```
(* Calculate 6 factorial and only use commands of a counter
 mashine. The counter machine code is the output of the program below. *)
list = {0, 6} ~ Join ~ Table[0, {10}]
Do[
 Label[begin2];
 If[list[[1]] == 0, Goto[end2]];
 list[[1]] --;
 Pause[0.05];
 Goto[begin2];
 Label[end2];
 list[[1]] ++;
 Pause[0.05];
 Label[begin4];
 If[list[[7]] == 0, Goto[end4]];
 list[[7]] --;
 Pause[0.05];
 Goto[begin4];
 Label[end4];
 Label[begin6];
 If[list[[2]] == 0, Goto[end6]];
 list[[2]] --;
 Pause[0.05];
 list[[7]] ++;
 Pause[0.05];
 list[[4]] ++;
 Pause[0.05];
 Goto[begin6];
 Label[end6];
 Label[begin7];
 If[list[[4]] == 0, Goto[end7]];
 list[[4]] --;
 Pause[0.05];
 list[[2]] ++;
 Pause[0.05];
 Goto[begin7];
 Label[end7];
 If[list[[7]] == 0, Goto[end0]];
 Label[begin0];
 Label[begin11];
 If[list[[5]] == 0, Goto[end11]];
 list[[5]] --;
 Pause[0.05];
 Goto[begin11];
 Label[end11];
 Label[begin13];
 If[list[[7]] == 0, Goto[end13]];
 list[[7]] --;
 Pause[0.05];
 list[[5]] ++;
 Pause[0.05];
 list[[4]] ++;
 Pause[0.05];
 Goto[begin13];
 Label[end13];
 Label[begin14];
```

```
If[list[[4]] == 0, Goto[end14]];
list[[4]]--;
Pause[0.05];
list[[7]]++;
Pause[0.05];
Goto[begin14];
Label[end14];
Label[begin9];
If[list[[7]] == 0, Goto[end9]];
list[[7]]--;
Pause[0.05];
Label[begin16];
If[list[[1]] == 0, Goto[end16]];
list[[1]]--;
Pause[0.05];
list[[6]]++;
Pause[0.05];
list[[4]]++;
Pause[0.05];
Goto[begin16];
Label[end16];
Label[begin17];
If[list[[4]] == 0, Goto[end17]];
list[[4]]--;
Pause[0.05];
list[[1]]++;
Pause[0.05];
Goto[begin17];
Label[end17];
Goto[begin9];
Label[end9];
Label[begin18];
If[list[[5]] == 0, Goto[end18]];
list[[5]]--;
Pause[0.05];
list[[7]]++;
Pause[0.05];
Goto[begin18];
Label[end18];
Label[begin20];
If[list[[1]] == 0, Goto[end20]];
list[[1]]--;
Pause[0.05];
Goto[begin20];
Label[end20];
Label[begin22];
If[list[[6]] == 0, Goto[end22]];
list[[6]]--;
Pause[0.05];
list[[1]]++;
Pause[0.05];
list[[4]]++;
Pause[0.05];
Goto[begin22];
Label[end22];
```

```
 Label[begin23];
 If[list[[4]] == 0, Goto[end23]];
 list[[4]]--;
 Pause[0.05];
 list[[6]]++;
 Pause[0.05];
 Goto[begin23];
 Label[end23];
 Label[begin24];
 If[list[[6]] == 0, Goto[end24]];
 list[[6]]--;
 Pause[0.05];
 Goto[begin24];
 Label[end24];
 list[[7]]--;
 Pause[0.05];
 If[list[[7]] == 0, Goto[end0]];
 Goto[begin0];
 Label[end0];
 Label[begin25];
 If[list[[7]] == 0, Goto[end25]];
 list[[7]]--;
 Pause[0.05];
 Goto[begin25];
 Label[end25],
 {1}
]
list
{0, 6, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0}

{720, 6, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0}

Dynamic[list]

list



(*Since nobody wants to write Code for Counter machines, this program does
 it for us by iteratively replacing complicated strings by easier ones.*)
(* The operation in string is converted to counter mashine commands. Copy
  paste these commands into the "Do"-Command above to see the execution. *)
