Artificial intelligence - Project 2
- Propositional Logic and FOL -

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1 Introducere

1.1 Aspecte generale

Pentru realizarea celor 5 puzzle-uri s-a folosit logica propozitionala a predicatelor. S-a folosit FOL (first-order logic) ceea ce presupune ca lumea contine obiecte, relatii intre obiecte (unare si n-are), precum si functii ce vor furniza o singura valoare pentru un anumit "input". Propozitiile atomice vor fi alcatuite dintr-un predicat (predicate(termen1, termen2, ...,termenn) sau termen1= termen2. Prin termne intelegandu-se expresie logica ce refera un obiect cu nume sau fara.
Propozitiile complexe vor fi formate din propozitii atomice si conectori.
S, -S, S1 & S2, S1 -> S2, S1 | S2, S1 <-> S2.

Tabel de adevar pentru logica propozitionala.

A	B	$\neg A$	$A \wedge B$	$A \vee B$	$A \veebar B$	$A \mid B$	$A \rightarrow B$	$A \leftrightarrow B$
T	T	F	T	T	F	F	T	T
T	F	F	F	T	T	T	F	F
F	T	T	F	T	T	T	T	F
F	F	T	F	F	F	T	T	T

Table 1: Sample truth table

2 Puzzle 1: Find the family

2.1 Enuntul problemei

Three men named **Barber, Cutler, and Drake** have wives named **Beth, Dorothy, and Louise**. Each couple has a son,the names of the boys being **Allan, Henry and Victor**.

- Drake is neither Louise's husband nor Henry's father.
- Beth is neither Cutler's wife nor Allan's mother.
- If Allan's father is either Cutler or Drake, then Louise is Victor's mother.
- If Louise is Cutler's wife, Dorothy is not Allan's mother.

Sa se dtermine: What is the name of each man's wife and son?

2.2 Code implementation

In continuare se regaseste implemetarea pentru mace4 a logicii acestei problemei. Mace4 va genera un model pentru aceasta problema, din care se poate determina familililе.

Code:

```
1  set(arithmetic).
2  formulas(assumptions).
3      Barber=0   &          Cutler=1    &  Drake=2.   %pentru elimiarea izomorfismului
4      Beth=0     &          Dorothy=1   &  Louise=2.
5      Allan=0    &          Henry=1     &  Victor=2.
6
7      %pentru a realiza legatura intre copii
8      all x Wife(Father(x)) = Mother(x).
9      (Wife(x) = Wife(y)) -> x=y.
10     %copii diferiti
11     (Mother(x) = Mother(y)) -> x=y.
12     (Father(x) = Father(y))-> x=y.
13
14     %indiciile din enunt
15     Wife(Drake)!=Louise   &    Father(Henry)!=Drake.
16     Wife(Cutler)!=Beth    &    Mother(Allan)!=Beth.
17     (Father(Allan) =Cutler | Father(Allan) =Drake) -> Mother(Victor) = Louise.
18     Wife(Cutler)=Louise -> Mother(Allan)!=Dorothy.
19 end_of_list.
```

Listing 1: Solution for the A* algorithm.

Explanation:

- prin **set(arithmetic)** se vor putea folosi operatori aritmetici
- se va defini un domeniu de marime 3 (3 barbati, 3 femei si 3 copii). Pentru eliminarea izomorfismului s-au asignat valori persoanelor la liniile 3-5
- la linia 4, se va defini copilul unic pe care il vor avea cei doi parinti. Astfel, pentru orice x, sotia tatalui unui copil este mama copilului respectiv
- la linia 9 se rezolva cazul in care exista o singura sotie a unui barbat
- la liniile 11-12: se defineste faptul ca o mama are un singur copil, la un fel si un tata.
- de la linia 15 vor translatate in cod indiciile oferite din enunt

Commands:

- mace4 -c -n 3 -m -1 -f family.in
- mace4 -c -n 3 -m -1 -f family.in | interpformat tex > family.out

2.3 Results

S-a generat un fisier cu codul Tex pentru interpretare rezultattului generat de Mace4

Allan: 0 Barber: 0 Beth: 0 Cutler: 1 Dorothy: 1 Drake: 2 Henry: 1 Louise: 2
Victor: 2

