Building Neural Net Software

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Abstract. In a recent paper [Neto *et al.* 97] we showed that programming languages can be translated on recurrent (analog, rational weighted) neural nets. The goal was not efficiency but simplicity. Indeed we used a number-theoretic approach to machine programming, where (integer) numbers were coded in a unary fashion, introducing a exponential slow down in the computations, with respect to a two-symbol tape Turing machine. Implementation of programming languages in neural nets turns to be not only theoretical exciting, but has also some practical implications in the recent efforts to merge symbolic and subsymbolic computation. To be of some use, it should be carried in a context of bounded resources. Herein, we show how to use resource boundedness to speed up computations over neural nets, through suitable data type coding like in the usual programming languages. We introduce data types and show how to code and keep them inside the information flow of neural nets. Data types and control structures are part of a suitable programming language called NETDEF. Each NETDEF program has a specific neural net that computes it. These nets have a strong modular structure and a synchronisation mechanism allowing sequential or parallel execution of subnets, despite the massive parallel feature of neural nets. Each instruction denotes an independent neural net. There are constructors for assignment, conditional and loop instructions. Besides the language core, many other features are possible using the same method. There is also a NETDEF compiler, available at www.di.fc.ul.pt/~jpn/netdef/netdef.htm.

1. Introduction

Analog recurrent neural nets can be formulated as dynamic systems. We adapt to our case the definition given in [Sontag 90], that corresponds to the concept of discrete, complete, time-invariant dynamic system. A dynamic system is a triple D = (S, U, ϕ) consisting of: (a) a non-empty set S called the state space of D, (b) a non-empty set U called the control-value or input-value space of D, and (c) a total map called the dynamic map, ϕ: S×U→S. We will consider S and U as being finite dimensional vector spaces over the reals, or restrictions to them.

Analog neural nets are considered particular cases of dynamic systems, where ϕ is of the form $\sigma\circ\pi$, being π: S×U→S an affine map, and σ: S→S a possibly discontinuous function. Linearity of π is equivalent to the existence of linear maps A: S→S and B: U→S such that $\phi(x,u) = \sigma(Ax+Bu)$. These systems are said to be autonomous whenever B is the null matrix, otherwise they are said to be non-autonomous or net systems with controls. If we assume that there exists one variable with constant value 1, and specific matrices, we recover the model in the form $\phi(x,u) = \sigma(Ax+Bu+c)$, where c is known as the bias vector.

We will consider two cases for the function σ:

(a) the McCulloch and Pitts neural net model,

$$\sigma(x) = \begin{cases} 0 & if \quad x < 0 \\ 1 & if \quad x \geq 0 \end{cases}$$

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(b) the saturated sigmoid model,

$$\sigma(x) = \begin{cases} 0 & if \quad x < 0 \\ x & if \quad 0 \leq x \leq 1 \\ 1 & if \quad x > 1 \end{cases} \tag{1}$$

For notational purposes we write

$$x(t+1) = \phi(x(t), u(t)) \tag{2}$$

to denote a step of computation, or just

$$x^+ = \phi(x, u)$$

With dynamical systems in general we have computation without programmability, i.e., the extra power these systems exhibit has to do with the decoupling between programming and computation. Up to the power of Turing machines, computations are describable by programs that correspond to the prescription by finite means of some rational parameters of the system. Beyond Turing power we have computations that are not describable by finite means: computation without a program. In this paper we want to shed some light on the programmability of neural nets.

1.1. Computability

The use of an analog neural net model in computability is due to Hava Siegelmann and Eduardo Sontag. In [Siegelmann and Sontag 95] they used it to establish lower bounds on the computational power of analog recurrent neural nets.

These systems satisfy the classical constraints of computation theory, namely, (a) input is discrete (binary) and finite, (b) output is discrete (binary) and (c) the system is itself finite (control is finite). Neurons may hold values within [0,1] with unbounded precision. To work with such analog systems, binary input is encoded into a rational number between 0 and 1, and the rational output is decoded into an output binary sequence.

The input streams u_k, for i=1..M, input bits into the system through time. Streams are maps $u_k:\mathbb{N}\rightarrow\{0,1\}$, different from 0 only finitely many times (this is the classical constraint of input finiteness). $(u_k)_{k=1..M}$, is the set of control symbols, to adopt the flavour of Minsky's description of such systems, that the reader may find in [Minsky 67]. In the absence of control the systems are said to be autonomous and the dynamics is given by

$$x_j(t+1) = \sigma(\sum_{i=1}^{N} a_{ji}x_j(t) + c_j)$$

We may then identify the set of computable functions by analog recurrent neural nets, provided that the type of the weights is given. This research program has been systematically pursued in [Siegelmann 99]:

- The first level of nets is NET[integer], where the type of the weights is integer. These nets are historically related with the work of Warren McCulloch and Walter Pitts. As the weights are integer numbers, each processor can only compute σ applied to a linear combination of zeros and ones. The activation values are thus always zero or one. Thus in the case of integer nets the activation function can be replaced by the Heaviside step function with no decrease (or increase) of computational power. In this case the nets 'degenerate' into a classical devices called finite automata. It was Kleene who first proved that McCulloch and Pitts' nets are equivalent to finite automata, and therefore they were able to recognize all regular languages (see [Minsky 67] for details).

- The second relevant class we consider in this paper is NET[rational], where the type of the weights is rational. Rationals are indeed computable numbers in finite time, and NET[rational] turn to be equivalent to Turing machines. Twofold equivalent: rational nets compute the same functions as Turing machines and, under appropriate coding of input, they are able to compute the same functions in exactly the same time.
- The third relevant class is NET[real], not considered in this paper, where the type of the weights is real. Reals are indeed in general non computable. But theories of physics consider real variables. The advantage of making an analog theory of computation is that non uniform classes of computation, namely the classes that arise in complexity theory using Turing machines with advice, are uniformly described in NET[real]. All sets over finite alphabets can be represented as reals that encode the families of Boolean circuits that recognize them. A further feature is that, if we allow only for computable reals, then we can develop a model that is strictly as powerful as Turing machines, but with the computations being speed up by exponential factors. The reason is that the complexity of computable reals have no upper limit. In classical artificial devices, these constants have to be calculated with the required precision, slowing down the computations.

1.2. Programmability of Analog Neural Nets

Within the class of NET[rational] we can develop the implementation of programming languages, providing for each written command, a suitable analog neural net. The implementation map will be provided in this paper for a (Turing complete) subset of the Occam language.

A first concern is the size of the resulting nets. In fact the size of the nets will increase with the complexity of programs. However, is always possible to implement the Occam interpreter of Occam, determining a universal neural net for the language interpretation.

We see two main contributions in this paper. In first place, we show how to perform symbolic computations over neural nets. And in second place, the high-level programming language is useful for high-level construction of particular nets, used in the proof of several results in neurocomputing theory, as in [Siegelmann 99], where a net descriptor is used to encode analog shift maps into neural nets.

2. Neural Software

2.1. Neural Net Model

An analog recurrent neural net is a dynamic system $\vec{x}(t+1) = \phi(\vec{x}(t), \vec{u}(t))$, with initial state $\vec{x}(0) = \vec{x_0}$, where $x_i(t)$ denotes the activity (firing frequency) of neuron i at time t within a population of N interconnected neurons, and $u_k(t)$ the input bit of input stream k at time t within a set of M input channels. The application map ϕ is taken as a composition of an affine map with a piecewise linear map of the interval [0,1], known as the saturated sigmoid σ, as in (2). The dynamic system becomes

$$x_j(t+1) = \sigma\left(\sum_{i=1}^{N} a_{ji} x_i(t) + \sum_{k=1}^{M} b_{jk} u_k(t) + c_j \right)$$

where a_{ji}, b_{jk} and c_j are rational weights, assuring that a system can be simulated by a Turing machine. Fig. 1 displays the graphical representation of the preceding equation used throughout this paper (when a_{ji}, b_{jk} or a_{jj} takes value 1, they are not displayed in the graph.).

