Practical 1

Expressing relations as ordered pairs and creating relations.

1

```
→ kill(all);
(%o0) done

→ A:setify(makelist(i, i, 1, 3));
  B:setify(makelist(i, i, 1, 3));
(%o1) {1,2,3}
(%o2) {1,2,3}

→ R:cartesian_product(A, B);
(%o3) {[1,1],[1,2],[1,3],[2,1],[2,2],[2,3],[3,1],[3,2],
  [3,3]}

→ A1:makelist(i, i, 1, 3);
  B1:makelist(i, i, 1, 3);
(%o4) [1,2,3]
(%o5) [1,2,3]

→ R1:cartesian_product_list(A1, B1);
(%o6) [[1,1],[1,2],[1,3],[2,1],[2,2],[2,3],[3,1],[3,2],[
  3,3]]
```

2

Figure 1: ex 4 : Rosen

> Let A be the set $\{1, 2, 3, 4\}$. Which ordered pairs are in the relation $R = \{(a, b) \mid a \text{ divides } b\}$?

```
→ kill(all);
(%o0) done

→ A:makelist(k, k, 1, 4);
(%o1) [1,2,3,4]

→ length(A);
(%o2) 4

→ remainder(4, 2);
(%o3) 0
```

```
→ remainder(5, 2);
(%o4) 1

→ A2:cartesian_product_list(A, A);
(%o5) [[1,1],[1,2],[1,3],[1,4],[2,1],[2,2],[2,3],[2,4],[
3,1],[3,2],[3,3],[3,4],[4,1],[4,2],[4,3],[4,4]]

→ R:[];

(%o6) []

→ for i:1 thru length(A2) do(
    t:A2[i],
    if(remainder(t[1], t[2])=0) then R:cons(t, R)
  );
(%o7) done

→ R;
(%o8) [[4,4],[4,2],[4,1],[3,3],[3,1],[2,2],[2,1],[1,1]]
```

3

Figure 2:

Let A be the set $\{1, 2, 3, 4\}$. Which ordered pairs are in the relation $R = \{(a, b) \mid a \text{ divides } b\}$?

```
→ kill(all);
(%o0) done

→ findRelation(A):=block(
    [A2:cartesian_product_list(A, A), R:[]],
    for i:1 thru length(A2) do(
    t:A2[i],
    if(remainder(t[2], t[1])=0) then R:cons(t, R)
    ),
    R
  );
(%o1) findRelation(A):=block([A2:cartesian_product_list(A,A),
  R:[]],for i thru length(A2) do
  (t:A2_i,if remainder(t_2,t_1)=0 then R:cons(t,R) ),R)

→ findRelation([1, 2]);
(%o2) [[2,2],[1,2],[1,1]]
```

```
(%i3) findRelation([1, 2, 3]);
(%o3) [[3,3],[2,2],[1,3],[1,2],[1,1]]

(%i4) findRelation([1, 2, 3, 4]);
(%o4) [[4,4],[3,3],[2,4],[2,2],[1,4],[1,3],[1,2],[1,1]]
```

4

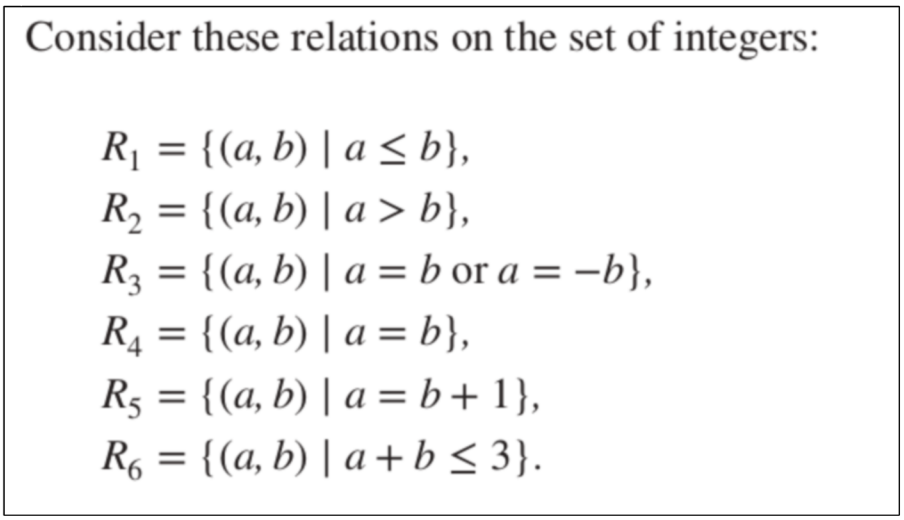
Let A be the set {1, 2, 3, 4}.

Which ordered pairs are in the relation R = {(a, b) | b divides a}?

```
(%i0) kill(all);
(%o0) done

(%i1) findRelation(A):=block(
    [A2:cartesian_product_list(A, A), R:[]],
    for i:1 thru length(A2) do(
    t:A2[i],
    if(remainder(t[1], t[2])=0) then R:cons(t, R)
    ),
    R
);
(%o1) findRelation(A):=block([A2:cartesian_product_list(A,A),
R:[]],for i thru length(A2) do
(t:A2_i,if remainder(t_1,t_2)=0 then R:cons(t,R) ),R)

(%i2) findRelation([1, 2]);
(%o2) [[2,2],[2,1],[1,1]]

(%i3) findRelation([1, 2, 3]);
(%o3) [[3,3],[3,1],[2,2],[2,1],[1,1]]

(%i4) findRelation([1, 2, 3, 4]);
(%o4) [[4,4],[4,2],[4,1],[3,3],[3,1],[2,2],[2,1],[1,1]]
```