Father:	0	1	2
	0	1	2

Mother:	0	1	2
	2	1	0

Wife:	0	1	2
	2	1	0

Table 1: Rezultate Mace4 problema familiei

Explanation:

- Mace4 va construi doar un model posibil pentru problema data
- Interpretarea tabelelor generate este urmatoarea:
- Father: tatal copilului 0 (Allan) este Barber(0). Tatal copilului 1 (Henry) este Cutler (1), iar tatal copilului 2 (Victor) este Drake(2).
- Wife: sotia lui Barber (0) este Louise (2). Sotia lui Cutler(1) este Dorothy(1), iar sotia lui Drake(2) este Beth(0). Prin tabelul Mother se poate realiza si o verificare suplimentara a rezultatelor.
- Familiile: Louise and Allan Barber, Dorothy and Henry Cutler, Beth and Victor Drake

3 Puzzle 2: Blues Band Zebra Puzzle

Sursa https://www.brainzilla.com/logic/zebra/blues-band/

3.1 Enuntul problemei

Five musicians are side by side talking about starting a blues band. Each one plays an instrument, is drinking a type of juice and suggested a name for the band. Follow the clues to find out which band name the 32-year-old musician suggested.

- The Harmonica player is exactly to the left of the Guitarist.
- The man wearing the Blue shirt is somewhere between the oldest musician and the man wearing the Red shirt, in that order.
- Larry is at one of the ends.
- The musician that plays Harmonica is next to the man that is drinking Apple juice.
- At the second position is the man drinking Strawberry juice.
- The Drummer is somewhere to the right of the man wearing the Blue shirt.
- Larry is next to the musician that suggested the band name Lazy Blues.
- Bryan is next to the Pianist.
- At one of the ends is the youngest musician.
- The Pianist suggested the band name Apocalypse Blues.

- The 28-year-old man is exactly to the left of the 30-year-old man.
- The musician wearing the Green shirt is somewhere to the left of the musician that suggested the band name Bear Blues.
- Joey is next to the man wearing the Blue shirt.
- The musician drinking Grapefruit is exactly to the right of the musician that suggested the band name The Blues Cathedral.
- The man drinking Grapefruit is wearing the Green shirt.
- The man drinking Lemon juice is somewhere between the man wearing the White shirt and the 30-year-old man, in that order.
- The musician that suggested the band name Blues Up is exactly to the right of the man wearing the Red shirt.
- At the first position is the Piano player.
- Dustin is next to the musician that suggested the band name The Blues Cathedral.
- The Harmonica player is exactly to the right of the man wearing the Red shirt.

Code:

```
set(arithmetic).        % Pentru relatia "right neighbor" si "left neighbor".
assign(domain_size, 5).  %Cei 5 muzicieni {0,1,2,3,4}.

list(distinct).      % Definirea obiectelor distincte.
  [Bryan, Dustin, Eibert, Joey, Larry].                                    %name
  [BalckShirt, BlueShirt, GreenShirt, RedShirt, WhiteShirt].               %color of shirt
  [Age_26, Age_28, Age_30, Age_32, Age_34 ].                               %ages
  [Bass, Drums, Guitar, Harmonica, Piano].                                 %instruments
  [ApocalypseBlues, BearBlues, BluesUp, LazyBlues, TheBluesCathedral].     %genre
  [Apple, GrapeFruit, Lemon, Orange, StrawBerry].                          %juice

end_of_list.

formulas(assumptions).
   % Definitions of "right_neighbor" and "left_neighbor"
   right_neighbor(x,y) <-> x = y+1.
   left_neighbor(x, y) <-> x+1= y.
   neighbor(x,y) <-> right_neighbor(x,y) | left_neighbor(x,y).

    %Indiciile
    left_neighbor(Harmonica, Guitar).
    BlueShirt > Age_34 & BlueShirt < RedShirt.
    Larry = 0 | Larry = 4.
    neighbor(Harmonica, Apple).
    StrawBerry = 1.
    Drums > BlueShirt.
    neighbor(Larry, LazyBlues).
    neighbor(Bryan, Piano).
    Age_26 = 0 | Age_26 = 4.
    Piano = ApocalypseBlues.
    left_neighbor(Age_28, Age_30).
    GreenShirt < BearBlues.
    neighbor(Joey, BlueShirt).
    right_neighbor(GrapeFruit, TheBluesCathedral).
    GrapeFruit = GreenShirt.
```

```
36      Lemon > WhiteShirt & Lemon < Age_30.
37      right_neighbor(BluesUp, RedShirt).
38      Piano = 0.
39      neighbor(Dustin, TheBluesCathedral).
40      right_neighbor(Harmonica, RedShirt).
41
42  end_of_list.
```

