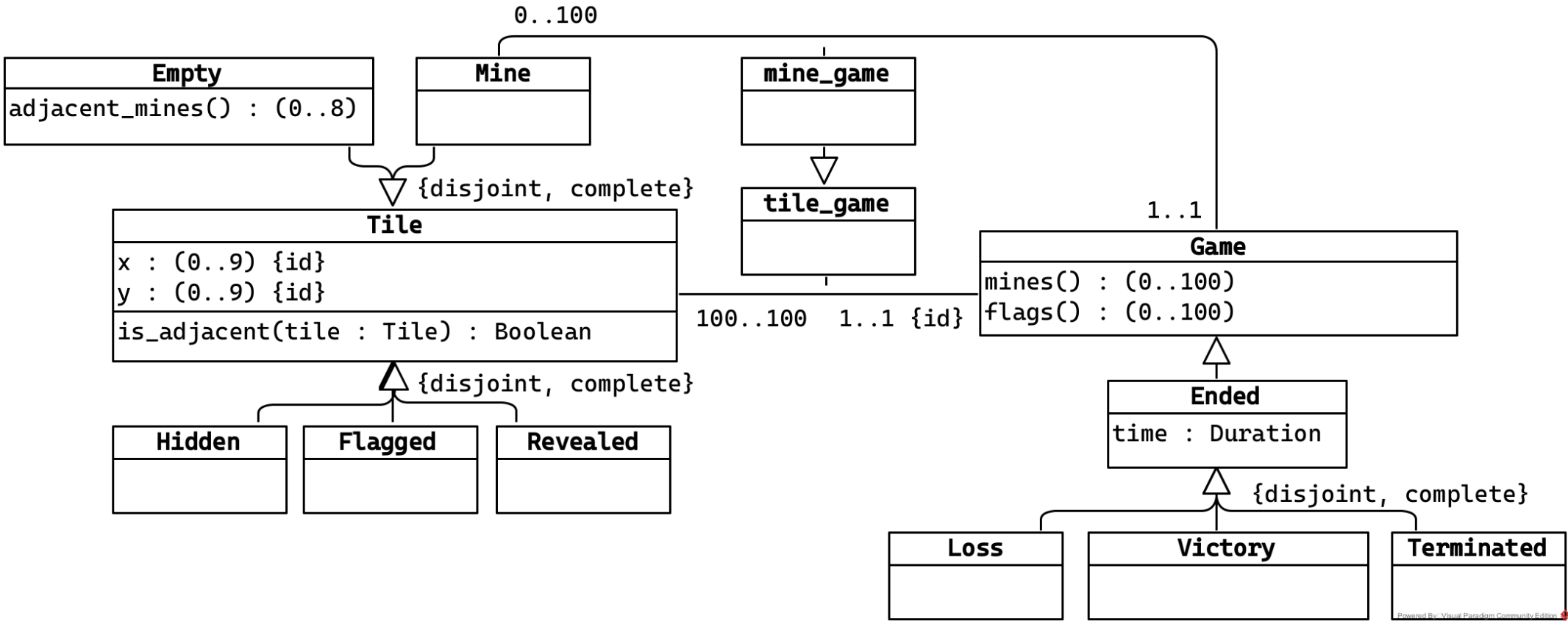


Minesweeper

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Game class specification

[V.Game.at_most_one_uncovered_mine]

```
∀ game
  Game(game) ⇒
    ¬ ∃ m1, m2
      m1 ≠ m2 ∧
      mine_game(m1, game) ∧
      mine_game(m2, game) ∧
      Revealed(m1) ∧
      Revealed(m2)
```

[V.Game.victory_condition]

```
∀ game
  Victory(game) ⇔
    ∀ tile mine_game(tile, game) ⇒ Flagged(tile) ∧
    ¬ ∃ tile tile_game(tile, game) ∧ Empty(tile) ∧ Flagged(tile)
    ∨
    ∀ tile (tile_game(tile, game) ∧ Empty(tile) ⇒ Revealed(tile))
```