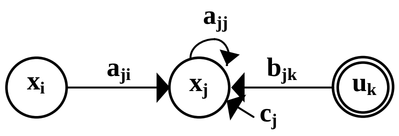


Fig. 1. Graphical notation for neurons, input channels and their interconnections.

Our problem will be to find a suitable neural network for each program written in the chosen programming language.

2.2. The NETDEF Language

We will adopt a fragment of Occam® for the programming language. Occam® was designed to express parallel algorithms on a network of processing computers (for more information, see [SGS-THOMSOM 95]). With this language a program can be described as a collection of processes executing concurrently, and communicating with each other through channels. Processes and channels are the main concepts of the Occam® programming paradigm.

Occam® programs are built from *processes*. The simplest process is an action. There are three types of action: assignment of an expression to a variable, input and output. Input means to receive a value from a channel and assign it to a variable. Output means to send the value held by a variable through a channel.

There are two primitive processes: skip and stop. The skip starts, performs no action and terminates. The stop starts, performs no action and never terminates. To construct more complex processes, there are several types of construction rules. Herein, we present some of them: *while*, *if*, *seq* and *par*.

The *if* is a conditional construct that combines a number of processes, guarded by a boolean expression. The *while* is a loop construct, that repeats a process while an associated boolean expression is true. The *seq* is a block construct, combining a number of processes sequentially. The *par* is a block construct, combining a number of processes in parallel.

A *communication channel* provides unbuffered, unidirectional point-to-point communication of values between two concurrent processes. The format and type of values are defined by a certain specified protocol.

Here follows the simplified grammar of NETDEF (Network Definition), in EBNF:

program ::= "NETDEF" id "IS" def-var process ".".

process ::= assignment | skip | stop | if-t-e | while-do | seq-block | par-block.

Our goal is to show that all NETDEF programs are compiled into neural nets. There exists a dynamic system of the kind (3) that runs any NETDEF program on some given input.

2.3. Information Coding and Operators

With the guidelines provided in [Siegelmann 96], the seminal work on the implementation of information coding in neural networks (see [Gruau *et al.* 95] for a different approach), we introduce data types and show how to encode and keep them inside the information flow of neural nets. NETDEF has the following type definitions.

type ::= primitive-type | channel-type | composite-type.

primitive-type ::= "BOOLEAN" | "INTEGER" | "REAL".

channel-type ::= "CHANNEL".

composite-type ::= "ARRAY" "[" number "]" "OF" primitive-type.

2.3.1. Primitive Types

To be of some use, implementation of programming languages in neural nets should be carried in a context of bounded resources. Herein we show how to use resource boundedness to speed up computations over neural nets, through suitable encoding of suitable data types like in the usual programming languages.

To take in consideration the lower and upper saturation limits of the activation function σ, every value *x* of a given basic type is encoded into some value of [0,1]. For each type T, there is an injective encoding map α_T:T$\rightarrow$[0,1] mapping a value $x \in T$ onto its specific code. The encoding map determines the operator neural architecture. Basic types include: *boolean*, *integer* and *real*.

If resources are bounded, then there exists a limit to the precision of every value (in fact, even reals are bounded rationals). Suppose a maximum precision of P digits. The minimum distance between any two values is 10^{-P}. Let us denote 10^{P} by M.

For booleans, T is B = {0,1}, the encoding map is given by

$$\alpha_B(x) = \begin{cases} 0 & , x=\text{FALSE} \\ 1 & , x=\text{TRUE} \end{cases}$$

For integers, T is Z = { $-\frac{M}{2}$, $\frac{M}{2}$ }, and

$$\alpha_Z(x) = \frac{M + 2x}{2M}$$

For reals, within [a,b],

$$\alpha_{[a,b]}(x) = \frac{x-a}{b-a}$$

2.3.2. Channel and Composite Types

Each channel has two neurons, one to keep the processed value and another neuron to keep a boolean flag (with value one if the channel is empty, or zero, otherwise). To see more about channels see section 2.4.2.

It is also possible to define array variables. Each one of the data elements is coded by a specific neuron. This means that a composite type is a finite set of neurons. The array has the following structure,

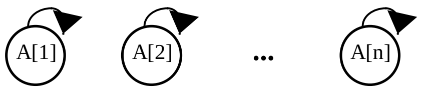


Fig. 2. An array basic structure.

2.3.4. Operators

With data types, many different operators are needed to process information. An arbitrary set of operators (together with constants, variables and input data) forms an expression that after evaluation returns a result of some type. Each expression starts its execution when it receives signal IN (for details see section 2.4.1). After evaluation, it returns the final result through output RES at the same time of signal OUT.

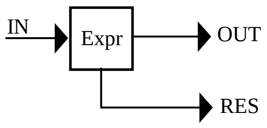


Fig. 3. An expression subnet.

Non-labelled arcs default to weight 1.

• **Boolean Operators**. These are the typical McCulloch-Pitts boolean operators (see [McCulloch and Pitts 43])

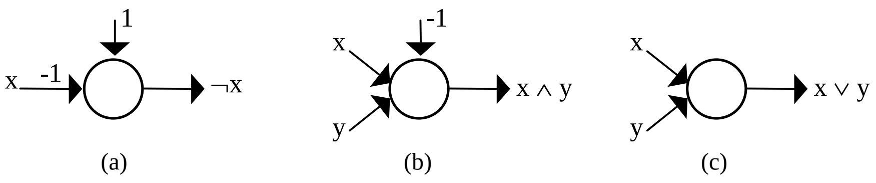


Fig. 4. Boolean Operators: (a) NOT X, (b) X AND Y, (c) X OR Y.

• **Integer Operators.** There are arithmetical and relational operators for integers.

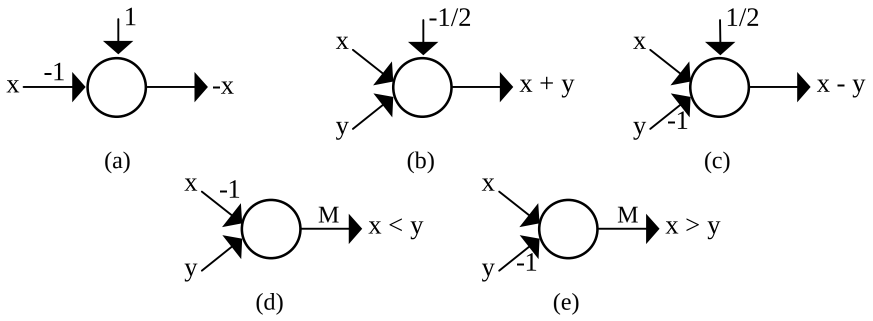


Fig. 5. Integer Operators: (a) -X, (b) X + Y, (c) X - Y, (d) X < Y, (e) X > Y.

• **Real Operators.** The encoding $\alpha_{[a,b]}$ is a scaling of the interval [a,b] into [0,1]. Binary sum, subtraction and multiplication by a constant are straightforward.

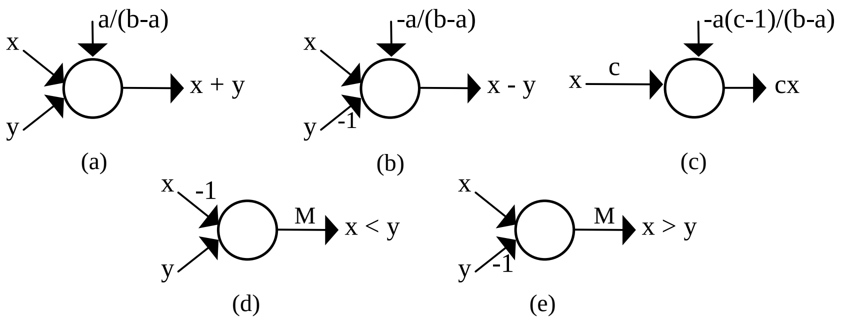


Fig. 6. Real Operators: (a) X + Y, (b) X - Y, (c) cX, (d) X < Y, (e) X > Y.