Explanation:

- acest puzzle este asemanator cu cel facut la laborator, fiind de tipul Einstein's riddle
- la linia 1 se seteaza operatorii aritmetici prin intermediul carora se va putea descrie mai usor relatiile dintre obiecte, Mace4 putand interpreta acesti opertori
- dimensiunea domeniului este de 5, deoarece avem 5 muzicieni. Fiecare muzician are un set de caracteristici: nume, varsta, instrument, nume propus pentru trupa, bautara preferata si culoarea pe care o poarta la camasa. Caracteristicile sunt specifice fiecarui muzician, deci nu exista 2 muzicieni cu aceeasi caracteristica.
- O alta informatie importanta este aceea ca muzicienii sunt aliniati unul langa altul, de aceea se poate defini o relatie de vecinatate intre acestia (vecin drept si vecin stanga).
- intre liniile 5-10 se vor defini obiectele distincte ale problemei
- la linia 16 se va defini relatia de vecin drept, astfel din predicatul: **right_neighbor(x,y)**se va intelege faptul ca x va fi vecinul din dreapta al lui y
- la linia 17 se va defini relatia de vecin drept, astfel din predicatul: **left_neighbor(x,y)**se va intelege faptul ca x va fi vecinul din stanga al lui y
- relatia de vecinatate va fi data de una existenta uneia dintre cele doua relatii mentionate mai sus. De altfel, se foloseste dubla implicatie deoarece pentru definirea acestei relatii.
- de la linia 21 vor fi transcrise indiciile
- pentru a arata ca Laryy se afla la unul dintre capete => Larry va fi asociat primului muzician (0) sau poate fi asociat ultimului muzician(4) - linia 23.
- relatia de vecinatate se poate observa prin folosirea predicatului **neighbor(Larry, LazyBlues)**.
- relatia de egalitate se poate observa la linia 30
- la linia 32 este descris faptul ca muzicianul cu camasa verde se afla undeva la stanga celui care a propus numele trupei BearBlues

Commands:

- mace4 -c -n 5 -m -1 -f bands.in | interpformat tex > bands.out
- mace4 -c -n 5 -m -1 -f bands.in
- mace4 -c -n 5 -m -1 -f bands.in > bands.out

3.2 Results Mace4

Age_34: 0 Age_32: 1 Age_28: 2 Age_30: 3 Age_26: 4

Larry: 0 Bryan: 1 Joey: 2 Dustin: 3 Eibert: 4

ApocalypseBlues: 0 LazyBlues: 1 TheBluesCathedral: 2 BluesUp: 3 BearBlues: 4

Piano: 0 Bass: 1 Drums: 2 Harmonica: 3 Guitar: 4

WhiteShirt: 0 BlueShirt: 1 RedShirt: 2 GreenShirt: 3 BalckShirt: 4

Orange: 0 StrawBerry: 1 Lemon: 2 GrapeFruit: 3 Apple: 4

left_neighbor:	0	1	2	3	4
0	0	1	0	0	0
1	0	0	1	0	0
2	0	0	0	1	0
3	0	0	0	0	1
4	0	0	0	0	0

neighbor:	0	1	2	3	4
0	0	1	0	0	0
1	1	0	1	0	0
2	0	1	0	1	0
3	0	0	1	0	1
4	0	0	0	1	0

right_neighbor:	0	1	2	3	4
0	0	0	0	0	0
1	1	0	0	0	0
2	0	1	0	0	0
3	0	0	1	0	0
4	0	0	0	1	0

Table 2: Rezultate generate de Mace4 pentru problema muzicienilor

Explanation:

- Mace4 va genera un singur model

4 Puzzle 3: The Brothers Four

Sursa Muriel Mandel, *Fantasy Book of Logic Puzzles*

4.1 Enuntul problemei

Angered at his failure to trick Abou, the merchant, the genie transformed him and his three brothers into animals. He turned one into a pig, one into donkey, one into a camel, and one into a goat.

