

Comprehensive Minecraft Bedrock Entity Development Guide for Cursor AI

This comprehensive guide contains detailed information from 150+ sources specifically designed to assist AI coding assistants like Cursor in creating professional-quality Minecraft Bedrock entities. The guide covers everything from basic entity structure to advanced rendering systems, animation controllers, and spawn mechanics.

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1. Entity Architecture & Core Concepts

What are Entities?

Entities are dynamic objects in Minecraft Bedrock Edition that can move, interact, and respond to their environment [^87]. They are composed of multiple interdependent systems:

- **Behavior Pack Entity:** Defines server-side logic, AI, and behaviors
- **Resource Pack Entity:** Defines visual appearance, models, textures, and animations
- **Spawn Rules:** Control when, where, and how entities spawn naturally [^100]

Entity File Structure

Behavior Pack Structure

```
behavior_pack/
├── manifest.json           # Pack metadata
├── entities/              # Entity behavior definitions
│   └── custom_entity.json # Main entity logic
├── spawn_rules/          # Natural spawn conditions
│   └── custom_entity.json # Spawn parameters
├── loot_tables/          # Death drops
│   └── entities/
│       └── custom_entity.json # Loot configuration
├── scripts/              # Script API files (optional)
│   └── main.js           # Custom behaviors
├── animations/           # Behavior-side animations
│   └── custom_entity.json # Command animations
```

Resource Pack Structure

```
resource_pack/
├── manifest.json           # Pack metadata
├── entity/                # Visual definitions
│   └── custom_entity.json # Client-side appearance
├── models/               # 3D geometry
│   └── entity/
│       └── custom_entity.geo.json # Blockbench model
├── textures/             # Visual assets
│   └── entity/
│       └── custom_entity.png    # Entity texture
├── animations/           # Visual animations
│   └── custom_entity.json      # Movement/action animations
├── animation_controllers/ # State machines
│   └── custom_entity.json      # Animation logic
├── render_controllers/   # Rendering logic
│   └── custom_entity.json      # Material/texture control
```

2. Entity Components Deep Dive

Core Components

Based on Microsoft's official documentation [^86], there are 200+ entity components available. Here are the essential categories:

Essential Components

- `minecraft:type_family`: Defines what family groups the entity belongs to
- `minecraft:collision_box`: Sets physical boundaries (width, height)
- `minecraft:health`: Defines health values and damage resistance
- `minecraft:physics`: Controls gravity and collision behavior

Movement Components

- `minecraft:movement`: Base movement speed (required for all moving entities)
- `minecraft:underwater_movement`: Movement speed in water
- `minecraft:flying_speed`: Movement speed while flying

Movement Types (choose one) [^94]:

```
{
  "minecraft:movement.basic": {},      // Standard land movement
  "minecraft:movement.amphibious": {}, // Can swim and walk
  "minecraft:movement.fly": {},        // Flying entities
  "minecraft:movement.generic": {}     // Can fly, swim, climb
}
```

Navigation Components (choose one):

- `minecraft:navigation.walk`: Standard pathfinding
- `minecraft:navigation.fly`: Air-based pathfinding
- `minecraft:navigation.swim`: Water-based pathfinding
- `minecraft:navigation.generic`: Multi-environment pathfinding

Interaction Components

Damage System [^123]:

```
{
  "minecraft:damage_sensor": {
    "triggers": [
      {
        "cause": "fall",
        "deals_damage": "no"
      },
      {
        "on_damage": {
          "filters": {
            "test": "is_family",
            "subject": "other",
            "value": "player"
          }
        }
      }
    ]
  }
}
```

```

        },
        "event": "custom:player_attack"
    },
    "deals_damage": "yes"
}
]
}
}

```

Damage Sensor Options:

- "deals_damage": "yes" - Normal damage
- "deals_damage": "no" - No damage taken
- "deals_damage": "no_but_side_effects_apply" - No damage but weapon durability/enchantments apply

Interaction Component:

```

{
  "minecraft:interact": {
    "interactions": [
      {
        "on_interact": {
          "filters": {
            "test": "is_family",
            "subject": "other",
            "value": "player"
          },
          },
        "event": "custom:on_interact"
      }
    ]
  }
}

```

Equipment & Inventory Components

Inventory System:

```

{
  "minecraft:inventory": {
    "container_type": "chest",          // chest, minecart_chest, horse
    "inventory_size": 27,               // Number of slots
    "can_be_siphoned_from": true,       // Hoppers can extract
    "private": false,                  // Only owner can access
    "restrict_to_owner": false          // Owner restrictions
  }
}

```

Equipment Components:

```
{
  "minecraft:equipment": {
    "table": "loot_tables/equipment/my_entity.json"
  },
  "minecraft:equippable": {
    "slots": [
      {
        "slot": 0,
        "item": "minecraft:iron_sword",
        "accepted_items": ["minecraft:sword"]
      }
    ]
  }
}
```

3. Entity AI Behaviors & Movement

AI Priority System

AI behaviors use a priority system where lower numbers execute first [^91]. Essential behaviors:

Basic Movement Behaviors:

```
{
  "minecraft:behavior.float": {
    "priority": 0 // Prevents drowning
  },
  "minecraft:behavior.random_stroll": {
    "priority": 8,
    "speed_multiplier": 0.8
  },
  "minecraft:behavior.look_at_player": {
    "priority": 7,
    "look_distance": 6.0
  },
  "minecraft:behavior.random_look_around": {
    "priority": 9
  }
}
```

Combat Behaviors:

```
{
  "minecraft:behavior.nearest_attackable_target": {
    "priority": 1,
    "within_radius": 16,
    "must_see": true,
    "entity_types": [
```

```

    {
      "filters": {
        "test": "is_family",
        "subject": "other",
        "value": "player"
      },
      "max_dist": 16
    }
  ]
},
"minecraft:behavior.melee_attack": {
  "priority": 2,
  "speed_multiplier": 1.2,
  "track_target": true
}
}

```

Advanced AI Behaviors:

```

{
  "minecraft:behavior.follow_owner": {
    "priority": 4,
    "speed_multiplier": 1.1,
    "start_distance": 10,
    "stop_distance": 2
  },
  "minecraft:behavior.tempt": {
    "priority": 3,
    "speed_multiplier": 1.0,
    "items": ["minecraft:wheat", "minecraft:carrot"]
  },
  "minecraft:behavior.breed": {
    "priority": 5,
    "speed_multiplier": 1.0
  }
}

```

Custom Pathfinding Example

For advanced pathfinding, use aggressive targeting with dummy entities [^94]:

```

{
  "minecraft:behavior.nearest_attackable_target": {
    "priority": 0,
    "reselect_targets": true,
    "target_search_height": 1000,
    "within_radius": 1000,
    "must_see": false,
    "entity_types": [
      {
        "filters": {
          "test": "is_family",
          "subject": "other",

```

```

        "value": "waypoint_marker"
      },
      "max_dist": 1000
    }
  ]
},
"minecraft:attack": {
  "damage": 0
},
"minecraft:behavior.melee_attack": {
  "priority": 0,
  "require_complete_path": true,
  "track_target": true
},
"minecraft:follow_range": {
  "value": 1000,
  "max": 1000
}
}

```

4. Spawn Rules & Population Control

Spawn Rule Structure [^103]

Spawn rules determine when, where, and how entities appear naturally in the world:

```

{
  "format_version": "1.8.0",
  "minecraft:spawn_rules": {
    "description": {
      "identifier": "custom:my_entity",
      "population_control": "monster"
    },
    "conditions": [
      {
        "minecraft:spawns_on_surface": {},
        "minecraft:brightness_filter": {
          "min": 0,
          "max": 7,
          "adjust_for_weather": true
        },
        "minecraft:biome_filter": {
          "test": "has_biome_tag",
          "operator": "=",
          "value": "forest"
        },
        "minecraft:weight": {
          "default": 10
        },
        "minecraft:herd": {
          "min_size": 1,
          "max_size": 3
        }
      ]
    ]
  }
}

```

```

    }
  ]
}
}

```

Population Control Pools [^103]

- "animal" - Peaceful mobs (cows, pigs, chickens)
- "monster" - Hostile mobs (zombies, skeletons, creepers)
- "water_animal" - Aquatic life (fish, dolphins, squid)
- "ambient" - Atmospheric mobs (bats)
- "cat" - Special village-based spawning

Spawn Conditions [^100]

Environment Filters:

```

{
  "minecraft:spawns_on_surface": {},
  "minecraft:spawns_underground": {},
  "minecraft:spawns_underwater": {},
  "minecraft:height_filter": {
    "min": 50,
    "max": 120
  },
  "minecraft:brightness_filter": {
    "min": 0,
    "max": 7,
    "adjust_for_weather": true
  }
}

```

Block Filters:

```

{
  "minecraft:spawns_on_block_filter": [
    "minecraft:grass_block",
    "minecraft:dirt"
  ],
  "minecraft:spawns_on_block_prevented_filter": [
    "minecraft:water",
    "minecraft:lava"
  ]
}

```


Advanced Spawn Conditions:

```
{
  "minecraft:difficulty_filter": {
    "min": "easy",
    "max": "hard"
  },
  "minecraft:distance_filter": {
    "min": 24,
    "max": 128
  },
  "minecraft:world_age_filter": {
    "min": 72000
  }
}
```

Spawn Mechanics [^92]

Bedrock spawning algorithm:

1. **Chunk Selection:** Random chunk within simulation distance
2. **Surface Detection:** Find solid blocks with air above
3. **Mob Selection:** Choose based on light level and biome
4. **Pack Spawning:** Spawn multiple entities if configured
5. **Density Checks:** Respect mob caps and density limits

5. Entity Events & Component Groups

Component Groups [^87]

Component groups are containers for components that can be dynamically added or removed:

```
{
  "component_groups": {
    "custom:adult_form": {
      "minecraft:scale": {
        "value": 1.0
      },
      "minecraft:attack": {
        "damage": 6
      },
      "minecraft:health": {
        "value": 20,
        "max": 20
      }
    },
    "custom:baby_form": {
      "minecraft:is_baby": {},
      "minecraft:scale": {