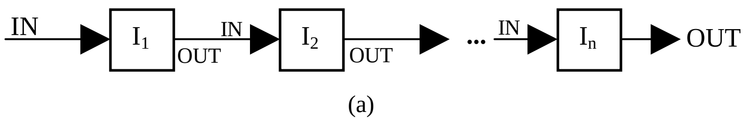
2.4. Synchronization Mechanisms

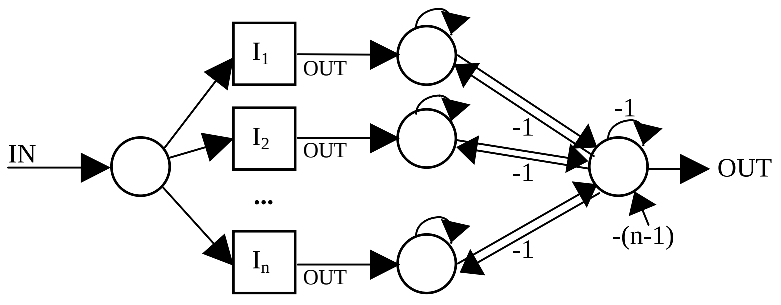
Neural nets are models of massive parallelism. At each instant, *all* neurons are updated, possibly with new values. This means that a network step with n neurons is a parallel execution of n assignments. Since programs (even parallel programs) have a sequence of well-defined steps, there must be a way to control it. This is done by a synchronization mechanism based on hand-shaking.

2.4.1. Instruction Blocks

There are two different ways to combine processes, the sequential block and the parallel block. Each process in a sequential block must wait until the previous process ends its computation. In a parallel block each process starts at the same time, independently of the others. But the parallel block (which is itself an process) only ends when all processes terminate. This semantic demands synchronisation mechanisms in order to control the intrinsic parallelism of neural nets.

To accomplish this, each NETDEF process has a specific and modular subnet binding its execution and its synchronization part. Each subnet is activated when the value 1 is received through a special input validation line IN. The computation of a subnet terminates when the validation output neuron OUT writes value 1.





(b)

Fig. 7. Block Processes: (a) SEQ I_1, …, I_n ENDSEQ,
(b) PAR I_1, …, I_n ENDPAR. All subnets are denoted by squares.

2.4.2. Occam® Channels

NETDEF assumes the Occam® channel communication protocol, allowing independent process synchronisation.

We introduce two new processes, SEND and RECEIVE.

send ::= "SEND" id "INTO" id.

receive ::= "RECEIVE" id "FROM" id.

SEND sends a value through a channel, blocking the process if the channel is full, and RECEIVE receives a value through the channel, blocking if the channel is empty, and waiting until something arrives. To minimise the blocking nature of channels, see sections 2.7 and 2.8.

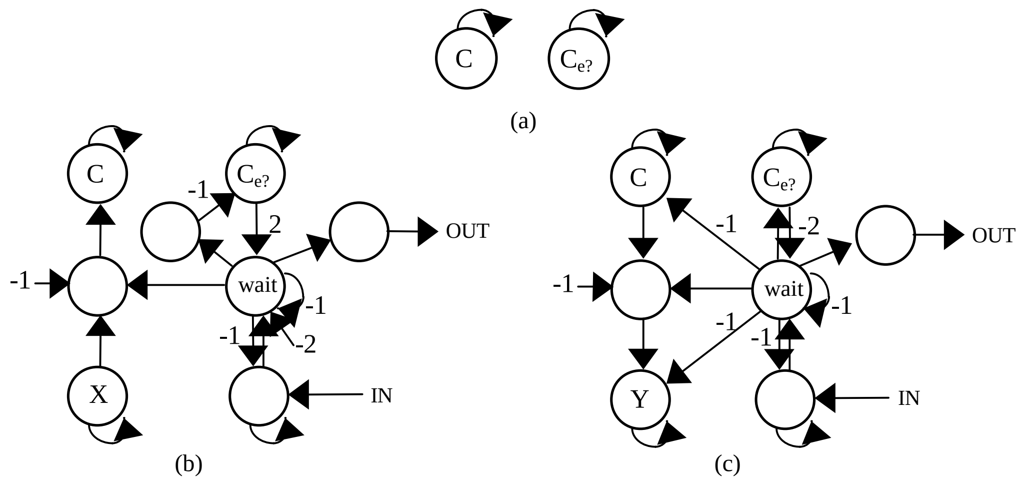


Fig. 8. Channel Instructions: (a) VAR C : CHANNEL, (b) SEND X INTO C (c) RECEIVE Y FROM C.

Each channel has a limited memory of one slot. Using several channels in sequence, it is possible to create larger buffers. For e.g.,

```
SEQ
  RECEIVE X1 FROM C1;      SEND X1 INTO C-TEMP;
  RECEIVE X2 FROM C-TEMP;  SEND X2 INTO C2;
ENDSEQ;
```

simulates a buffer with two elements.

2.4.3. Shared Variables

Processes may communicate through global variables - variables defined on the initial block. In principle, each neuron could see every other neuron in the net. The subject of variable scope is an a-priori restriction made by the compilation process.

Several methods in literature, like semaphores or monitors, are implemented as primitive instructions. These methods are used to promote mutual exclusion proprieties to a certain language, helping the programmer to solve typical concurrent problems. In NETDEF there is also a mutual exclusion mechanism for blocks, providing the same type of service.

2.5. Control NETDEF Structure

The control structure of a NETDEF program consists of one block process (SEQ or PAR). This process denotes an independent neural net as seen before. The implementation is then recursive, because each process might correspond to a set of several processes. The process subnets are built in a modular way, but they may share information (via channels or shared variables).

Besides the IN and OUT synchronization mechanism explained in 2.4.1, there is a special reset input for each instruction module. This reset is connected to every neuron of the subnet instruction with weight -1. So, if the signal one is sent through this channel, all neuron activation terminates on the next instant. For simplification, we do not show these connections. Once more, all subnets are denoted by squares and non-labelled arcs default to weight 1.

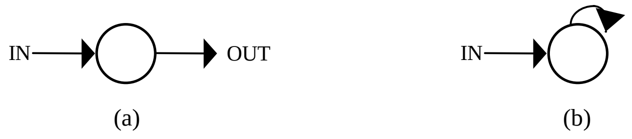


Fig. 9. Skip and Stop processes: (a) SKIP, (b) STOP.

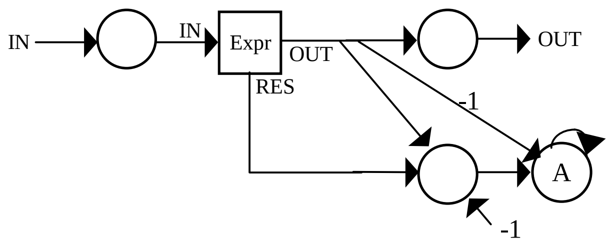


Fig. 10. Assignment Process: A := EXPR. All subnets are denoted by squares.

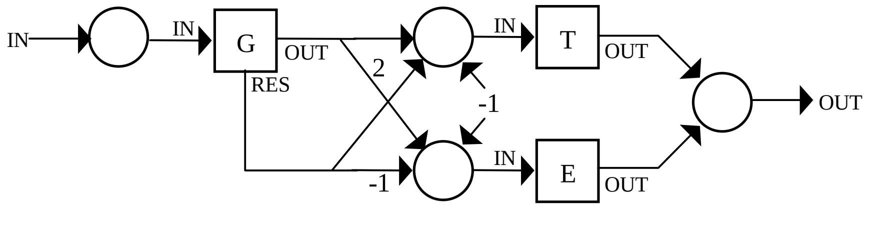


Fig. 11. Conditional Process: IF G THEN T ELSE E. All subnets are denoted by squares.