(*string="list[[3]]=list[[1]]^list[[2]];";*)
string = "list[[1]]=list[[2]]!;";
(*string="If[list[[1]]==list[[2]],Goto[3]];";*)


x = 0;
While[x < 100,
 newstring = StringReplace[string,
   {

     (* EqualTest
       RegularExpression["If\[list\[\[(.)\]\]>=list\[\[(.)\]\],Goto\[(.)\]\];"]→
      StringJoin["$1, $2, $3"],*)
```

```
(*Factorial*)
RegularExpression["list\[\[(.)\]\]=list\[\[(.)\]\]!;"] →
 StringJoin["list[[$1]]=1;list[[7]]=list[[$2]];If[list[[7]]==0,Goto[end",
  ToString[x], "]];Label[begin", ToString[x],
  "];list[[$1]]*=list[[7]];list[[7]]--;If[list[[7]]==0,Goto[end", ToString[x],
  "]];Goto[begin", ToString[x], "];Label[end", ToString[x], "];list[[7]]=0;"],

(*Power*)
RegularExpression["list\[\[(.)\]\]=list\[\[(.)\]\]\\^list\[\[(.)\]\];"] →
 StringJoin["list[[7]]=list[[$3]];list[[$1]]=1;Label[begin",
  ToString[x], "];If[list[[$3]]==0,Goto[end", ToString[x],
  "]];list[[$3]]--;list[[$1]]*=list[[$2]];Goto[begin",
  ToString[x], "];Label[end", ToString[x], "];DRAIN(7,$3);"],

(* * *)
RegularExpression["list\[\[(.)\]\]=list\[\[(.)\]\]list\[\[(.)\]\];"] →
 StringJoin["list[[5]]=list[[$3]];Label[begin",
  ToString[x], "];If[list[[$3]]==0,Goto[end", ToString[x],
  "]];list[[$3]]--;list[[$1]]+=list[[$2]];Goto[begin",
  ToString[x], "];Label[end", ToString[x], "];DRAIN(5,$3);"],

(*DRAIN: Addiert $1 auf $2 und löscht $1. *)
RegularExpression["DRAIN\\((.),(.)\\);"] →
 StringJoin["Label[begin", ToString[x], "];If[list[[$1]]==0,Goto[end",
  ToString[x], "]];list[[$1]]--;list[[$2]]++;Goto[begin",
  ToString[x], "];Label[end", ToString[x], "];"],

(*DRAIN 2: Addiert $1 und $2 UND $3 und löscht $1. *)
RegularExpression["DRAIN\\((.),(.),(.)\\);"] →
 StringJoin["Label[begin", ToString[x], "];If[list[[$1]]==0,Goto[end",
  ToString[x], "]];list[[$1]]--;list[[$2]]++;list[[$3]]++;Goto[begin",
  ToString[x], "];Label[end", ToString[x], "];"],

(* *= *)
RegularExpression["list\[\[(.)\]\]\\*=list\[\[(.)\]\];"] → StringJoin[
  "list[[6]]=list[[$1]]list[[$2]];list[[$1]]=list[[6]];list[[6]]=0;"],

(* = *)
RegularExpression["list\[\[(.)\]\]=list\[\[(.)\]\];"] →
 StringJoin["list[[$1]]=0;list[[$1]]+=list[[$2]];"],

(* += *)
RegularExpression["list\[\[(.)\]\]\\+=list\[\[(.)\]\];"] →
 StringJoin["DRAIN($2,$1,4);DRAIN(4,$2);"],

(* =1 *)
RegularExpression["list\[\[(.)\]\]=1;"] →
 StringJoin["list[[$1]]=0;list[[$1]]++;"],

(* =0 *)
RegularExpression["list\[\[(.)\]\]=0;"] → StringJoin[
  "Label[begin", ToString[x], "];If[list[[$1]]==0,Goto[end", ToString[x],
  "]];list[[$1]]--;Goto[begin", ToString[x], "];Label[end", ToString[x], "];"]
```

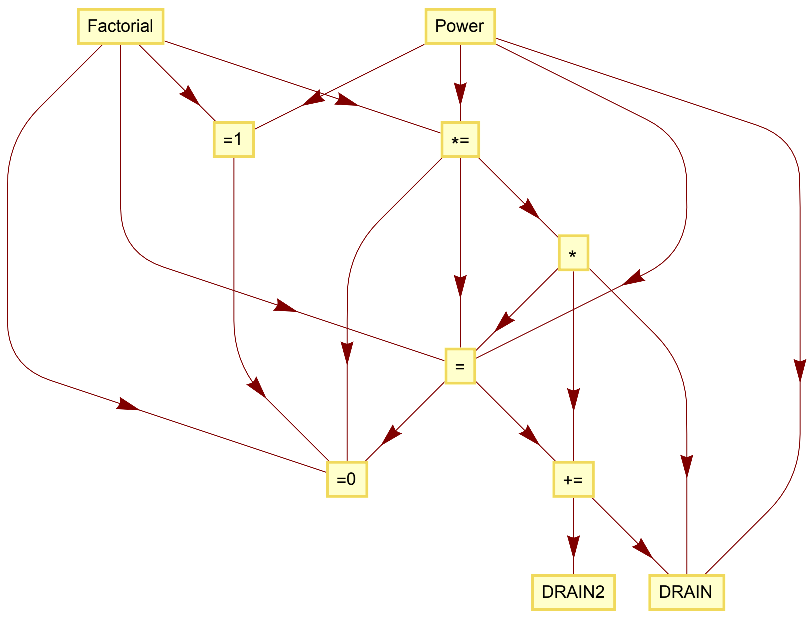
```
   }, 1
  ];
 If[SameQ[newstring, string], Break[], string = newstring];
 x++
]
(* This inserts a Pause after each incement or decrement
 s.t. one can nicely watch the calculation with Dynamic *)
string = StringReplace[string,
  {
