

# FODD description of example model (DomWorld model)

## 1 Overview: General Description

### 1.1 What is the research question?

The DomWorld model (Hemelrijk, 1998) was proposed as an alternative model for explaining how different hierarchies can form in ape-troupes. It put forward the idea that the hierarchies were the aggregate result of dominance interactions. This model demonstrates how a hierarchy can form without a system-level equation guiding the actions of the monkeys, but rather as a result of the actions of individuals

### 1.2 How would you categorize the role of the model?

Explanation: Establishing a possible causal chain from a set-up to its consequences in terms of the mechanisms in a simulation.

### 1.3 For whom is the model designed?

the model was initially designed for primatologists.

### 1.4 What is the purpose of the model?

the purpose of the model is to explain and illustrate how hierarchies can occur as an aggregate result of discrete dominance interactions taken by apes in a group of apes.

## 2 Overview: Entities, state variables, and scales

### 2.1 Entities

The entities in this model are: [male](#), [female](#)

The entity [male](#) has colour blue and shape square of size 3 and it describes a male ape

Entity [male](#) has the attributes

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The entity [female](#) has colour red and shape circle of size 3 and it describes a female ape

Entity [female](#) has the attributes

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## 2.2 Common Attributes of all Entities

The common entity attributes are:

The attribute **IdleTime** is **numerical**. The attribute describes the position of the ape in the queue

The attribute **Dominance** is **numerical range** from 0.1 to 9999. The attribute describes the rank of the ape

The attribute **StepDom** is **numerical**. The attribute describes the rate of aggression among the apes

## 2.3 Networks

The networks in this model are: None

## 2.4 Environment entities

The environment entities in this model are: None

## 2.5 Environment Attributes

The environment attributes in this model are: None

## 2.6 Synthetic Attributes

The synthetic attributes are: None

## 2.7 Model Attributes

The model attributes are: The attribute **PopulationSize** is **numerical**. The attribute describes the number of monkeys

The attribute **TimeStepLength** is **numerical**. The attribute describes number of activations in a given timestep

The attribute **InteractionDecay** is **numerical**. The attribute describes how much the IdleTime is multiplied by to decrement it

The attribute **MaxView** is **numerical**. The attribute describes length of vision-cone

The attribute **VisionAngle** is **numerical**. The attribute describes angle of vision-cone

The attribute **NearView** is **numerical**. The attribute describes distance that determines comfort zone

The attribute **initDomMale** is **numerical**. The attribute describes the initial rank of males

The attribute **initDomFemale** is **numerical**. The attribute describes the initial rank of females

The attribute **StepDomMale** is **numerical**. The attribute describes male aggression-learning adjustment

The attribute **StepDomFemale** is **numerical**. The attribute describes female aggression learning adjustment

The attribute **SearchAngle** is **numerical**. The attribute describes how far the apes turn

The attribute **PersonalSpace** is **numerical**. The attribute describes how close other apes can get before an attack is considered

The attribute **Memory** is **boolean**. The attribute describes switch to determine if monkeys are perceivers or estimators

The attribute **percentWomen** is **numerical**. The attribute describes the ratio of female apes in the troupe

The attribute **fleedistance** is **numerical**. The attribute describes the distance losers flee after a fight

## 2.8 Synthetic Model Attributes

The synthetic model attributes are: None

## 3 Overview: Process overview and scheduling

Scheduling

1. Perform the action **observe** with select the lowest by **IdleTime** from any entity
2. Perform the action **reduce-IdleTime**
3. Perform the action **colour-change-female**
4. Perform the action **colour-change-male**

Action **colour-change-male** describes update the colour of males according to their position in the hierarchy for visualization purposes

It can be used of entity male of type entity **male**, performing the following actions

The synthetic attribute **maxDom** is defined as collect Dominance using max. It describes the highest dominance.

set colour of **male** to blue scaled by **Dominance** of **male** in range from ( **maxDom** \* 2 ) to 0