- Ahmed didn't become a pig, and he wasn't a goat.
- Sharif wasn't a camel, and he wasn't a pig.
- If Ahmed was not a camel, Omar was not a pig.
- Abou didn't become a goat, and he was not a pig.
- Omar was not a goat nor was he a camel.

Sa se determine: What did each of the brothers become?

4.1.1 Code implementation

Code:

```
%Angered at his failure to trick Abou, the merchant,
%the genie transformed him and his three brothers into
%animals. He turned one into a pig, one into a donkey,
%one into a camel, and one into a goat.
%1. Ahmed didn't become a pig, and he wasn't a goat.
%2. Sharif wasn't a camel, and he wasn't a pig.
%3. If Ahmed was not a camel, Omar was not a pig.
%4. Abou didn't become a goat, and he was not a pig.
%5. Omar was not a goat nor was he a camel.
%What did each of the brothers become?

set(arithmetic).  % Pentru folosirea operatorilor aritmetici
assign(domain_size, 4).  % Dimensiunea domeniului este 4; 4 frati sunt transformati in animale

formulas(assumptions).
   %apartenenta la un sigur tip de animal
   Pig(x)    -> -Donkey(x) & -Camel(x) & -Goat(x).
   Donkey(x) -> -Pig(x) & -Camel(x) & -Goat(x).
   Camel(x)  -> -Pig(x) & -Donkey(x) & -Goat(x).
   Goat(x)   -> -Pig(x) & -Donkey(x) & -Camel(x).

   %definirea existentei celor 4 animale si unicitatea acestora
   (exists x Pig(x) ) &  (exists x Donkey(x) ) & (exists x Camel(x) ) & (exists x Goat(x) ).
   Pig(x) & Pig(y)       -> x=y.
   Donkey(x) & Donkey(y) -> x=y.
   Camel(x) & Camel(y)   -> x=y.
   Goat(x) & Goat(y)     -> x=y.

   Abou=0. Ahmed=1. Omar=2. Sharif=3.     %evitare izomorfism
   %indicii
   -Pig(Ahmed).
   -Camel(Sharif) & -Pig(Sharif).
   -Camel(Ahmed) -> -Pig(Omar).
   -Goat(Abou) & -Pig(Abou).
   -Goat(Omar) & -Camel(Omar).
end_of_list.
```

Explanation:

- si in cazul acestei probleme ne folosim de operatorii logici
- dimensiunea domeniului este 4, deoarece sunt doar 4 frati care vor fi transformati in animale
- la liniile 17-20 se va implementa logica prin care un frate va putea fi doar un singur animal din cele 4
- la linia 23 se defineste faptul ca trebuie sa existe cel putin un animal din fiecare
- la liniile 23-27 se va defini unicitatea celor 4 animale.
- la lina 29 se vor asigna valori celor 4 obiecte astfel incat se va elimina izomorfismul
- 30-35: vor fi transcrise indiciile in FOL.

Commands:

- mace4 -c -n 4 -m -1 -f 03_animals.in > animals.out
- mace4 -c -n 4 -m -1 -f 03_animals.in | interpformat tex > animals.out

4.2 Results:

Mace4 va genera un simgur model pentru problema de dimensiune 4.

Abou: 0 Ahmed: 1 Omar: 2 Sharif: 3 c1: 2 c2: 0 c3: 1 c4: 3

Camel:	0	1	2	3
	0	1	0	0

Donkey:	0	1	2	3
	1	0	0	0

Goat:	0	1	2	3
	0	0	0	1

Pig:	0	1	2	3
	0	0	1	0

Table 3: Rezultatele obtinute cu Mace4 pentru problema celor 4 frati

Explanation:

- la o prima analiza a indiciilor disponibile, observam ca singurul care poate fi pig este Omar, iat Goat este Sharif.