```

```

        "value": 0.5
    },
    "minecraft:ageable": {
        "duration": 1200,
        "feed_items": ["minecraft:wheat"],
        "grow_up": {
            "event": "custom:grow_up",
            "target": "self"
        }
    }
},
"custom:angry_state": {
    "minecraft:angry": {
        "duration": 25,
        "calm_event": {
            "event": "custom:calm_down",
            "target": "self"
        }
    }
},
"minecraft:attack": {
    "damage": 12
}
}
}
}

```

Entity Events [^112]

Events control when component groups are added or removed:

```

{
  "events": {
    "custom:grow_up": {
      "remove": {
        "component_groups": ["custom:baby_form"]
      },
      "add": {
        "component_groups": ["custom:adult_form"]
      }
    },
    "custom:become_angry": {
      "add": {
        "component_groups": ["custom:angry_state"]
      },
      "trigger": "custom:attack_nearby"
    },
    "custom:calm_down": {
      "remove": {
        "component_groups": ["custom:angry_state"]
      }
    }
  }
}

```

Event Triggers [^120]

Events can be triggered by various components:

Environment-based Triggers:

```
{
  "minecraft:environment_sensor": {
    "triggers": [
      {
        "filters": {
          "test": "is_underwater",
          "operator": "==",
          "value": true
        },
        "event": "custom:enter_water"
      }
    ]
  }
}
```

Timer-based Triggers:

```
{
  "minecraft:timer": {
    "time": [30, 60],
    "looping": true,
    "time_down_event": {
      "event": "custom:special_ability",
      "target": "self"
    }
  }
}
```

Damage-based Triggers [^123]:

```
{
  "minecraft:damage_sensor": {
    "triggers": {
      "on_damage": {
        "filters": {
          "test": "is_family",
          "subject": "other",
          "value": "player"
        },
        "event": "custom:player_attacked_me"
      },
      "deals_damage": "yes"
    }
  }
}
```

Advanced Event Features

Sequential Events:

```
{
  "custom:complex_transformation": {
    "sequence": [
      {
        "filters": {
          "test": "has_component",
          "value": "minecraft:is_baby"
        },
        "add": {
          "component_groups": ["custom:teenage_form"]
        },
        "remove": {
          "component_groups": ["custom:baby_form"]
        }
      },
      {
        "delay": 5.0,
        "add": {
          "component_groups": ["custom:adult_form"]
        },
        "remove": {
          "component_groups": ["custom:teenage_form"]
        }
      }
    ]
  }
}
```

Randomized Events:

```
{
  "custom:random_transformation": {
    "randomize": [
      {
        "weight": 80,
        "add": {
          "component_groups": ["custom:normal_variant"]
        }
      },
      {
        "weight": 15,
        "add": {
          "component_groups": ["custom:rare_variant"]
        }
      },
      {
        "weight": 5,
        "add": {
          "component_groups": ["custom:legendary_variant"]
        }
      }
    ]
  }
}
```

```
}
  }
]
}
}
```

6. Entity Modeling & Animation with Blockbench

Blockbench Setup [^107]

Blockbench is the primary tool for creating Bedrock entity models and animations.

Project Setup:

1. Open Blockbench
2. Select "Bedrock Model"
3. Set "Mob Geometry Name" using snake_case (e.g., custom_robot)
4. Configure texture size (typically 64x64 or 128x128)

Bone Structure Best Practices [^107]:

```
root_bone           // Main parent bone
├── head             // Head components
│   ├── head_main    // Head geometry
│   └── head_accessories // Hats, horns, etc.
├── body             // Torso components
│   ├── body_main     // Main body
│   ├── left_arm       // Left arm
│   ├── right_arm      // Right arm
│   └── wings          // Optional wings
└── legs             // Leg components
    ├── left_leg       // Left leg
    └── right_leg      // Right leg
```

Critical Rules:

- Use snake_case for all bone names
- Each bone name must be unique
- Pivot points should be at joint locations
- Use consistent naming conventions

Animation Creation [^111]

Basic Walk Animation:

```
{
  "format_version": "1.8.0",
  "animations": {
    "animation.custom_entity.walk": {
      "loop": true,
      "animation_length": 1.0,
      "bones": {
        "left_leg": {
          "rotation": {
            "0.0": [-22.5, 0, 0],
            "0.5": [22.5, 0, 0],
            "1.0": [-22.5, 0, 0]
          }
        },
        "right_leg": {
          "rotation": {
            "0.0": [22.5, 0, 0],
            "0.5": [-22.5, 0, 0],
            "1.0": [22.5, 0, 0]
          }
        },
        "left_arm": {
          "rotation": {
            "0.0": [22.5, 0, 0],
            "0.5": [-22.5, 0, 0],
            "1.0": [22.5, 0, 0]
          }
        },
        "right_arm": {
          "rotation": {
            "0.0": [-22.5, 0, 0],
            "0.5": [22.5, 0, 0],
            "1.0": [-22.5, 0, 0]
          }
        }
      }
    }
  }
}
```

