
2. "Roll" for effectiveness - player's HP increased by health modifier (1) + d4

Problem Statement

For the simplistic case, let states at time-step k , be

$$x_k = \begin{bmatrix} x_{pc,p} \\ x_{mn,p} \\ x_{pc,hp} \\ x_{mn,hp} \end{bmatrix} \in \mathcal{X} = \mathcal{X}_p^2 \times \mathcal{X}_{hp}^2 \subseteq \mathbb{Z}^4 \times \mathbb{Z}_+^2$$

Let the inputs to the system be only the players inputs

$$u_k = \begin{bmatrix} u_{pc,m} \\ u_{pc,a} \end{bmatrix} \in \mathcal{U} = \mathcal{U}_p \times \mathcal{U}_a$$

The monster's inputs to the system will be incorporated as a deterministic and stochastic input that are closed-loop within the system and treated as part of the nonlinear aspects of the update function/Markov chains.

The evolution of the system can be described as Markov chains or by a nonlinear update function:

$$x_{k+1} = f(x_k, u_k)$$

which is described as ... (more complicated..)