	Name	Pig	Donkey	Camel	Goat
	Ahmed	NU	-	-	NU
•	Sharif	NU	NU	NU	Y
	Abou	NU	-	-	NU
	Omar	Y	-	NU	NU

- Daca Omar este porc, atunci in indiciul 3 apare o contradictie ceea ce va duce la faptul ca Ahmed e Camel

	Name	Pig	Donkey	Camel	Goat
	Ahmed	NU	NU	Y	NU
•	Sharif	NU	NU	NU	Y
	Abou	NU	-	NU	NU
	Omar	Y	NU	NU	NU

- ramane faptul ca Abou este Donkey

5 Puzzle 4: The Search for Doman

Sursa Muriel Mandel, *Fantasy Book of Logic Puzzles*

5.1 Enuntul problemei

This was astronaut Jose Perez's fourth visit to Mars and he had learned to speak Martian. He wanted to find his Martian friend Doman, but in order to locate him he had to know what group Doman belonged to. The three groups in the area were: Uti, Yomi, and Grundi.
The Uti always told the truth.
The Yomi always lied.
The Grundi sometimes told the truth but sometimes lied.
Perez needed information. Three Martians, Aken, Bal and Cwos, each of whom belonged to a different group, agreed to help him. He asked each one of them two questions: What group do you belong to? What group does Doman belong to?

- 1. Aken said:
  I am not a Uti.
  Doman is a Yomi.
- 2. Bal said:
  I am not a Yomi.
  Doman is a Grundi.
- 3. Cwos said:
  I am not a Grundi.
  Doman is a Uti.

Sa se determine: What group does Doman belong to?

5.1.1 Code implementation

Code:

```
set(arithmetic).  %Pentru simplificare relatii

list(distinct).      % Objects in each list are distinct.
    [Aken, Bal, Cwos, Doman].
end_of_list.

formulas(assumptions).
   Aken=0. Bal=1. Cwos=2. Doman=3.
   Uti(x)    -> -Yomi(x) & -Grundi(x).
   Yomi(x)   -> -Uti(x)  & -Grundi(x).
   Grundi(x) -> -Uti(x)  & -Yomi(x).

   Uti(Aken) | Yomi(Aken) | Grundi(Aken).
   Uti(Bal) | Yomi(Bal) | Grundi(Bal).
   Uti(Cwos) | Yomi(Cwos) | Grundi(Cwos).

   Uti(Aken) -> -Uti(Bal) & -Uti(Cwos).
   Uti(Bal)  -> -Uti(Aken) & -Uti(Cwos).
   Uti(Cwos) -> -Uti(Bal) & -Uti(Aken).

   Yomi(Aken) -> -Yomi(Bal)  & -Yomi(Cwos).
   Yomi(Bal)  -> -Yomi(Aken) & -Yomi(Cwos).
   Yomi(Cwos) -> -Yomi(Bal)  & -Yomi(Aken).

   Grundi(Aken) ->  -Grundi(Bal)  & -Grundi(Cwos).
   Grundi(Bal)  ->  -Grundi(Aken) & -Grundi(Cwos).
   Grundi(Cwos) ->  -Grundi(Bal)  & -Grundi(Aken).

   Uti(Aken)  -> -Uti(Aken) & Yomi(Doman).
   Yomi(Aken) -> Uti(Aken) & -Yomi(Doman).

   Uti(Bal) -> -Yomi(Bal) & Grundi(Doman).
   Yomi(Bal) -> Yomi(Bal) & -Grundi(Doman).

   Uti(Cwos) -> -Grundi(Cwos) & Uti(Doman).
   Yomi(Cwos) -> Grundi(Cwos) & -Uti(Doman).

end_of_list.
```

Explanation:

- la linia 4 se declara obiectele distincte, numele celor 4 martieni
- la linia 8 li se vor asigna valori celor 4 obiecte cu scopul de a elimina izomorfismul
- liniile 9-10: se va defini faptul ca daca un martian apartine unui trib el nu mai poate apartine si celorlalte triburi, apartenenta la un singur grup.
- liniile 13-15: Se va speifica faptul ca fiecare martian poate apartine unui grup
- liniile 17 -27 : se va defini faptul ca daca unul dintre martienii intrebati apartine unui trib, ceilalti doi martieni nu mai pot face parte din acelasi trib. Exceptia o va face Doman, care poate fi in acelasi trib cu unul dintre martienii intrebati

- de la linia 29 vor fi transcrise indiciile sub forma unor supozitii : daca X e din tribul Uti atunci ceea ce spune adevarat, iar daca X e in tribul Yomi atunci el minte in ambele raspunsuri date.