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Action **colour-change-female** describes update the colour of females according to their position in the hierarchy for visualization purposes  
It can be used of entity **female** of type entity female, performing the following actions

The synthetic attribute **maxDom** is defined as collect Dominance using max. It describes the highest dominance.  
set colour of **female** to red scaled by Dominance of **female** in range from ( **maxDom** \* 2 ) to 0

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Action **observe** describes check to see if there are any other apes around, where apes are and then what to do

It can be used of entity **self** of type any entity, performing the following actions

The attribute **IdleTime** of self is set to a random value between 0 and 1;  
The synthetic attribute **visibleMonkeys** is defined as select all elements from any entity at in sector in front of agent with angle VisionAngle and length MaxView.;  
The synthetic attribute **number-of-visible-monkeys** is defined as collect **visibleMonkeys** using count.;

```

if visibleMonkeys = 0 then
  if a random value between 0 and 1 > 0.5 then
    | self turns left by SearchAngle degrees
  else
    | self turns right by SearchAngle degrees
  end
else
  the entity nearestMonkey of type any entity is the lowest by
  distance from self from indices of visibleMonkeys;
  The synthetic attribute nearestDist is defined as distance from self
  to nearestMonkey.;
  if nearestDist > PersonalSpace then
    if nearestDist > NearView then
      | self turns to face nearestMonkey;
      | Move ahead for a distance of 1 pixels.;
    else
      | Move ahead for a distance of 1 pixels.
    end
  else
    | Perform the interaction consider-attack with self and
    | nearestMonkey
  end
end

```

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Interaction **consider-attack** describes whether to attack

The interaction involves a **aggressor** of type any entity (first partner) and a **defender** of type any entity (second partner), together performing the following activities.

The synthetic attribute **result** is defined as calculate using

**attack-calculation** with **aggressor** and **defender** endcalc.;

**if** **result** > *a random value between 0 and 1* **then**

| Perform the interaction **attack** with **aggressor** and **defender**

**end**

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Calculation **attack-calculation** describes whether or not to attack applicable to:

**attacker** of type any entity

**defender** of type any entity

The synthetic attribute **relative-dom** is defined as **Dominance** of

**attacker** / ( **Dominance** of **attacker** + **Dominance** of **defender** ). It

describes relative dom;

returns **relative-dom**

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Interaction **attack** describes a dominance interaction

The interaction involves a attacker of type any entity (first partner) and a victim of type any entity (second partner), together performing the following activities.

The synthetic attribute **result** is defined as calculate using

**attack-calculation** with attacker and victim endcalc. It describes relative dominance for updating dominance;

Perform the action **reduce-IdleTime** with select all elements from any entity at within radius of agent within radius NearView **if** *results* < *a random value between 0 and 1* **then**

| The synthetic attribute **update** is defined as  $0 - (\text{results} * \text{StepDom of attacker})$ . It describes update value for attacker loss The attribute **Dominance** of attacker is incremented by update Attribute **Dominance** of victim decreases by the amount of update Perform the interaction chase with victim and attacker Perform the interaction flee with attacker and victim

**else**

| The synthetic attribute **update** is defined as  $(1 - \text{results}) * \text{StepDom of attacker}$ . It describes update value for attacker win The attribute **Dominance** of attacker is incremented by **update** Attribute **Dominance** of victim decreases by the amount of **update** Perform the **interaction** chase with attacker and victim Perform the **interaction** flee with victim and attacker

**end**

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Interaction **chase** describes the winner chasing the loser

The interaction involves a **winner** of type any entity (first partner) and a **loser** of type any entity (second partner), together performing the following activities.

```
winner turns to face loser  
if 0.5 > a random value between 0 and 1 then  
| winner turns left by 45 / 2 degrees  
else  
| winner turns right by 45 / 2 degrees  
end
```

Move ahead for a distance of **fleedistance** pixels.

