COMP110: Principles of Computing

Finite State Machines

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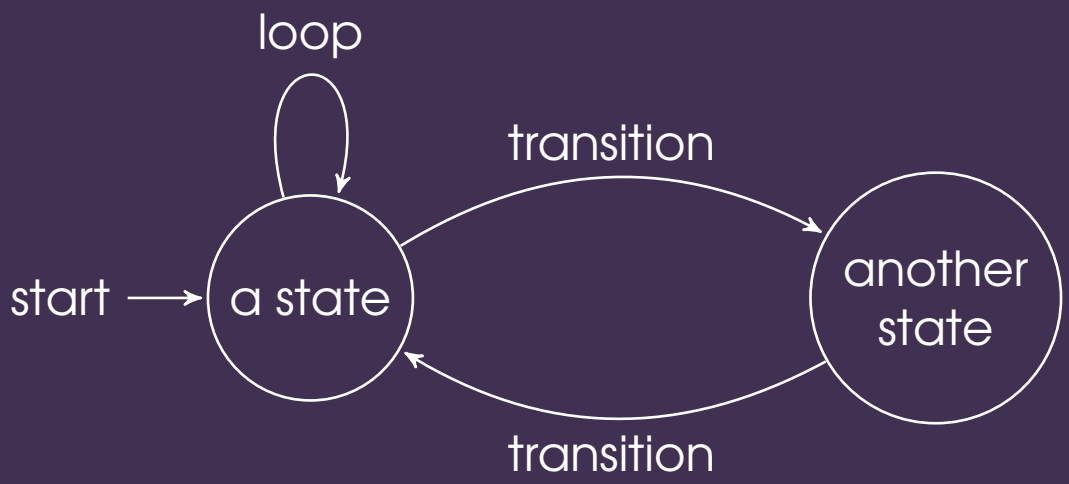
  - A set of **states**; and
  - **Transitions** between states
- At any given time, the FSM is in a **single state**
- **Inputs** or **events** can cause the FSM to transition to a different state

State transition diagrams



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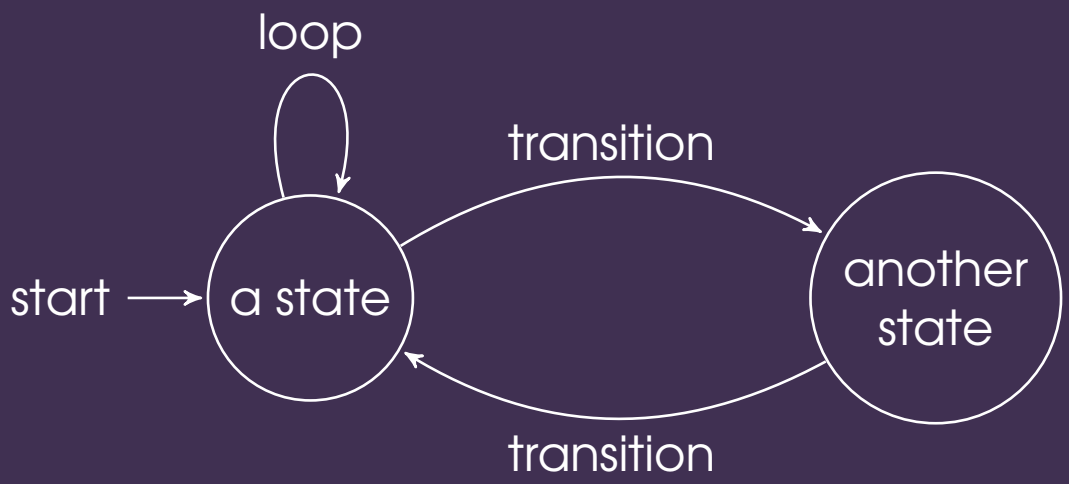