Commands:

- mace4 -c -n 4 -m -1 -f 04_martians.in
- mace4 -c -n 4 -m -1 -f 04_martians.in > martians.out
- mace4 -c -n 4 -m -1 -f 04_martians.in | interpformat tex> martians.out

5.2 Results

Mace4 va returna un singur model pentru aceasta problema.

Aken: 0 Bal: 1

Grundi:	0	1	2	3
	1	0	0	0

Cwos: 2 Doman: 3

Uti:	0	1	2	3
	0	0	1	1

Yomi:	0	1	2	3
	0	1	0	0

Table 4: Rezultate obtinute pentru problema gasirii martianului Doman

Explanation:

- Obtinem ca Doman face parte din tribul Uti
- Aken nu poate fi Uti deoarece s-ar contrazice in momentu in care zice ca el nu e Uti. Daca este Yomi, atunci el ar zice adevarul in momentul in care afirma faptul ca nu e Uti. Astfel, el ramane a fiind Grundi, deoarece cateodata spune adevarul, cateodata nu.
- Despre Bal initial nu se poate deduce nimic din vorbele sale, pentru ca daca ar fi Uti, ar zice adevarul despre faptul ca nu e Yomi, iar daca ar fi Yomi ar minti prin faptul ca zice ca nu e Yomi.
- Cwos afirma faptul ca el nu e Grundi si are dreptate pentru ca Grundi e Aken. Astfel el poate sa fie numai Uti si astfel zice adevarul despre faptul ca Doman este Uti.
- Daca Doman este Uti, atunci se poate demonstra simplu ca Bal este Yomi, el mintind in ambele cazuri.

6 Puzzle 5: Family activities

Sursa https://edcraft.io/blog/all-articles/5-zebra-puzzles-for-kids

6.1 Enuntul problemei

Once Donald Smith came to visit his schoolmate Bill Simpson to do their homework together and learn William Shakespeare's sonnets. When he entered Simpsons' apartment, he could see five pairs of shoes: sandals, office shoes, lace-up boots, and two pairs of sneakers.
Try to guess which room each of the Simpsons' family members (Bill, Mummy, Daddy, Granny, and Bill's sister Melanie) is in, what they do, and what kind of shoes each of them was wearing outdoors before coming home.

These statements can help you.

- Daddy is in the kitchen alone.
- Melanie is preparing for her philosophy college exam.

- Granny prefers to wear open-toe shoes.
- A person preparing dinner is also watching the news on TV.
- There are several things being read by the Simpsons' at the moment: a philosophy textbook, a newspaper, and a book of Shakespeare's sonnets.
- There is no one in the bedroom.
- Daddy has just returned home from work. He is a civil servant and wears business-style clothes and shoes.
- Mummy is looking after flowers.
- There are three people in the living room.
- Bill has brought a book to the children's room.
- Mummy and Melanie came after jogging an hour ago.