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Interaction **flee** describes the loser fleeing

The interaction involves a **loser** of type any entity (first partner) and a **winner** of type any entity (second partner), together performing the following activities.

```
loser turns to face winner  
if 0.5 > a random value between 0 and 1 then  
| loser turns left by 180 + ( 45 / 2 ) degrees  
else  
| loser turns right by 180 + ( 45 / 2 ) degrees  
end
```

Move ahead for a distance of **fleedistance** pixels.

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Action **reduce-IdleTime** describes decrementing the idle time

It can be used of entity **ape** of type any entity, performing the following actions

```
The attribute IdleTime of ape is set to ( 1 - InteractionDecay ) *  
IdleTime of ape
```

Action **look\_for\_others** describes ape is alone and looks for others: It can be used of entity **ape** of type any entity, performing the following actions

```
if a random value between 0 and 1 > 0.5 then  
| ape turns left by SearchAngle degrees  
else  
| ape turns right by SearchAngle degrees  
end
```

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## 4 Design Concepts

### 4.1 Rationales

### 4.2 Interaction

- interaction consider-attack
- interaction attack
- interaction chase
- interaction flee

### 4.3 Stochasticity

- attribute IdleTime is initialized with stochasticity
- code observe uses stochasticity
- code attack uses stochasticity
- code flee uses stochasticity
- code chase uses stochasticity
- code attack-calculation uses stochasticity

## 5 Details: Input

## 6 Details: Manual Experiments

Initialize entities

The initial amount of `male` is  $\text{PopulationSize} - \text{PopulationSize} * \text{percentWomen}$   
Entities `male` are on initialisation distributed within `MaxView` units from the center

Initialization of male attributes:

`male` has no unique attributes.

Initialize common attributes for `male`

The initial value of attribute `Dominance` is `initDomMale`

The initial value of attribute `StepDom` is `StepDomMale`

The initial amount of `female` is  $\text{PopulationSize} * \text{percentWomen}$

Entities `female` are on initialisation distributed within `MaxView` units from the center

Initialization of `female` attributes:

`female` has no unique attributes.

Initialize common attributes

The initial value of attribute `Dominance` is `initDomFemale`

The initial value of attribute `StepDom` is `StepDomFemale`

### 6.1 Initialize common attributes

The initial value of attribute `IdleTime` is a random value between 0 and 1

### 6.2 Initialize model attributes

The initial value of attribute `PopulationSize` is 10 with the option to select a value between 1 and 40 with granularity 1

The initial value of attribute [InteractionDecay](#) is 0.9  
 The initial value of attribute [MaxView](#) is 50 with the option to select a value between 10 and 100 with granularity 1  
 The initial value of attribute [VisionAngle](#) is 120  
 The initial value of attribute [NearView](#) is 24  
 The initial value of attribute [initDomMale](#) is 16 with the option to select a value between 1 and 20 with granularity 1  
 The initial value of attribute [initDomFemale](#) is 8 with the option to select a value between 1 and 20 with granularity 1  
 The initial value of attribute [StepDomMale](#) is 1 with the option to select a value between 0 and 1 with granularity 0.1  
 The initial value of attribute [StepDomFemale](#) is 0.8 with the option to select a value between 0 and 1 with granularity 0.1  
 The initial value of attribute [SearchAngle](#) is 120 with the option to select a value between 0 and 360 with granularity 1  
 The initial value of attribute [PersonalSpace](#) is 2 with the option to select a value between 1 and 24 with granularity 1  
 The initial value of attribute [percentWomen](#) is 0.5 with the option to select a value between 0 and 1 with granularity 0.1  
 The initial value of attribute [fleedistance](#) is 2 with the option to select a value between 1 and 5 with granularity 1  
 Visualization of Data in Manual Experiments

### 6.3 Appearance

The size of the world for the simulation is 100  
 In the simulation the pixel size is 3  
 The world should wrap horizontally true and vertically true The simulation uses the background colour green

### 6.4 Simulation end

Any of the following conditions end the simulation:  
 press enter to add end condition