The CASE process can be seen as the parallel block of IF processes. The COND process is the sequential block of IF processes.

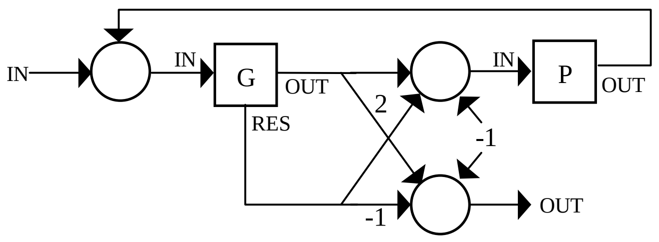


Fig. 12. Loop Instruction: WHILE G DO P. All subnets are denoted by squares.

Other loop instructions (like REPEAT-UNTIL) are built in the same way.

2.6. Procedures and Functions

Functions and Procedures are not duplicated. They have complex neural nets to ensure that just one call is executed at each time, blocking other calls until the end of execution. This make effective lock mechanisms on shared data (e.g., accessing data through only one procedure).

Functions and procedures have parameters by value (copy the value of the expression into the argument of the procedure/function) and a sort of parameter by result (copy the value of the variable into the argument and when the function/procedure ends, copy the value of the argument back to the initial variable). For syntax details see example in 3.2.

However, an important fault exists in NETDEF functions and procedures, there is no recursion. This is a complex problem, since the number of neurons is fixed by compilation. There is no easy way to simulate a stack mechanism of function calls into neural nets.

2.7. Input / Output

To handle input from the environment and output results, NETDEF uses the channel primitives with two special set of channels, IN_k (linked directly with input channel u_k) and OUT_k. The number of in/out channels is defined before compilation. This subject depends on the application context, so we do not define the architecture of these interfaces. In principle, input channels must have a FIFO list in order to keep the incoming data, and a structure to maintain the IN_k channels in a coherent state (i.e., update the channel flag of IN_k each time u_k sends a value).

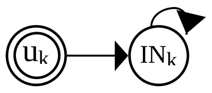


Fig. 13. Input channel u_k connects with NETDEF channel IN_k.

With these, in/out operations are simple channel calls. An in/out example could be,

```
SEQ
  RECEIVE a FROM IN1;
  SEND a INTO OUT2;
ENDSEQ;
```

receiving data into variable ‘a’ from the first input channel, and send it through the second output channel.

To obtain asynchronous in/out, there is a boolean function ISEMPTY(channel) returning true if the channel is empty, or false otherwise.

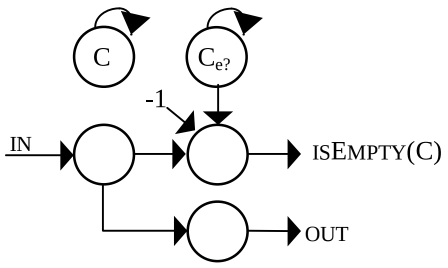


Fig. 14. Asynchronous in/out.

E.g., to implement an asynchronous output,

```
IF ISEMPTY(C)THEN SEND X INTO C
```

2.8. Timers

In real applications, some processes may create deadlock situations. The NETDEF communication primitives (SEND and RECEIVE) are blocking, i.e., they wait until some premises are satisfied (the channel must be empty for SEND and full for RECEIVE). The problem lies if these premises never happen. And waiting indefinitely for input can be a serious problem in real-time applications. To handle this, NETDEF has several timer processes.

The first one is TRY. It guarantees termination, if the instruction does not end before the expected time (given by an integer variable).

timed-instruction ::= "TRY" "(" variable ")" instruction.

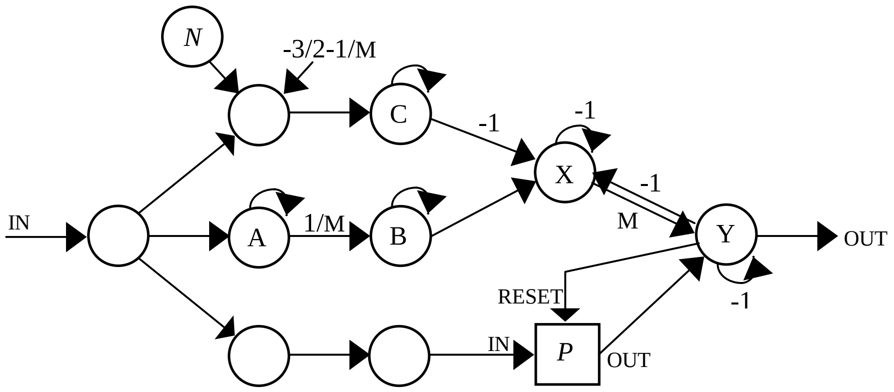


Fig. 15. Timer Constructor: TRY(N) P. All subnets are denoted by squares.

neurons X has arcs with weight –M, and Y has arcs with weight –1, to neurons A, B and C.

Two other types of timers exist: delay-timers and cyclic-timers. Delay timers delay the execution of instructions during a given time.

delayed-instruction ::= "DELAY" "(" variable ")" instruction.

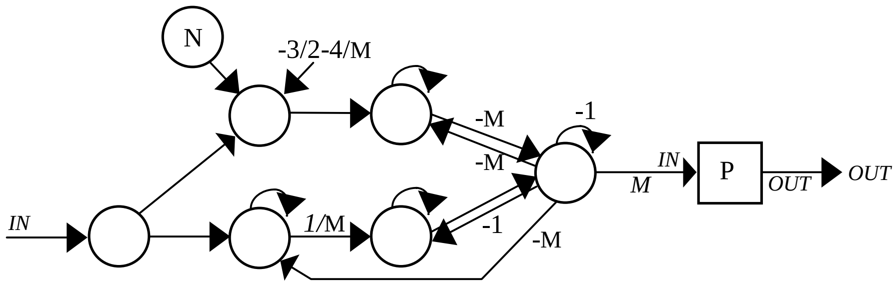


Fig. 16. Timer Constructor: DELAY(N) P. All subnets are denoted by squares.

Cyclic-timers restart the execution of an instruction whenever a specific time passed. They can be used to simulate interrupts.

cyclic-instruction ::= "CYCLE" "(" variable ")" instruction.

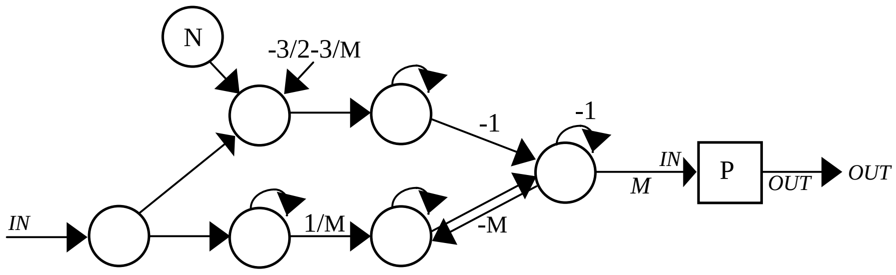


Fig. 17. Timer Constructor: CYCLE (N) P. All subnets are denoted by squares.

Several timer constructs can be used sequentially. For e.g.,

```
CYCLE (10000) TRY(50) IF flag = 1 THEN SEND X INTO C;
```

means that on each 10 000 cycles, it will check if an integer variable 'flag' has value 1. If it is, send value X through channel C. If the variable cannot be sent in 50 cycles, abort execution.

2.9. Non Determinism

The CHOOSE construct introduces non determinism in NETDEF. Process CHOOSE non deterministically selects one of its instructions and executes it.

choose ::= "CHOOSE" instruction ";"instruction { ";" instruction } "ENDCHOOSE".