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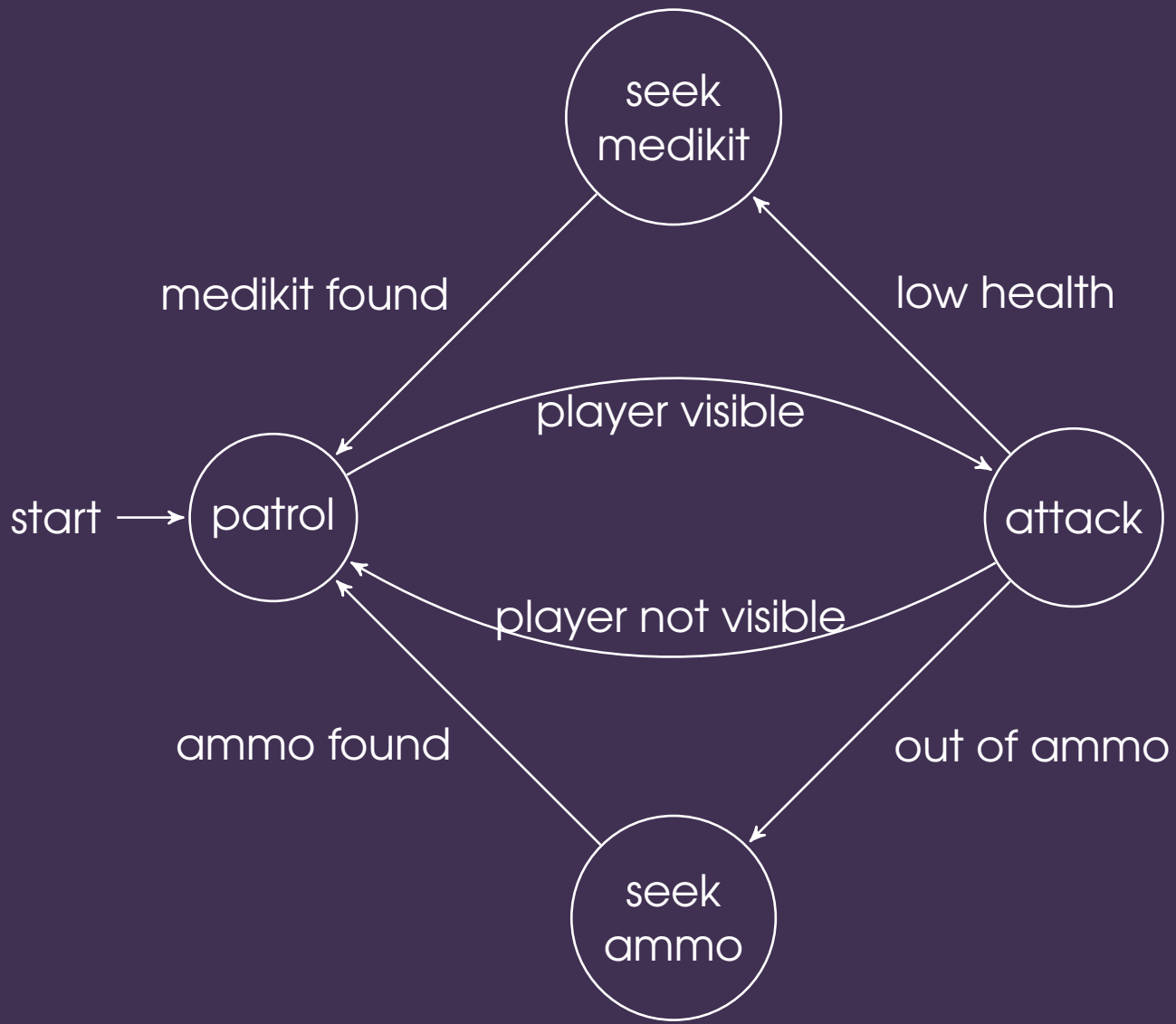
seek
medikit
medikit found
low health
player visible
start
patrol
attack
player not visible
ammo found
out of ammo
seek
ammo

Activity

- In your **COMP150 groups**, on the **whiteboards**
- **Extend** the FSM on the previous slide to produce **more realistic behaviour**
- Add at least **two** states, and associated transitions
- **5 minutes**...

Other uses of FSMs

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- ...

Activity

- In your **COMP150 groups**, on the **whiteboards**
- **Draw** an FSM for the overall UI structure of a typical game
- Include **at least** the following states, and appropriate transitions:
  - Main menu
  - Options menu
  - Game screen
  - Pause menu
  - Exit
- **5 minutes**...

FSMs in C++: Option 1

Use an **enum** to represent the states:

```
enum class SoldierState
{
    Patrol, Attack, SeekMedikit, SeekAmmo
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enum class SoldierState
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};
```

Store the **current state** as a field, initialised to the start state:

```
SoldierState currentState = SoldierState::Patrol;
```

Use a **switch** statement to implement the FSM itself:

```
void Soldier::update()
{
    switch (currentState)
    {
    case SoldierState::Attack:
        attack();

        if (!isPlayerVisible())
            currentState = NPCState::Patrol;
        else if (health < LOW_HEALTH_THRESHOLD)
            currentState = NPCState::SeekMedikit;
        else if (ammo == 0)
            currentState = NPCState::SeekAmmo;
        break;
    // ...
    }
}
```

FSMs in C++: Option 2

Use **classes** to represent the states:

```
class SoldierState
{
public:
    virtual void update(Soldier& soldier) = 0;
};

class SoldierAttackState : public SoldierState
{
public:
    virtual void update(Soldier& soldier);
};
```

Implementing FSMs: Option 2

Store the current state as a (pointer to an) **instance** of a state class:

```
std::shared_ptr<SoldierState> currentState
    = std::make_shared<SoldierPatrolState>();
```

Use **virtual method overriding** to implement behaviour:

```
void SoldierAttackState::update(Soldier& soldier)
{
    soldier.attack();

    if (!soldier.isPlayerVisible())
        soldier.currentState
            = std::make_shared<SoldierPatrolState>();
    else if (soldier.health < LOW_HEALTH_THRESHOLD)
        soldier.currentState
            = std::make_shared<SoldierSeekMedikit>();
    else if (soldier.ammo == 0)
        soldier.currentState
            = std::make_shared<SoldierSeekAmmo>();
}
```

Beyond FSMs

Some topics for you to research, for when plain old FSMs aren't enough...

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- Hierarchical FSMs
- Nested FSMs
- Stack-based FSMs
- Behaviour trees
- Hierarchical task networks
- ...

Summary

- Finite state machines (FSMs) can be used to model systems which have **one state** at any given time, and where inputs or events trigger **transitions** between states
- In games, often used for **simple AI behaviours** and for handling transitions between **UI screens**
- Can be implemented using **enums** and **switch** statements, or using **classes** and **polymorphism**