

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

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

Entity [female](#) has the attributes

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

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

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

```

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

```

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**

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

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 $0.5 \neq \text{a random value between 0 and 1}$ **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.

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 $0.5 > \text{a random value between } 0 \text{ and } 1$ **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.

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 $(1 - \text{InteractionDecay}) *$

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 $\text{a random value between } 0 \text{ and } 1 \hat{>} 0.5$ **then**

| **ape** turns left by **SearchAngle** degrees

else

| **ape** turns right by **SearchAngle** degrees

end

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