To do so, NETDEF has a special input GUESS that returns random binary values. If we have N instructions, there is the need of $K = \lceil \log_2 N \rceil$ bits of information in order to choose one of them. To do so, CHOOSE picks K (binary) values from GUESS, b_1, b_2, …, b_K; and use them to activate instruction number $M = b_1b_2…b_K$, (in binary notation). If $M > N$, then CHOOSE tries again.

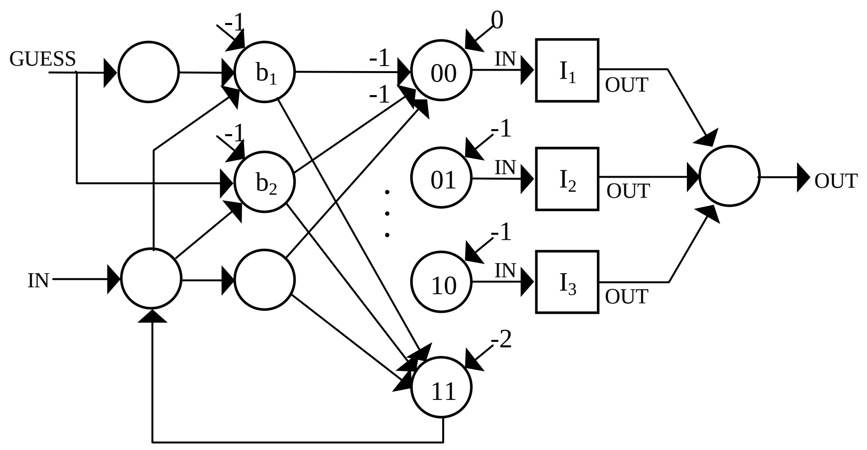


Fig. 18. Choosing between three instructions (i.e., CHOOSE needs two random bits). All subnets are denoted by squares.

The weights between neurons b_i and neurons 01 and 10 are not presented for clarity reasons. But the main idea is to activate one specific neuron for each binary string obtained.

2.10. Exceptions

In high-level languages, like Eiffel® [Interactive 89] or Ada® [USDD 83], exceptions are unexpected events occurring during the execution of a system and disrupting the normal flow of execution (e.g., division by zero or an operation overflow). Some exceptions are raised by the system, others by the program itself. The (hypothetical) neural net hardware is homogenous, there is no system disruption other than neuron (in one of the operations or in the activation function computation) or sinapse failure.

Despite the possibility of system failures, our concern herein will be only about programmer raised exceptions. These exceptions adds some extra block control. They appear as part of a SEQ or PAR block. First, an example,

```
meth1-failed := FALSE;
SEQ
IF meth1-failed  THEN method-1  -- with a 'RAISE excp-1'
                 ELSE method-2; -- with a 'RAISE excp-2'
  job-accomplished := TRUE;
EXCEPTION
  WHEN excp-1 DO
    SEQ
      meth1-failed:= TRUE;
      RETRY;
    ENDSEQ;
  WHEN excp-2 DO
    SEQ
     job-accomplished := FALSE;
     TERMINATE;
    ENDSEQ;
ENDSEQ;
```

Suppose we have two methods to do the same work. In this sequential block, if the first method fails, it raises an exception called 'excp-1' trapped by the handler part of the block. It changes the value of the boolean variable and then execute the block again, trying the second method. If this also fails, then the block terminates with a no job accomplishment status.

Process RAISE E raises exception E. Each exception has an associated process (that can be again a SEQ or PAR block), and some special block handlers. These block handlers define what do to with the actual block:

RETRY	- reset and execute the block again,
ABORT	- reset and terminate the block,
PROPAGATE	- reset the block and raise the same exception in the upper block.

Each instruction block with an exception part, has its net architecture changed.

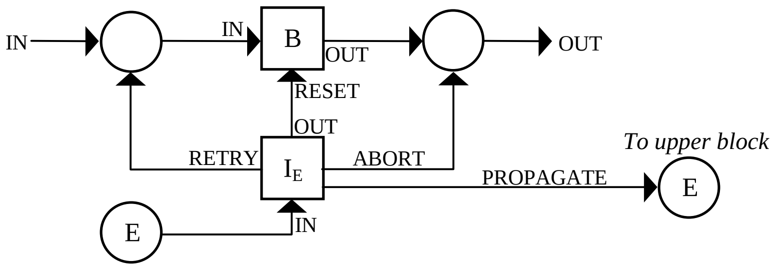


Fig. 19. The exception handler E of instruction block B.
Block I_E is the instruction associated with exception E.
All subnets are denoted by squares.

Each exception has a specific neuron receiving the block process signal. With this type of structure, RAISE is defined as,

```
PAR
  E:=1;       ≡     RAISE E
  STOP;
ENDPAR;
```

There is a cascade effect for no handled exceptions. If a block raises an exception E but has no handler for it, the compiler inserts by default the following handler,

```
WHEN E DO PROPAGATE;
```

Any process sending this signal is not resumed (unless one of the upper blocks retries its execution).

2.11. Space and Time Complexity

The proposed implementation map is able to translate any given NETDEF program to an analog recurrent (rational) neural net that performs the same computations. We wonder what is the space complexity of the implementation, i.e., how many neurons are needed to support a given NETDEF program? We take a close look at each basic process, to evaluate its contribution to the size of the final net.

The *assignment* inserts 3 neurones plus those that are needed to compute the expression. The SKIP and STOP needs only one neuron. The IF-THEN-ELSE needs 4, and the WHILE needs 5 neurons. The SEQ statement needs no neurons and the PAR of n processes needs n+2 neurons. SEND needs 5 neurons and RECEIVE needs 4. Timers also have constant number of neurons. All other processes have the same behaviour about the number of neurons.

Data types and operators need a constant or linear number of neurons to the size of the used information. All expressions can be evaluated with a linear growth in that number. Every process adds a constant or linear complexity to the final net. The spatial complexity of the emulation is linear on the size of the algorithm.

Concerning time complexity, each subnet executes its respective command with a constant delay. NETDEF adds a linear time slow down to the complexity of the corresponding program.

3. Application

3.1. Replicated Workers

To illustrate the use of NETDEF, we present an example based on the Replicated Worker paradigm. There are several parallel algorithms in which the computing tasks are not known in advance, but are generated dynamically as the program runs. In these algorithms, the computing tasks cannot be initially divided among the available processes. In order to achieve a balanced load, the tasks must be assigned to processors in a dynamic manner as they are created during the algorithm execution.

In the Replicated Worker standpoint, an abstract data structure, called *Work Pool* (WP), is used. A WP is a collection of task descriptions, each one identifying a specific task to be performed by any of the available *workers*. When a worker ends a task, it gets a new task descriptor from the WP and performs the required computation. During this process, the worker may produce new tasks, which are added to the WP (for more details, see [Lester 93]).

The WP has two associated primitives, GETWORK and PUTWORK, through which the workers may access the WP set of available tasks. A worker fetches one task using operation GETWORK and may call PUTWORK several times during that task processing. The worker will keep fetching tasks until it receives a special termination task.

There is an important issue, termination. When WP ends its processing? The obvious answer is when there is no more work to do! This is a problem because it is a global property, it depends on WP state and of all workers. It is not enough to see if WP is empty, since there is the possibility of an active worker still add some new tasks to be processed. The algorithm must terminate if and only if all workers are idle and there is no task in WP.

3.2. The NETDEF program

There are three major structures in NETDEF implementation of Replicated Workers, the WP, the worker and the shared structure that will ensure termination.