[V.Game.loss_condition]

```
∀ game
  Loss(game) ⇔ ∃ mine mine_game(mine, game) ∧ Revealed(mine)
```

[V.Game.only_one_uncompleted_game]

```
∀ g1, g2
  Game(g1) ∧ Game(g2) ∧ g1 ≠ g2 ⇒
    Ended(g1) ∨ Over(g2)
```

mines(): (0..100)

pre-conditions

post-conditions

result = |{ mine | mine_game(mine, this) }|

flags(): (0..100)

pre-conditions

post-conditions

result = |{ flag | tile_game(flag, this) ∧ Flag(tile) }|

Tile class specification

is_adjacent(tile: Tile): Boolean

pre-conditions

post-conditions

```
result = True  $\iff$   $\exists$  game, x, y
  tile_game(this, game)  $\wedge$ 
  tile_game(tile, game)  $\wedge$ 
  x(this, x)  $\wedge$ 
  y(this, y)  $\wedge$ 
  (
    (x(tile, x - 1)  $\wedge$  y(tile, y - 1))  $\vee$ 
    (x(tile, x )  $\wedge$  y(tile, y - 1))  $\vee$ 
    (x(tile, x + 1)  $\wedge$  y(tile, y - 1))  $\vee$ 
    (x(tile, x - 1)  $\wedge$  y(tile, y + 1))  $\vee$ 
    (x(tile, x )  $\wedge$  y(tile, y + 1))  $\vee$ 
    (x(tile, x + 1)  $\wedge$  y(tile, y + 1))  $\vee$ 
    (x(tile, x - 1)  $\wedge$  y(tile, y))  $\vee$ 
    (x(tile, x + 1)  $\wedge$  y(tile, y))  $\vee$ 
  )
```

Empty class specification

[V.Empty.revealed_empty_tile_reveals_adjacents]

```
 $\forall$  safe, game, adjacent
  tile_game(safe, game)  $\wedge$ 
  Empty(safe)  $\wedge$ 
  Revealed(safe)  $\wedge$ 
  is_adjacentTile, Tile, Boolean(safe, adjacent, True)  $\wedge$ 
  adjacent_minesEmpty, (0..8)(safe, 0)  $\implies$ 
    Revealed(adjacent)
```

adjacent_mines(): (0..8)

pre-conditions

post-conditions

```
result = |{ mine |  $\exists$  game
  tile_game(this, game)  $\wedge$ 
  mine_game(mine, game)  $\wedge$ 
  is_adjacentTile, Tile, Boolean(this, mine, True)
}|
```

Use Case

start_game(): Game

pre-conditions

$\neg \exists \text{ game } \text{Game}(\text{game}) \wedge \neg \text{Ended}(\text{game})$

terminate_game(game: Game): Terminated

pre-conditions

$\neg \text{Ended}(\text{game})$

reveal(tile: Hidden): Revealed

pre-conditions

$\exists \text{ game } \text{tile_game}(\text{tile}, \text{game}) \implies \neg \text{Ended}(\text{game})$

flag(tile: Hidden): Flagged

pre-conditions

$\exists \text{ game } \text{tile_game}(\text{tile}, \text{game}) \implies \neg \text{Ended}(\text{game})$

remove_flag(tile: Flagged): Hidden

pre-conditions

$\exists \text{ game } \text{tile_game}(\text{tile}, \text{game}) \implies \neg \text{Ended}(\text{game})$

games_played(): Integer ≥ 0

pre-conditions

post-conditions

$\text{result} = |\{ \text{game} \mid \text{Game}(\text{game}) \}|$

games_won(): Integer ≥ 0

pre-conditions

post-conditions

$\text{result} = |\{ \text{game} \mid \text{Victory}(\text{game}) \}|$

Wireframe