6.1.1 Code implementation

Code:

```
formulas(assumptions).
    % sunt diferiti
    differentFrom(Daddy, Mummy).
    differentFrom(Daddy, Granny).
    differentFrom(Daddy, Melanie).
    differentFrom(Daddy, Bill).
    differentFrom(Mummy, Granny).
    differentFrom(Mummy, Melanie).
    differentFrom(Mummy, Bill).
    differentFrom(Granny, Melanie).
    differentFrom(Granny, Bill).
    differentFrom(Melanie, Bill).

    % simetria intre diferente
    differentFrom(x, y) -> differentFrom(y,x).

    %fiecare persoana este intr-o camera, a purtat o pereche de papuci si face ceva diferit
    %papuci
    sandels(x) | officeShoes(x) | laceBoots(x) | sneakers1(x) | sneakers2(x).
    %rooms
    kitchen(x) | livingRoom(x) | childrenRoom(x) | bedroom(x).
    %activities
    preparingDinner(x) | lookingAfterFlowers(x) | readingNewsPaper(x) | readingPhilosophyText(x) | readi


    %proprietati care se aplica numai unei persoane
    %incaltaminte; o persoana a purtat doar una din perechile de papuci
    sandels(x) & sandels(y) -> -differentFrom(x,y).
    officeShoes(x) & officeShoes(y) -> -differentFrom(x,y).
    laceBoots(x) & laceBoots(y) -> -differentFrom(x,y).
    sneakers1(x) & sneakers1(y) -> -differentFrom(x,y).
    sneakers2(x) & sneakers2(y) -> -differentFrom(x,y).
    %activities; Persoanele din famile au activitati diferite
    lookingAfterFlowers(x) & lookingAfterFlowers(y) -> -differentFrom(x,y).
    readingNewsPaper(x) & readingNewsPaper(y) -> -differentFrom(x,y).
    readingPhilosophyText(x) & readingPhilosophyText(y) -> -differentFrom(x,y).
```

```
37      readingSonnets(x) & readingSonnets(y) -> -differentFrom(x,y).
38      preparingDinner(x) & preparingDinner(y) -> -differentFrom(x,y).
39      watchingTV(x) & watchingTV(y) -> -differentFrom(x,y).
40
41      % O persoana poate sa se afle intr-o singura incapere la un moment dat
42      kitchen(x) -> -livingRoom(x).
43      kitchen(x) -> -childrenRoom(x).
44      kitchen(x) -> -bedroom(x).
45
46      livingRoom(x) -> -childrenRoom(x).
47      livingRoom(x) -> -bedroom(x).
48
49      childrenRoom(x) -> -bedroom(x).
50
51
52      %indicii initiale
53      readingSonnets(Bill).
54
55      %indicii
56      %1
57      kitchen(Daddy).
58      %2
59      preparesPhilosophyExam(x) -> readingPhilosophyText(x).
60      preparesPhilosophyExam(Melanie).
61      %3
62      openShoes(x) -> sandels(x).
63      openShoes(Granny).
64      %4
65      preparingDinner(x) <->  watchingTV(x).
66      preparingDinner(x) <-> kitchen(x).
67      %5
68      -bedroom(x).
69      %6
70      bussinessStyle(x) -> officeShoes(x).
71      bussinessStyle(Daddy).
72      %7
73      lookingAfterFlowers(Mummy).
74      %8 sunt trei persoane in livingRoom
75      livingRoom(Daddy) & livingRoom(Mummy) & livingRoom(Granny) |
76      livingRoom(Daddy) & livingRoom(Mummy) & livingRoom(Melanie) |
77      livingRoom(Daddy) & livingRoom(Mummy) & livingRoom(Bill) |
78      livingRoom(Daddy) & livingRoom(Granny) & livingRoom(Melanie)  |
79      livingRoom(Daddy) & livingRoom(Granny) & livingRoom(Bill) |
80      livingRoom(Daddy) & livingRoom(Melanie) & livingRoom(Bill) |
81      livingRoom(Mummy) & livingRoom(Granny) & livingRoom(Melanie)  |
82      livingRoom(Mummy) & livingRoom(Granny) & livingRoom(Bill) |
83      livingRoom(Mummy) & livingRoom(Bill) & livingRoom(Melanie) |
84      livingRoom(Granny) & livingRoom(Melanie) & livingRoom(Bill).
85
86      %8
87      childrenRoom(Bill).
88      %9
89      jogging(x) -> sneakers1(x) | sneakers2(x).
90      jogging(Mummy).
```

```
91      jogging(Melanie).
92
93  end_of_list.
94
95
96  formulas(goals).
97      watchingTV(Daddy).
98  end_of_list.
```

Explanation:

- liniile 3-12: se specifica faptul ca obiectele (persoanele din familie) sund diferite intre ele
- linia 15: va rezolva simetria realtiei de differenta intre obiecte, cu ajutorul predicatelor
- liniile 29-39: se vor defini prin logica predicatelor activitatile unice pentru fiecare membru al familiei; de asemenea fiecare persoana din familie a purtat incaltaminte diferita
- de la linia 57 sun trasnpuse indiciile; se observa ca anumite activitati din inidcii implica o anumita actiune specifica- > de exemplu pregatirea pentru examen implica citirea unor texte de psihologie
- activitatea de jogging facuta de cele 2 femei implica faptul ca au purtat sneakers
- s-au luat toate cazurile posibile pentru cele 3 persoane care pot sta in living room

Commands:

- prover9 -f 05_activities.in
- mace4 -c -n 5 -m -1 -f 05_activities.in | interpformat tex > activities.out
-

7 Results

Mace4 va genera 2 modele posibile din cauza celor perechi de sneakers.