3.2.1. The Work Pool

The WP will be a queue with a limited number of tasks. The FIFO discipline is good to achieve fairness in task assignation (it could be implemented with levels of priority). This is the NETDEF code for the queue data structure and its associated primitives, INIWP, PUTTASK and GETTASK,

```
CONST endWork = 0;  -- special task termination

VAR task : integer; -- task descriptor
    wkPool : ARRAY [100] OF integer;
    firstTask, lastTask : integer;
```

```
FUNCTION iniWP IS NIL
SEQ
  firstTask := 1;
  lastTask := 1;
ENDSEQ;

FUNCTION putTask ( Task : integer ) IS NIL
SEQ
  IF mod(lastTask+1, 100) = firstTask
   THEN RAISE wkPoolFull
   ELSE SEQ
        lastTask := mod(lastTask+1, 100);
        wkPool[lastTask] := Task;
       ENDSEQ;
EXCEPTION
  WHEN wkPoolFull DO RETRY;
ENDSEQ;

FUNCTION getTask ( VAR Task : integer ) IS NIL
SEQ
  IF lastTask = firstTask
   THEN RAISE wkPoolEmpty
   ELSE SEQ
        Task := wkPool[firstTask] ;
        firstTask := mod(firstTask+1, 100);
       ENDSEQ;
EXCEPTION
  WHEN wkPoolEmpty DO RETRY;
ENDSEQ;
```

Procedures GETTASK and PUTTASK use exception handlers when the queue is empty or full respectively. It is expected that some other worker will solve the situation. If that does not happen, the system will deadlock. Hence, a greater queue is needed.

3.2.2. Termination

To handle termination we will use a global shared integer variable workCount. When it is positive it keeps how many tasks are at that moment in the WP. If it is not positive, it says that there are no tasks in the WP and there are |workCount| workers in an idle state. So, when the variable is equal to -(number of workers), the WP must terminate. We use the following procedure to update this value:

```
FUNCTION updateCount ( isGet : boolean ) IS NIL
IF isGet THEN workCount := pred(workCount)
        ELSE workCount := succ(workCount);
```

Since workCount is only modified inside procedure UPDATECOUNT, it works like a locked shared variable. This control will be done by the GETWORK procedure. When trying to get a work, if it sees that the termination condition is true, it raises an exception sending (number of workers-1) special termination tasks to the WP and terminates itself.

```
FUNCTION putWork ( Task : integer ) IS NIL
SEQ
  updateCount( FALSE );
  putTask( Task );
ENDSEQ;
```

```
FUNCTION getWork ( VAR Task : integer ) IS NIL
SEQ
  VAR i : INTEGER;

   updateCount( TRUE );
   IF workCount = -nWorkers
    THEN RAISE TerminateWP
    ELSE getTask( Task );
EXCEPTION
   WHEN TerminateWP DO
    SEQ
      i := 1;
      while i < nWorkers do
        putTask( endWork );
      ABORT;
    ENDSEQ;
ENDSEQ;
```

3.2.3. The worker

The workers are instances of the same worker model. Of course, each problem requires a specific worker model. Herein, we present its usual structure. The code consists of a main loop that stars with a first getWork procedure call. During the execution of that work, it may generate new tasks and subsequently call PUTWORK several times to add these new tasks to the WP. It may also have some access to shared data. These accesses must be handled by techniques similar to the one used in procedure updateCount.

```
SEQ   -- code template for worker
  VAR Task : integer;
   …
  getwork( Task );
   WHILE Task <> endWork DO
     SEQ
        … -- with some putWork calls
       getwork( Task );
     ENDSEQ;
ENDSEQ;
```

3.2.4. Main Program

The main program will be:

```
NETDEF WorkPool IS
  ... – variables and procedures declaration
SEQ
   VAR iniTask : integer;
   PAR
     workCount := 1;
     iniWP;
     … -- construction of iniTask
   ENDPAR;
   putTask( iniTask );
   PAR
     ... – worker code repeated as many times as needed
   ENDPAR;
ENDSEQ;
ENDDEF.
```

4. Conclusions

We introduced the core of a new language, NETDEF. NETDEF develops an easy way to build neural nets performing arbitrarily complex computations. This method is modular, where each process is mapped in an independent neural net. Modularity brings great flexibility. For example, if a certain task is programmed and compiled, the resulting net is a module that can be used elsewhere.

The Replicated Workers paradigm was used as an example of parallel programming in NETDEF. It was shown how to make procedure calls to lock access to shared variables in a truly synchronous parallel architecture.

The use of finite neural networks as deterministic machines to implement arbitrary complex algorithms is now possible by the automation of compilers like NETDEF. If someday, neural net hardware would be as easy to build as Von Neumann hardware, then the NETDEF approach will provide a way to insert algorithms into the massive parallel architecture of artificial neural nets. To test our program, able to compile and simulate the dynamics of neural nets described in this paper, go to www.di.fc.ul.pt/~jpn/netdef/netdef.htm.

5. References

[INTERACTIVE 89]
Interactive Software Engineering Inc., **Eiffel®: the Language**, TR-EI 17/RM, 1989.

[GRUAU *et al.* 95]
Gruau, F.; Ratajszczak, J. and Wiber, G., *A Neural Compiler*, **Theoretical Computer Science**, [141] (1-2), 1995, 1-52.

[LESTER 93]
Lester, B. P., **The Art of Parallel Programming**, 1993, Prentice Hall.

[MCCULLOCH and PITTS 43]
McCulloch, W. and Pitts, W., *A Logical Calculus of the Ideas Immanent in Nervous Activity*, **Bulletin of Mathematical Biophysics**, 5, 1943, 115-133.

[MINSKY 67]
Minsky, M., **Computation: Finite and Infinite Machines**, Prentice Hall, 1967.

[NETO *et al.* 97]
Neto, J. P., Siegelmann, H., Costa, J. F., Araujo, C. S., *Turing Universality of Neural Nets (revisited)*, **Lecture Notes in Computer Science – 1333**, Springer-Verlag, 1997, 361-366.

[SIEGELMANN and SONTAG 95]
Siegelmann, H. and Sontag, E., *On the Computational Power of Neural Nets*, **Journal of Computer and System Sciences** [50] 1, Academic Press, 1995, 132-150.

[SIEGELMANN 96]
Siegelmann, H., *On NIL: The Software Constructor of Neural Networks*, **Parallel Processing Letters**, [6] 4, World Scientific Publishing Company, 1996, 575-582.

[SIEGELMANN 99]
Siegelmann, H., **Neural Networks and Analog Computation, Beyond the Turing Limit**, Birkhauser, 1999.

[SGS-THOMSOM 95]
SGS-THOMSON, **Occam® 2.1 Reference Manual**, 1995.

[SONTAG 90]
Sontag, E., *Mathematical Control Theory: Deterministic Finite Dimensional Systems*, Springer-Verlag, New York, 1990.

[USDD 83]
United States Department of Defence, **Reference Manual for the Ada® Programming Language**, American National Standards Institute Inc., 1983.

[WATT 90]
Watt, D., **Programming Language Concepts and Paradigms**, Prentice Hall International Series in Computer Science, 1990.