   RegularExpression["list\[\[(.)\]\](\\+\\+|--);"] → "list[[$1]]$2;Pause[0.05];"
  }
 ]
x
```

```
Label[begin2];If[list[[1]]==0,Goto[end2]];list[[1]]--;Pause[0.05];Goto[begin2];Label
  [end2];list[[1]]++;Pause[0.05];Label[begin4];If[list[[7]]==0,Goto[end4]];list[[7]]
  --;Pause[0.05];Goto[begin4];Label[end4];Label[begin6];If[list[[2]]==0,Goto[end6]];
  list[[2]]--;Pause[0.05];list[[7]]++;Pause[0.05];list[[4]]++;Pause[0.05];Goto[
  begin6];Label[end6];Label[begin7];If[list[[4]]==0,Goto[end7]];list[[4]]--;Pause[
  0.05];list[[2]]++;Pause[0.05];Goto[begin7];Label[end7];If[list[[7]]==0,Goto[end0]]
  ;Label[begin0];Label[begin11];If[list[[5]]==0,Goto[end11]];list[[5]]--;Pause[0.05]
  ;Goto[begin11];Label[end11];Label[begin13];If[list[[7]]==0,Goto[end13]];list[[7]]
  --;Pause[0.05];list[[5]]++;Pause[0.05];list[[4]]++;Pause[0.05];Goto[begin13];Label
  [end13];Label[begin14];If[list[[4]]==0,Goto[end14]];list[[4]]--;Pause[0.05];list[[
  7]]++;Pause[0.05];Goto[begin14];Label[end14];Label[begin9];If[list[[7]]==0,Goto[
  end9]];list[[7]]--;Pause[0.05];Label[begin16];If[list[[1]]==0,Goto[end16]];list[[1
  ]]--;Pause[0.05];list[[6]]++;Pause[0.05];list[[4]]++;Pause[0.05];Goto[begin16];
  Label[end16];Label[begin17];If[list[[4]]==0,Goto[end17]];list[[4]]--;Pause[0.05];
  list[[1]]++;Pause[0.05];Goto[begin17];Label[end17];Goto[begin9];Label[end9];Label[
  begin18];If[list[[5]]==0,Goto[end18]];list[[5]]--;Pause[0.05];list[[7]]++;Pause[
  0.05];Goto[begin18];Label[end18];Label[begin20];If[list[[1]]==0,Goto[end20]];list[
  [1]]--;Pause[0.05];Goto[begin20];Label[end20];Label[begin22];If[list[[6]]==0,Goto[
  end22]];list[[6]]--;Pause[0.05];list[[1]]++;Pause[0.05];list[[4]]++;Pause[0.05];
  Goto[begin22];Label[end22];Label[begin23];If[list[[4]]==0,Goto[end23]];list[[4]]--
  ;Pause[0.05];list[[6]]++;Pause[0.05];Goto[begin23];Label[end23];Label[begin24];If[
  list[[6]]==0,Goto[end24]];list[[6]]--;Pause[0.05];Goto[begin24];Label[end24];list[
  [7]]--;Pause[0.05];If[list[[7]]==0,Goto[end0]];Goto[begin0];Label[end0];Label[
  begin25];If[list[[7]]==0,Goto[end25]];list[[7]]--;Pause[0.05];Goto[begin25];Label[
  end25];
```

```
26
```

```
(*
Placeholders:
 3: Result
  4: PlusEqual
  5: Times
  6: TimesEqual
  7: Power and Factorial
*)
```

```
(* Care must be taken not to create circles in the dependancy
 graph. Also the placeholder of a function must be different
 from all placeholders of functions that it depends on. *)
LayeredGraphPlot[{"Factorial" → "=1", "Factorial" → "=0", "Factorial" → "*=",
  "Factorial" → "=", "*=" → "=", "*=" → "*", "*=" → "=0",
  "Power" → "=1", "Power" → "*=", "Power" → "=", "Power" → "DRAIN",
  "*" → "=", "*" → "+=", "*" → "DRAIN", "=" → "=0", "=" → "+=",
  "+=" → "DRAIN", "+=" → "DRAIN2", "=1" → "=0"}, VertexLabeling → True]
```



```
(* Next
 step: Be able to do If[list[[1]]==0, COMMAND] or even If[CONDITION , COMMAND] *)
```