Attack Animation:

```
{
  "animation.custom_entity.attack": {
    "animation_length": 0.5,
    "bones": {
      "right_arm": {
        "rotation": {
          "0.0": [0, 0, 0],
```

```

    "0.25": [-90, 0, 0],
    "0.5": [0, 0, 0]
  }
},
"body": {
  "rotation": {
    "0.0": [0, 0, 0],
    "0.25": [0, -15, 0],
    "0.5": [0, 0, 0]
  }
}
}
}
}

```

Model Export Process [^114]

1. **File > Export Bedrock Geometry**
2. Save model as `custom_entity.geo.json` in `models/entity/`
3. Save texture as `custom_entity.png` in `textures/entity/`
4. Save animations as `custom_entity.json` in `animations/`

7. Client Entity Definitions & Render Controllers

Client Entity Structure [^113]

The resource pack entity file connects all visual assets:

```
{
  "format_version": "1.10.0",
  "minecraft:client_entity": {
    "description": {
      "identifier": "custom:my_entity",
      "materials": {
        "default": "entity_alphatest",
        "glowing": "entity_emissive"
      },
      "textures": {
        "default": "textures/entity/custom_entity",
        "angry": "textures/entity/custom_entity_angry"
      },
      "geometry": {
        "default": "geometry.custom_entity"
      },
      "animations": {
        "walk": "animation.custom_entity.walk",
        "attack": "animation.custom_entity.attack",
        "look_at_target": "animation.common.look_at_target"
      },
      "animation_controllers": [
```

```

    {
      "movement": "controller.animation.custom_entity.movement"
    },
    {
      "attack": "controller.animation.custom_entity.attack"
    }
  ],
  "render_controllers": [
    "controller.render.custom_entity"
  ],
  "spawn_egg": {
    "base_color": "#3F3F3F",
    "overlay_color": "#FF6600"
  }
}
}
}

```

Render Controllers [^141]

Render controllers determine which materials, textures, and geometry are used:

```

{
  "format_version": "1.8.0",
  "render_controllers": {
    "controller.render.custom_entity": {
      "geometry": "Geometry.default",
      "materials": [
        {
          "*": "Material.default"
        },
        {
          "head": "Material.glowing"
        }
      ],
      "textures": [
        "query.is_angry ? Texture.angry : Texture.default"
      ],
      "part_visibility": [
        {
          "wings": "query.variant == 1"
        }
      ]
    }
  }
}
}

```


Advanced Render Controller [^142]:

```
{
  "controller.render.custom_entity_advanced": {
    "arrays": {
      "textures": {
        "Array.skins": [
          "Texture.variant_1",
          "Texture.variant_2",
          "Texture.variant_3",
          "Texture.variant_4"
        ]
      }
    },
    "geometry": "Geometry.default",
    "materials": [
      {
        "★": "Material.default"
      },
      {
        "glowing_parts": "Material.emissive"
      }
    ],
    "textures": [
      "Array.skins[query.variant]"
    ],
    "part_visibility": [
      {
        "armor_overlay": "query.is_item_equipped"
      },
      {
        "baby_head": "query.is_baby"
      }
    ]
  }
}
```

Animation Controllers [^154]

State machines that control when animations play:

```
{
  "format_version": "1.10.0",
  "animation_controllers": {
    "controller.animation.custom_entity.movement": {
      "initial_state": "default",
      "states": {
        "default": {
          "animations": [
            {
              "walk": "query.modified_move_speed"
            }
          ]
        },
        "transitions": [
```

```

        {
          "attacking": "query.is_delayed_attacking"
        }
      ]
    },
    "attacking": {
      "animations": ["attack"],
      "transitions": [
        {
          "default": "!query.is_delayed_attacking"
        }
      ]
    }
  }
}
}
}
}
}
}
}
}
}
}

```

Materials System [^143]

Different materials provide various visual effects:

- `entity` - Standard opaque material
- `entity_alphatest` - Supports transparency (below 50% = invisible)
- `entity_alphablend` - Smooth transparency blending
- `entity_emissive` - Glowing/light-emitting material
- `entity_emissive_alpha` - Glowing with transparency

8. Damage Systems & Invulnerability

Damage Sensor Component [^123]

The damage sensor is the most flexible way to control entity damage:

Complete Invulnerability:

```

{
  "minecraft:damage_sensor": {
    "triggers": {
      "cause": "all",
      "deals_damage": "no"
    }
  }
}
}

```

Conditional Damage Immunity:

```
{
  "minecraft:damage_sensor": {
    "triggers": [
      {
        "cause": "fall",
        "deals_damage": "no"
      },
      {
        "cause": "fire",
        "deals_damage": "no"
      },
      {
        "on_damage": {
          "filters": {
            "test": "is_family",
            "subject": "other",
            "value": "player"
          },
          "event": "custom:player_attacked"
        },
        "deals_damage": "yes",
        "damage_multiplier": 0.5
      }
    ]
  }
}
```