Appendix A – NETDEF Code for WorkPool sample

```
NETDEF netName(0,0) IS --NORESET

CONST
    endWork = 0;  -- special task termination

VAR
        task : integer; -- task descriptor
        wkPool : array [10] of integer;
        firstTask, lastTask, sizePool, i, j : integer;
          workCount, nWorkers : integer;
        b : boolean;

--------------------------------------------------

FUNCTION mod( x : integer; y : integer ) IS INTEGER
SEQ
  WHILE x>=y DO x := x-y;
  RETURN x;
ENDSEQ;

-- initialize WorkPool structure

FUNCTION iniWP IS NIL
SEQ
  firstTask := 1;
  lastTask := 1;
  sizePool := 10;
  endWork := 255;
ENDSEQ;

-- insert a Task into the WorkPool

FUNCTION putTask ( Task : integer ) IS NIL
SEQ
  i := lastTask+1;
  j := mod(i, sizePool);
  IF j = firstTask
   THEN RAISE wkPoolFull
   ELSE SEQ
          lastTask := mod(i, sizePool);
          wkPool[lastTask] := Task;
        ENDSEQ;
EXCEPTION
  WHEN wkPoolFull DO RETRY;
ENDSEQ;

-- get a Task from the WorkPool

FUNCTION getTask ( var Task : integer ) IS NIL
SEQ
  VAR i : integer;

  IF lastTask = firstTask
   THEN RAISE wkPoolEmpty
   ELSE SEQ
          Task := wkPool[firstTask] ;
          i := firstTask+1;
          firstTask := mod(i, sizePool);
        ENDSEQ;
EXCEPTION
  WHEN wkPoolEmpty DO RETRY;
ENDSEQ;

     -- procedure to handle termination

FUNCTION updateCount ( isGet : boolean ) IS NIL
```

```
IF isGet THEN workCount := pred(workCount)
         ELSE workCount := succ(workCount);

-- insert Work to be done

FUNCTION putWork ( Task : integer ) IS NIL
SEQ
  b := false;
  updateCount( b );
  putTask( Task );
ENDSEQ;

-- get undone Work

FUNCTION getWork ( var Task : integer ) IS NIL
SEQ
  VAR i : integer;;

  b := true;
  updateCount( b );
  IF workCount = - nWorkers
   THEN RAISE TerminateWP
   ELSE getTask( Task );
EXCEPTION
  WHEN TerminateWP DO
    SEQ
      i := 1;
      WHILE i < nWorkers DO
        putTask( endWork );
      ABORT;
    ENDSEQ;
ENDSEQ;

--------------------------------------------------

SEQ   -- Main Block

VAR iniTask, Task1 : integer;

PAR
  workCount := 1;
  nWorkers := 1;
  iniWP();

ENDPAR;
putTask( iniTask );

PAR  -- workers...

  SEQ   -- worker1

    getWork( Task1 );
    WHILE Task1 <> endWork DO
      SEQ
          -- with some putWork calls
        getWork( Task1 );
      ENDSEQ;

  ENDSEQ; -- endWorker1

     ENDPAR;

ENDSEQ;
ENDDEF.
```