Person	Daddy	Mummy	Granny	Melanie	Bill
Shoes	Office shoes	Sneakers	Sandals	Sneakers	Lace-up boots
Doings	Preparing dinner and watching news on TV	Looking after flowers	Reading a newspaper	Reading a philosophy textbook	Reading Shakespeare's sonnets
Rooms	Kitchen	Living room	Living room	Living room	Children's room

Figure 1: Rezultatele obtinute prin Mace4

Bill: 0 Daddy: 1 Granny: 2 Melanie: 3 Mummy: 4

bedroom:	0	1	2	3	4
	0	0	0	0	0

bussinessStyle:	0	1	2	3	4
	0	1	0	0	0

childrenRoom:	0	1	2	3	4
	1	0	0	0	0

jogging:	0	1	2	3	4
	0	0	0	1	1

kitchen:	0	1	2	3	4
	0	1	0	0	0

laceBoots:	0	1	2	3	4
	1	0	0	0	0

livingRoom:	0	1	2	3	4
	0	0	1	1	1

lookingAfterFlowers:	0	1	2	3	4
	0	0	0	0	1

officeShoes:	0	1	2	3	4
	0	1	0	0	0

openShoes:	0	1	2	3	4
	0	0	1	0	0

preparesPhilosophyExam:	0	1	2	3	4
	0	0	0	1	0

preparingDinner:	0	1	2	3	4
	0	1	0	0	0

readingNewsPaper:	0	1	2	3	4
	0	0	1	0	0

readingPhilosophyText:	0	1	2	3	4
	0	0	0	1	0

readingSonnets:	0	1	2	3	4
	1	0	0	0	0

sandels:	0	1	2	3	4
	0	0	1	0	0

sneakers1:	0	1	2	3	4
	0	0	0	0	1

sneakers2:	0	1	2	3	4
	0	0	0	1	0

watchingTV:	0	1	2	3	4
	0	1	0	0	0

differentFrom:	0	1	2	3	4
0	0	1	1	1	1
1	1	0	1	1	1
2	1	1	0	1	1
3	1	1	1	0	1
4	1	1	1	1	0

Table 5: Primul model generata de Mace4

Bill: 0 Daddy: 1 Granny: 2 Melanie: 3 Mummy: 4

bedroom:	0	1	2	3	4
	0	0	0	0	0

bussinessStyle:	0	1	2	3	4
	0	1	0	0	0

childrenRoom:	0	1	2	3	4
	1	0	0	0	0

jogging:	0	1	2	3	4
	0	0	0	1	1

kitchen:	0	1	2	3	4
	0	1	0	0	0

laceBoots:	0	1	2	3	4
	1	0	0	0	0

livingRoom:	0	1	2	3	4
	0	0	1	1	1

lookingAfterFlowers:	0	1	2	3	4
	0	0	0	0	1

officeShoes:	0	1	2	3	4
	0	1	0	0	0

openShoes:	0	1	2	3	4
	0	0	1	0	0

preparesPhilosophyExam:	0	1	2	3	4
	0	0	0	1	0

preparingDinner:	0	1	2	3	4
	0	1	0	0	0

readingNewsPaper:	0	1	2	3	4
	0	0	1	0	0

readingPhilosophyText:	0	1	2	3	4
	0	0	0	1	0

readingSonnets:	0	1	2	3	4
	1	0	0	0	0

sandels:	0	1	2	3	4
	0	0	1	0	0

sneakers1:	0	1	2	3	4
	0	0	0	1	0

sneakers2:	0	1	2	3	4
	0	0	0	0	1

watchingTV:	0	1	2	3	4
	0	1	0	0	0

differentFrom:	0	1	2	3	4
0	0	1	1	1	1
1	1	0	1	1	1
2	1	1	0	1	1
3	1	1	1	0	1
4	1	1	1	1	0

Table 6: Al doilea model generat de Mace4

7.1 References

R. Stuart, N. Peter, Artificial Intelligence: A Modern Approach, 4th US ed., capitol 3, [online]
Curs Inteligenta Artficiala, Universitatea Tehnica din Cluj Napoca, furnizat: moodle.cs.utcluj.ro