Advanced Damage Handling:

```
{
  "minecraft:damage_sensor": {
    "triggers": [
      {
        "on_damage": {
          "filters": {
            "all_of": [
              {
                "test": "is_family",
                "subject": "other",
                "value": "player"
              },
              {
                "test": "has_equipment",
                "subject": "other",
                "domain": "hand",
                "value": "minecraft:diamond_sword"
              }
            ]
          },
          "event": "custom:special_sword_damage"
        },
        "damage_modifier": -2,
      }
    ]
  }
}
```

```
        "damage_multiplier": 1.5,  
        "deals_damage": "yes"  
      }  
    ]  
  }  
}
```

Health Component Variations

Standard Health:

```
{  
  "minecraft:health": {  
    "value": 20,  
    "max": 20  
  }  
}
```

Invulnerable Entity [^124]:

```
{  
  "minecraft:health": {  
    "value": 1,  
    "max": 1,  
    "min": 1  
  }  
}
```

Damage Causes

Available damage causes for filtering:

- "all" - Any damage source
- "fall" - Fall damage
- "fire" - Fire/lava damage
- "lightning" - Lightning strikes
- "projectile" - Arrows, snowballs, etc.
- "suffocation" - Block suffocation
- "void" - Void damage
- "drowning" - Water damage
- "magic" - Potion effects
- "wither" - Wither effect
- "starve" - Hunger damage

9. Loot Tables & Drops

Loot Table Structure [^131]

Loot tables control what entities drop when they die:

```
{
  "pools": [
    {
      "rolls": {
        "min": 1,
        "max": 3
      },
      "entries": [
        {
          "type": "item",
          "name": "minecraft:leather",
          "weight": 40,
          "functions": [
            {
              "function": "set_count",
              "count": {
                "min": 1,
                "max": 2
              }
            },
            {
              "function": "looting_enchant",
              "count": {
                "min": 0,
                "max": 1
              }
            }
          ]
        },
        {
          "type": "item",
          "name": "minecraft:raw_beef",
          "weight": 40,
          "functions": [
            {
              "function": "set_count",
              "count": {
                "min": 1,
                "max": 3
              }
            },
            {
              "function": "furnace_smelt",
              "conditions": [
                {
                  "condition": "entity_on_fire"
                }
              ]
            }
          ]
        }
      ]
    }
  ]
}
```

```

    ]
  }
]
}

```

Loot Functions [^131]

Common Functions:

```

{
  "functions": [
    {
      "function": "set_count",
      "count": {
        "min": 1,
        "max": 5
      }
    },
    {
      "function": "set_name",
      "name": "$6Epic Sword"
    },
    {
      "function": "set_lore",
      "lore": [
        "$7A legendary weapon",
        "$7forged by ancient smiths"
      ]
    },
    {
      "function": "enchant_randomly",
      "treasure": true
    },
    {
      "function": "set_damage",
      "damage": {
        "min": 0.1,
        "max": 0.9
      }
    }
  ]
}

```

Conditional Functions:

```

{
  "functions": [
    {
      "function": "set_count",
      "count": {

```

```

        "min": 2,
        "max": 5
    },
    "conditions": [
        {
            "condition": "killed_by_player"
        }
    ]
},
{
    "function": "looting_enchant",
    "count": {
        "min": 0,
        "max": 2
    },
    "conditions": [
        {
            "condition": "killed_by_player_or_pets"
        }
    ]
}
]
}

```

Entity Loot Component [^137]

Link the loot table to your entity:

```

{
  "minecraft:loot": {
    "table": "loot_tables/entities/custom_entity.json"
  }
}

```

Advanced Loot Examples

Experience Rewards:

```

{
  "minecraft:experience_reward": {
    "on_death": "query.last_hit_by_player ? Math.Random(1,3) : 0"
  }
}

```

Rare Drop System:

```
{
  "pools": [
    {
      "rolls": 1,
      "entries": [
        {
          "type": "item",
          "name": "custom:rare_item",
          "weight": 1,
          "conditions": [
            {
              "condition": "random_chance",
              "chance": 0.05
            },
            {
              "condition": "killed_by_player"
            }
          ]
        },
        {
          "type": "empty",
          "weight": 19
        }
      ]
    }
  ]
}
```

10. Entity Variants & Permutations

Variant System [¹³⁶]

The variant component allows multiple visual forms of the same entity:

```
{
  "component_groups": {
    "custom:variant_red": {
      "minecraft:variant": {
        "value": 0
      }
    },
    "custom:variant_blue": {
      "minecraft:variant": {
        "value": 1
      }
    },
    "custom:variant_green": {
      "minecraft:variant": {
        "value": 2
      }
    }
  }
}
```



```

    },
    "custom:variant_rare": {
      "minecraft:variant": {
        "value": 3
      }
    }
  },
  "events": {
    "minecraft:entity_spawned": {
      "randomize": [
        {
          "weight": 40,
          "add": {
            "component_groups": ["custom:variant_red"]
          }
        },
        {
          "weight": 35,
          "add": {
            "component_groups": ["custom:variant_blue"]
          }
        },
        {
          "weight": 20,
          "add": {
            "component_groups": ["custom:variant_green"]
          }
        },
        {
          "weight": 5,
          "add": {
            "component_groups": ["custom:variant_rare"]
          }
        }
      ]
    }
  }
}

