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 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 - (results * 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 - results) * 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 > 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 > 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.

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

---

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 PopulationSize - PopulationSize * 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 PopulationSize * 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