5

Figure 3: ex 5 : Rosen



5.1

```
→  kill(all);
(%o0) done

→  findRelation(A):=block(
     [A2:cartesian_product_list(A, A), R:[]],
     for i:1 thru length(A2) do(
     t:A2[i],
     if(is(t[1] <= t[2]) = true) then R:cons(t, R)
     ),
     R
   );
(%o1) findRelation(A):=block([A2:cartesian_product_list(A,A),
   R:[]],for i thru length(A2) do
   (t:A2_i,if is(t_1≤t_2)=true then R:cons(t,R) ),R)

→  findRelation([1, 2]);
(%o2) [[2,2],[1,2],[1,1]]

→  findRelation([1, 2, 3]);
(%o3) [[3,3],[2,3],[2,2],[1,3],[1,2],[1,1]]

→  findRelation([1, 2, 3, 4]);
(%o4) [[4,4],[3,4],[3,3],[2,4],[2,3],[2,2],[1,4],[1,3],[
   1,2],[1,1]]
```

5.2

```
→  kill(all);
(%o0) done
```

```
(%i1) findRelation(A):=block(
        [A2:cartesian_product_list(A, A), R:[]],
        for i:1 thru length(A2) do(
        t:A2[i],
        if(is(t[1] > t[2]) = true) then R:cons(t, R)
        ),
        R
      );
```

(%o1) findRelation(A):=block([A2:cartesian_product_list(A,A), R:[]], for i thru length(A2) do (t:A2[i], if is(t[1]>t[2])=true then R:cons(t,R)),R)

```
(%i2) findRelation([1, 2]);
```

(%o2) [[2,1]]

```
(%i3) findRelation([1, 2, 3]);
```

(%o3) [[3,2],[3,1],[2,1]]

```
(%i4) findRelation([1, 2, 3, 4]);
```

(%o4) [[4,3],[4,2],[4,1],[3,2],[3,1],[2,1]]

5.3

```
(%i5) kill(all);
```

(%o0) done

```
(%i1) findRelation(A):=block(
        [A2:cartesian_product_list(A, A), R:[]],
        for i:1 thru length(A2) do(
        t:A2[i],
        if(is((t[1] = t[2]) or (t[1] = -t[2])) = true) then R:cons(t, R)
        ),
        R
      );
```

(%o1) findRelation(A):=block([A2:cartesian_product_list(A,A), R:[]], for i thru length(A2) do (t:A2[i], if is(t[1]=t[2] ∨ t[1]=-t[2])=true then R:cons(t,R)),R)

```
(%i2) findRelation([1, 2]);
```

(%o2) [[2,2],[1,1]]

```
(%i3) findRelation([1, 2, 3]);
```

(%o3) [[3,3],[2,2],[1,1]]

```
→  findRelation([1, 2, 3, 4]);
```
(%o4) **[[4,4],[3,3],[2,2],[1,1]]**

5.4

```
→  kill(all);
```
(%o0) *done*

```
→  findRelation(A):=block(
     [A2:cartesian_product_list(A, A), R:[]],
     for i:1 thru length(A2) do(
     t:A2[i],
     if(is(t[1] = t[2]) = true) then R:cons(t, R)
     ),
     R
   );
```
(%o1) findRelation**(**A**):=**block**([**A2**:**cartesian_product_list**(**A**,**A**),** R**:[]],**for i thru length**(**A2**)** do **(**t**:**A2$_i$**,**if is**(**$t_1 = t_2$**)=true** then R**:**cons**(**t**,**R**)),**R**)**

```
→  findRelation([1, 2]);
```
(%o2) **[[2,2],[1,1]]**

```
→  findRelation([1, 2, 3]);
```
(%o3) **[[3,3],[2,2],[1,1]]**

```
→  findRelation([1, 2, 3, 4]);
```
(%o4) **[[4,4],[3,3],[2,2],[1,1]]**

5.5

```
→  kill(all);
```
(%o0) *done*

```
(%i1) findRelation(A):=block(
        [A2:cartesian_product_list(A, A), R:[]],
        for i:1 thru length(A2) do(
        t:A2[i],
        if(is(t[1] = t[2] + 1) = true) then R:cons(t, R)
        ),
        R
      );
```

(%o1) findRelation(A):=block([A2:cartesian_product_list(A,A), R:[]], for i thru length(A2) do (t:A2[i], if is(t[1]=t[2]+1)=true then R:cons(t,R)),R)

```
(%i2) findRelation([1, 2]);
```

(%o2) [[2,1]]

```
(%i3) findRelation([1, 2, 3]);
```

(%o3) [[3,2],[2,1]]

```
(%i4) findRelation([1, 2, 3, 4]);
```

(%o4) [[4,3],[3,2],[2,1]]

5.6

```
(%i5) kill(all);
```

(%o0) done

```
(%i6) findRelation(A):=block(
        [A2:cartesian_product_list(A, A), R:[]],
        for i:1 thru length(A2) do(
        t:A2[i],
        if(is(t[1] + t[2] <= 3) = true) then R:cons(t, R)
        ),
        R
      );
```

(%o1) findRelation(A):=block([A2:cartesian_product_list(A,A), R:[]], for i thru length(A2) do (t:A2[i], if is(t[1]+t[2]≤3)=true then R:cons(t,R)),R)

```
(%i7) findRelation([1, 2]);
```

(%o2) [[2,1],[1,2],[1,1]]

```
(%i8) findRelation([1, 2, 3]);
```

(%o3) [[2,1],[1,2],[1,1]]

```
(%i4) findRelation([1, 2, 3, 4]);
(%o4) [[2,1],[1,2],[1,1]]
```