```

Spawn Rule Permutations [^129]

Control variant spawning through spawn rules:

```

{
  "minecraft:permute_type": [
    {
      "weight": 90,
      "entity_type": "custom:my_entity"
    },
    {
      "weight": 10,
      "entity_type": "custom:my_entity<custom:spawn_rare_variant>"
    }
  ]
}

```

```
]
}
```

Mark Variant System

For additional visual variations beyond the main variant:

```
{
  "minecraft:mark_variant": {
    "value": 0
  }
}
```

Use in render controller:

```
{
  "textures": [
    "Array.base_textures[query.variant]",
    "Array.pattern_textures[query.mark_variant]"
  ]
}
```

11. Script API Integration

Basic Script Entity Interaction

```
import { world, system } from "@minecraft/server";

// Entity spawning and manipulation
world.afterEvents.worldLoad.subscribe(() => {
  const overworld = world.getDimension("overworld");

  // Spawn custom entity
  const entity = overworld.spawnEntity("custom:my_entity", {
    x: 0, y: 64, z: 0
  });

  // Modify entity properties
  const health = entity.getComponent("minecraft:health");
  health.setCurrentValue(health.defaultValue);

  // Add tags for identification
  entity.addTag("custom_spawned");
  entity.addTag("special_behavior");
});

// Entity event handling
world.afterEvents.entitySpawn.subscribe((event) => {
  const entity = event.entity;
```

```

    if (entity.typeId === "custom:my_entity") {
        // Custom spawn behavior
        entity.setDynamicProperty("spawn_time", Date.now());

        // Trigger custom event
        entity.triggerEvent("custom:post_spawn_setup");
    }
});

// Custom entity AI via Script API
world.afterEvents.entityHurt.subscribe((event) => {
    const entity = event.hurtEntity;
    const damager = event.damageSource.damagingEntity;

    if (entity.hasTag("special_behavior") && damager?.typeId === "minecraft:player") {
        // Custom retaliation behavior
        entity.addEffect("speed", 200, {
            amplifier: 2,
            showParticles: false
        });

        entity.triggerEvent("custom:become_aggressive");
    }
});

```

Advanced Entity Management

```

class EntityManager {
    constructor() {
        this.trackedEntities = new Map();
        this.setupEventHandlers();
    }

    setupEventHandlers() {
        world.afterEvents.entitySpawn.subscribe((event) => {
            if (this.isCustomEntity(event.entity)) {
                this.registerEntity(event.entity);
            }
        });

        world.afterEvents.entityDie.subscribe((event) => {
            this.unregisterEntity(event.deadEntity);
        });
    }

    isCustomEntity(entity) {
        return entity.typeId.startsWith("custom:");
    }

    registerEntity(entity) {
        const data = {
            spawnTime: Date.now(),
            lastUpdate: Date.now(),
            customBehaviors: []
        };
    }
}

```

```

        this.trackedEntities.set(entity.id, data);

        // Apply custom initialization
        this.initializeCustomBehavior(entity);
    }

    initializeCustomBehavior(entity) {
        // Set custom properties
        entity.setDynamicProperty("behavior_state", "idle");
        entity.setDynamicProperty("interaction_count", 0);

        // Schedule periodic updates
        system.runInterval(() => {
            if (entity.isValid()) {
                this.updateEntity(entity);
            } else {
                this.unregisterEntity(entity);
            }
        }, 20); // Every second
    }

    updateEntity(entity) {
        const state = entity.getDynamicProperty("behavior_state");

        switch (state) {
            case "idle":
                this.handleIdleBehavior(entity);
                break;
            case "following":
                this.handleFollowBehavior(entity);
                break;
            case "aggressive":
                this.handleAggressiveBehavior(entity);
                break;
        }
    }

    handleIdleBehavior(entity) {
        const nearbyPlayers = entity.dimension.getEntitiesAtBlockLocation(
            entity.location
        ).filter(e => e.typeId === "minecraft:player" &&
            this.getDistance(entity, e) < 10);

        if (nearbyPlayers.length > 0) {
            entity.setDynamicProperty("behavior_state", "following");
            entity.setDynamicProperty("follow_target", nearbyPlayers[0].id);
        }
    }

    getDistance(entity1, entity2) {
        const dx = entity1.location.x - entity2.location.x;
        const dy = entity1.location.y - entity2.location.y;
        const dz = entity1.location.z - entity2.location.z;
        return Math.sqrt(dx*dx + dy*dy + dz*dz);
    }
}

```

```
}  
  
// Initialize entity manager  
world.afterEvents.worldLoad.subscribe(() => {  
    new EntityManager();  
});
```

12. Troubleshooting & Best Practices

Common Issues and Solutions

Entity Not Spawning

1. **Check manifest.json syntax** - Use JSON validator
2. **Verify spawn rules** - Ensure conditions are met
3. **Check identifiers** - Must match between BP and RP
4. **Enable experimental features** - Required for some components
5. **Clear cache** - Delete `minecraftpe/games/com.mojang/minecraftWorlds/[world]/behavior_packs/cache`

Visual Issues

1. **Missing textures** - Verify file paths and names
2. **Animation not playing** - Check animation controller states
3. **Wrong model** - Ensure geometry identifier matches
4. **Material problems** - Verify material definitions

AI Behavior Problems

1. **Entity not moving** - Add navigation and movement components
2. **Targeting issues** - Check priority values and filters
3. **Path-finding problems** - Adjust navigation parameters

Performance Optimization

Entity Efficiency:

```
{  
    "minecraft:conditional_bandwidth_optimization": {  
        "max_optimized_distance": 60.0,  
        "max_dropped_ticks": 10,  
        "use_motion_prediction_hints": true
```

```
}  
}
```

Animation Optimization:

- Use `blend_transition` for smooth state changes
- Minimize bone count in animations
- Use efficient keyframe placement
- Avoid complex mathematical expressions in animations

Development Workflow

1. Use Development Folders:

- `development_behavior_packs/`
- `development_resource_packs/`

2. Enable Content Log:

- Settings > Creator > Enable Content Log

3. Testing Strategy:

- Create dedicated test worlds
- Use creative mode for rapid testing
- Test on multiple devices/platforms

4. Version Control:

- Use stable API versions for production
- Document compatibility requirements
- Test with different Minecraft versions

13. Advanced Entity Features

Custom Hit Testing

```
{  
  "minecraft:custom_hit_test": {  
    "hitboxes": [  
      {  
        "width": 1.0,  
        "height": 2.0,  
        "pivot": [0, 1, 0]  
      }  
    ]  
  }  
}
```

Entity Sensors

Target Nearby Sensor:

```
{
  "minecraft:target_nearby_sensor": {
    "inside_range": 5.0,
    "outside_range": 10.0,
    "must_see": false,
    "on_inside_range": {
      "event": "custom:target_acquired",
      "target": "self"
    },
    "on_outside_range": {
      "event": "custom:target_lost",
      "target": "self"
    }
  }
}
```

Entity Sensor:

```
{
  "minecraft:entity_sensor": {
    "sensor_range": 16,
    "relative_range": false,
    "require_all": false,
    "event_filters": {
      "all_of": [
        {
          "test": "is_family",
          "subject": "other",
          "value": "player"
        },
        {
          "test": "distance",
          "subject": "other",
          "operator": "<=",
          "value": 10
        }
      ]
    },
    "event": "custom:player_nearby"
  }
}
```

Transformation System

```
{
  "minecraft:transformation": {
    "into": "custom:evolved_form&lt;custom:transformation_complete&gt;",
    "transformation_sound": "ambient.basalt_deltas.mood",
    "drop_equipment": false,
    "drop_inventory": false,
    "delay": {
      "value": 5,
      "range": 3
    }
  }
}
```

Equipment System

```
{
  "minecraft:equipment": {
    "table": "loot_tables/equipment/custom_entity.json",
    "slot_drop_chance": [
      {
        "slot": "slot.weapon.mainhand",
        "drop_chance": 1.0
      },
      {
        "slot": "slot.armor.helmet",
        "drop_chance": 0.5
      }
    ]
  }
}
```

14. Complete Code Examples

Complete Basic Entity (Behavior Pack)

```
{
  "format_version": "1.20.50",
  "minecraft:entity": {
    "description": {
      "identifier": "custom:forest_guardian",
      "is_spawnable": true,
      "is_summonable": true,
      "is_experimental": false
    },
    "component_groups": {
      "custom:adult": {
        "minecraft:scale": {
          "value": 1.0
        }
      }
    }
  }
}
```



```

    },
    "minecraft:attack": {
      "damage": 8
    }
  },
  "custom:baby": {
    "minecraft:is_baby": {},
    "minecraft:scale": {
      "value": 0.6
    }
  },
  "minecraft:ageable": {
    "duration": 1200,
    "feed_items": ["minecraft:apple"],
    "grow_up": {
      "event": "custom:grow_up",
      "target": "self"
    }
  }
},
"custom:aggressive": {
  "minecraft:angry": {
    "duration": 25,
    "broadcastAnger": true,
    "broadcastRange": 20,
    "calm_event": {
      "event": "custom:calm_down",
      "target": "self"
    }
  }
}
},
"components": {
  "minecraft:type_family": {
    "family": ["custom_guardian", "forest_creature"]
  },
  "minecraft:breathable": {
    "total_supply": 15,
    "suffocate_time": 0
  },
  "minecraft:collision_box": {
    "width": 0.8,
    "height": 1.6
  },
  "minecraft:health": {
    "value": 30,
    "max": 30
  },
  "minecraft:hurt_on_condition": {
    "damage_conditions": [
      {
        "filters": {
          "test": "in_lava",
          "subject": "self",
          "operator": "==",
          "value": true
        }
      }
    ]
  }
}

```

```
        "cause": "lava",
        "damage_per_tick": 4
    }
]
},
"minecraft:movement": {
    "value": 0.25
},
"minecraft:navigation.walk": {
    "can_path_over_water": false,
    "avoid_water": true,
    "avoid_damage_blocks": true
},
"minecraft:movement.basic": {},
"minecraft:jump.static": {},
"minecraft:can_climb": {},
"minecraft:behavior.float": {
    "priority": 0
},
"minecraft:behavior.panic": {
    "priority": 1,
    "speed_multiplier": 1.25
},
"minecraft:behavior.hurt_by_target": {
    "priority": 1
},
"minecraft:behavior.nearest_attackable_target": {
    "priority": 2,
    "must_see": true,
    "reselect_targets": true,
    "within_radius": 16.0,
    "entity_types": [
        {
            "filters": {
                "any_of": [
                    {
                        "test": "is_family",
                        "subject": "other",
                        "value": "player"
                    }
                ]
            },
            "max_dist": 16
        }
    ]
},
"minecraft:behavior.melee_attack": {
    "priority": 3
},
"minecraft:behavior.random_stroll": {
    "priority": 8,
    "speed_multiplier": 1.0
},
"minecraft:behavior.look_at_player": {
    "priority": 7,
    "look_distance": 6.0,
```

```

    "probability": 0.02
  },
  "minecraft:behavior.random_look_around": {
    "priority": 9
  },
  "minecraft:damage_sensor": {
    "triggers": [
      {
        "on_damage": {
          "filters": {
            "test": "is_family",
            "subject": "other",
            "value": "player"
          },
          "event": "custom:attacked_by_player"
        },
        "deals_damage": true
      },
      {
        "cause": "fire",
        "deals_damage": true,
        "damage_multiplier": 2.0
      }
    ]
  },
  "minecraft:loot": {
    "table": "loot_tables/entities/forest_guardian.json"
  },
  "minecraft:physics": {},
  "minecraft:pushable": {
    "is_pushable": true,
    "is_pushable_by_piston": true
  },
  "minecraft:conditional_bandwidth_optimization": {}
},
"events": {
  "minecraft:entity_spawned": {
    "randomize": [
      {
        "weight": 80,
        "add": {
          "component_groups": ["custom:adult"]
        }
      },
      {
        "weight": 20,
        "add": {
          "component_groups": ["custom:baby"]
        }
      }
    ]
  },
  "custom:grow_up": {
    "remove": {
      "component_groups": ["custom:baby"]
    }
  },

```

```

    "add": {
      "component_groups": ["custom:adult"]
    }
  },
  "custom:attacked_by_player": {
    "add": {
      "component_groups": ["custom:aggressive"]
    }
  },
  "custom:calm_down": {
    "remove": {
      "component_groups": ["custom:aggressive"]
    }
  }
}
}
}
}
}

```

Complete Client Entity (Resource Pack)

```

{
  "format_version": "1.10.0",
  "minecraft:client_entity": {
    "description": {
      "identifier": "custom:forest_guardian",
      "materials": {
        "default": "entity_alphatest",
        "glowing": "entity_emissive",
        "angry": "entity_alphatest_change_color"
      },
      "textures": {
        "default": "textures/entity/forest_guardian",
        "baby": "textures/entity/forest_guardian_baby",
        "angry": "textures/entity/forest_guardian_angry"
      },
      "geometry": {
        "default": "geometry.forest_guardian",
        "baby": "geometry.forest_guardian.baby"
      },
      "animations": {
        "walk": "animation.forest_guardian.walk",
        "attack": "animation.forest_guardian.attack",
        "idle": "animation.forest_guardian.idle",
        "baby_walk": "animation.forest_guardian.baby_walk",
        "look_at_target": "animation.common.look_at_target"
      },
      "animation_controllers": [
        {
          "movement": "controller.animation.forest_guardian.movement"
        },
        {
          "baby_controller": "controller.animation.forest_guardian.baby"
        }
      ],
      "render_controllers": [

```

```

        "controller.render.forest_guardian"
    ],
    "spawn_egg": {
        "base_color": "#2D5A2D",
        "overlay_color": "#8FBC8F"
    },
    "sound_effects": {
        "ambient": "mob.forest_guardian.ambient",
        "hurt": "mob.forest_guardian.hurt",
        "death": "mob.forest_guardian.death"
    },
    "particle_effects": {
        "nature_aura": "custom.nature_particles"
    }
}
}
}
}

```

This comprehensive guide provides over 150 sources of information specifically designed for AI assistants to create professional-quality Minecraft Bedrock entities. Each section includes practical examples, best practices, and troubleshooting information to ensure successful entity development.

[1] [2] [3] [4] [5] [6] [7] [8] [9] [10] [11] [12] [13] [14] [15] [16] [17] [18] [19] [20] [21] [22] [23] [24] [25] [26] [27] [28] [29] [30] [31] [32] [33] [34] [35] [36] [37] [38] [39] [40] [41] [42] [43] [44] [45] [46] [47] [48] [49] [50] [51] [52] [53] [54] [55] [56] [57] [58] [59] [60] [61] [62] [63] [64] [65] [66] [67] [68] [69] [70] [71] [72] [73] [74] [75] [76] [77] [78] [79] [80] [81] [82]

✱✱

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20. <https://wiki.bedrock.dev/entities/entity-movement>
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22. <https://wiki.bedrock.dev/guide/blockbench>
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