Appendix B – Neural net structure of the previous code (679 neurons and 1438 synapses)

```
Mn0In(i+1) = sigma( )
Mn0Out(i+1) = sigma( + 1,0 * SEQ10Out(i) )
CONI:endWork(i+1) = sigma( - 1,0 * VI8Out(i) + 1,0 * ATR5ExpR(i) + 0,5 )
VARIMn0:task(i+1) = sigma( + 1,0 * VARIMn0:task(i) )
VARIMn0:wkPoolIn(i+1) = sigma( + 1,0 * ATR9dW(i) + 1,0 * VV17Out(i) )
VARIMn0:wkPoolOut(i+1) = sigma( + 1,0 * VARIMn0:wkPoold3In(i) + 1,0 *
           VARIMn0:wkPoold7In(i) )
VARIMn0:wkPoolResl(i+1) = sigma( + 1,0 * VARIMn0:wkPool[1]6(i) + 1,0 *
           VARIMn0:wkPool[2]6(i) + 1,0 * VARIMn0:wkPool[3]6(i) + 1,0 *
           VARIMn0:wkPool[4]6(i) + 1,0 * VARIMn0:wkPool[5]6(i) + 1,0 *
           VARIMn0:wkPool[6]6(i) + 1,0 * VARIMn0:wkPool[7]6(i) + 1,0 *
           VARIMn0:wkPool[8]6(i) + 1,0 * VARIMn0:wkPool[9]6(i) + 1,0 *
           VARIMn0:wkPool[10]6(i) )
VARIMn0:wkPoolVal(i+1) = sigma( + 1,0 * ATR9dVal(i) )
VARIMn0:wkPooldV(i+1) = sigma( + 1,0 * VARIMn0:wkPoolIn(i) + 1,0 *
           VARIMn0:wkPoolVal(i) - 1,0 )
VARIMn0:wkPoolddV(i+1) = sigma( + 1,0 * VARIMn0:wkPooldV(i) )
VARIMn0:wkPoold3V(i+1) = sigma( + 1,0 * VARIMn0:wkPoolddV(i) )
VARIMn0:wkPoolId(i+1) = sigma( + 1,0 * ATR9dId(i) )
VARIMn0:wkPooldId(i+1) = sigma( + 1,0 * VARIMn0:wkPoolIn(i) + 1,0 *
           VARIMn0:wkPoolId(i) - 1,0 )
VARIMn0:wkPooldIn(i+1) = sigma( + 1,0 * VARIMn0:wkPoolIn(i) + 2E13 *
           VARIMn0:wkPoolId(i) - 1,0 )
VARIMn0:wkPoolddIn(i+1) = sigma( + 1,0 * VARIMn0:wkPooldIn(i) )
VARIMn0:wkPoold3In(i+1) = sigma( + 1,0 * VARIMn0:wkPoolddIn(i) )
VARIMn0:wkPoold4In(i+1) = sigma( + 1,0 * VARIMn0:wkPoolIn(i) + 2E13 *
           VARIMn0:wkPoolValO(i) - 1,0 )
VARIMn0:wkPoold5In(i+1) = sigma( + 1,0 * VARIMn0:wkPoold4In(i) )
VARIMn0:wkPoold6In(i+1) = sigma( + 1,0 * VARIMn0:wkPoold5In(i) )
VARIMn0:wkPoold7In(i+1) = sigma( + 1,0 * VARIMn0:wkPoold6In(i) )
VARIMn0:wkPoolValO(i+1) = sigma( + 1,0 * VV17Resl(i) )
VARIMn0:wkPooldVO(i+1) = sigma( + 1,0 * VARIMn0:wkPoolIn(i) + 1,0 *
           VARIMn0:wkPoolValO(i) - 1,0 )
VARIMn0:wkPool[1](i+1) = sigma( + 1,0 * VARIMn0:wkPool[1](i) - 1,0 *
           VARIMn0:wkPool[1]2(i) + 1,0 * VARIMn0:wkPool[1]3(i) + 1,0 *
           VARIMn0:wkPool[2]2(i) )
VARIMn0:wkPool[1]1(i+1) = sigma( + 1,0 * VARIMn0:wkPooldId(i) - 0,5 )
VARIMn0:wkPool[1]2(i+1) = sigma( + 2E13 * VARIMn0:wkPool[1]1(i) )
VARIMn0:wkPool[1]3(i+1) = sigma( + 1,0 * VARIMn0:wkPoold3V(i) + 1,0 *
           VARIMn0:wkPool[1]2(i) - 1,0 * VARIMn0:wkPool[2]2(i) - 1,0 )
VARIMn0:wkPool[1]4(i+1) = sigma( + 1,0 * VARIMn0:wkPooldVO(i) - 0,50000000000001 )
VARIMn0:wkPool[1]5(i+1) = sigma( + 2E13 * VARIMn0:wkPool[1]4(i) )
VARIMn0:wkPool[1]6(i+1) = sigma( + 1,0 * VARIMn0:wkPool[1](i) + 1,0 *
           VARIMn0:wkPool[1]5(i) - 1,0 * VARIMn0:wkPool[2]5(i) - 1,0 )
VARIMn0:wkPool[2](i+1) = sigma( + 1,0 * VARIMn0:wkPool[2](i) - 1,0 *
           VARIMn0:wkPool[2]2(i) + 1,0 * VARIMn0:wkPool[2]3(i) + 1,0 *
           VARIMn0:wkPool[3]2(i) )
VARIMn0:wkPool[2]1(i+1) = sigma( + 1,0 * VARIMn0:wkPooldId(i) - 0,5000000000001 )
VARIMn0:wkPool[2]2(i+1) = sigma( + 2E13 * VARIMn0:wkPool[2]1(i) )
VARIMn0:wkPool[2]3(i+1) = sigma( + 1,0 * VARIMn0:wkPoold3V(i) + 1,0 *
           VARIMn0:wkPool[2]2(i) - 1,0 * VARIMn0:wkPool[3]2(i) - 1,0 )
VARIMn0:wkPool[2]4(i+1) = sigma( + 1,0 * VARIMn0:wkPooldVO(i) - 0,50000000000011 )
VARIMn0:wkPool[2]5(i+1) = sigma( + 2E13 * VARIMn0:wkPool[2]4(i) )
VARIMn0:wkPool[2]6(i+1) = sigma( + 1,0 * VARIMn0:wkPool[2](i) + 1,0 *
           VARIMn0:wkPool[2]5(i) - 1,0 * VARIMn0:wkPool[3]5(i) - 1,0 )
VARIMn0:wkPool[3](i+1) = sigma( + 1,0 * VARIMn0:wkPool[3](i) - 1,0 *
           VARIMn0:wkPool[3]2(i) + 1,0 * VARIMn0:wkPool[3]3(i) + 1,0 *
           VARIMn0:wkPool[4]2(i) )
VARIMn0:wkPool[3]1(i+1) = sigma( + 1,0 * VARIMn0:wkPooldId(i) - 0,5000000000002 )
VARIMn0:wkPool[3]2(i+1) = sigma( + 2E13 * VARIMn0:wkPool[3]1(i) )
VARIMn0:wkPool[3]3(i+1) = sigma( + 1,0 * VARIMn0:wkPoold3V(i) + 1,0 *
           VARIMn0:wkPool[3]2(i) - 1,0 * VARIMn0:wkPool[4]2(i) - 1,0 )
VARIMn0:wkPool[3]4(i+1) = sigma( + 1,0 * VARIMn0:wkPooldVO(i) - 0,50000000000021 )
VARIMn0:wkPool[3]5(i+1) = sigma( + 2E13 * VARIMn0:wkPool[3]4(i) )
VARIMn0:wkPool[3]6(i+1) = sigma( + 1,0 * VARIMn0:wkPool[3](i) + 1,0 *
           VARIMn0:wkPool[3]5(i) - 1,0 * VARIMn0:wkPool[4]5(i) - 1,0 )
VARIMn0:wkPool[4](i+1) = sigma( + 1,0 * VARIMn0:wkPool[4](i) - 1,0 *
           VARIMn0:wkPool[4]2(i) + 1,0 * VARIMn0:wkPool[4]3(i) + 1,0 *
           VARIMn0:wkPool[5]2(i) )
VARIMn0:wkPool[4]1(i+1) = sigma( + 1,0 * VARIMn0:wkPooldId(i) - 0,5000000000003 )
VARIMn0:wkPool[4]2(i+1) = sigma( + 2E13 * VARIMn0:wkPool[4]1(i) )
```

```
VARIMn0:wkPool[4]3(i+1) = sigma( + 1,0 * VARIMn0:wkPoold3V(i) + 1,0 *
            VARIMn0:wkPool[4]2(i) - 1,0 * VARIMn0:wkPool[5]2(i) - 1,0 )
VARIMn0:wkPool[4]4(i+1) = sigma( + 1,0 * VARIMn0:wkPooldVO(i) - 0,50000000000031 )
VARIMn0:wkPool[4]5(i+1) = sigma( + 2E13 * VARIMn0:wkPool[4]4(i) )
VARIMn0:wkPool[4]6(i+1) = sigma( + 1,0 * VARIMn0:wkPool[4](i) + 1,0 *
            VARIMn0:wkPool[4]5(i) - 1,0 * VARIMn0:wkPool[5]5(i) - 1,0 )
VARIMn0:wkPool[5](i+1) = sigma( + 1,0 * VARIMn0:wkPool[5](i) - 1,0 *
            VARIMn0:wkPool[5]2(i) + 1,0 * VARIMn0:wkPool[5]3(i) + 1,0 *
            VARIMn0:wkPool[6]2(i) )
VARIMn0:wkPool[5]1(i+1) = sigma( + 1,0 * VARIMn0:wkPooldId(i) - 0,5000000000004 )
VARIMn0:wkPool[5]2(i+1) = sigma( + 2E13 * VARIMn0:wkPool[5]1(i) )
VARIMn0:wkPool[5]3(i+1) = sigma( + 1,0 * VARIMn0:wkPoold3V(i) + 1,0 *
            VARIMn0:wkPool[5]2(i) - 1,0 * VARIMn0:wkPool[6]2(i) - 1,0 )
VARIMn0:wkPool[5]4(i+1) = sigma( + 1,0 * VARIMn0:wkPooldVO(i) - 0,50000000000041 )
VARIMn0:wkPool[5]5(i+1) = sigma( + 2E13 * VARIMn0:wkPool[5]4(i) )
VARIMn0:wkPool[5]6(i+1) = sigma( + 1,0 * VARIMn0:wkPool[5](i) + 1,0 *
            VARIMn0:wkPool[5]5(i) - 1,0 * VARIMn0:wkPool[6]5(i) - 1,0 )
VARIMn0:wkPool[6](i+1) = sigma( + 1,0 * VARIMn0:wkPool[6](i) - 1,0 *
            VARIMn0:wkPool[6]2(i) + 1,0 * VARIMn0:wkPool[6]3(i) + 1,0 *
            VARIMn0:wkPool[7]2(i) )
VARIMn0:wkPool[6]1(i+1) = sigma( + 1,0 * VARIMn0:wkPooldId(i) - 0,5000000000005 )
VARIMn0:wkPool[6]2(i+1) = sigma( + 2E13 * VARIMn0:wkPool[6]1(i) )
VARIMn0:wkPool[6]3(i+1) = sigma( + 1,0 * VARIMn0:wkPoold3V(i) + 1,0 *
            VARIMn0:wkPool[6]2(i) - 1,0 * VARIMn0:wkPool[7]2(i) - 1,0 )
VARIMn0:wkPool[6]4(i+1) = sigma( + 1,0 * VARIMn0:wkPooldVO(i) - 0,50000000000051 )
VARIMn0:wkPool[6]5(i+1) = sigma( + 2E13 * VARIMn0:wkPool[6]4(i) )
VARIMn0:wkPool[6]6(i+1) = sigma( + 1,0 * VARIMn0:wkPool[6](i) + 1,0 *
            VARIMn0:wkPool[6]5(i) - 1,0 * VARIMn0:wkPool[7]5(i) - 1,0 )
VARIMn0:wkPool[7](i+1) = sigma( + 1,0 * VARIMn0:wkPool[7](i) - 1,0 *
            VARIMn0:wkPool[7]2(i) + 1,0 * VARIMn0:wkPool[7]3(i) + 1,0 *
            VARIMn0:wkPool[8]2(i) )
VARIMn0:wkPool[7]1(i+1) = sigma( + 1,0 * VARIMn0:wkPooldId(i) - 0,5000000000006 )
VARIMn0:wkPool[7]2(i+1) = sigma( + 2E13 * VARIMn0:wkPool[7]1(i) )
VARIMn0:wkPool[7]3(i+1) = sigma( + 1,0 * VARIMn0:wkPoold3V(i) + 1,0 *
            VARIMn0:wkPool[7]2(i) - 1,0 * VARIMn0:wkPool[8]2(i) - 1,0 )
VARIMn0:wkPool[7]4(i+1) = sigma( + 1,0 * VARIMn0:wkPooldVO(i) - 0,50000000000061 )
VARIMn0:wkPool[7]5(i+1) = sigma( + 2E13 * VARIMn0:wkPool[7]4(i) )
VARIMn0:wkPool[7]6(i+1) = sigma( + 1,0 * VARIMn0:wkPool[7](i) + 1,0 *
            VARIMn0:wkPool[7]5(i) - 1,0 * VARIMn0:wkPool[8]5(i) - 1,0 )
VARIMn0:wkPool[8](i+1) = sigma( + 1,0 * VARIMn0:wkPool[8](i) - 1,0 *
            VARIMn0:wkPool[8]2(i) + 1,0 * VARIMn0:wkPool[8]3(i) + 1,0 *
            VARIMn0:wkPool[9]2(i) )
VARIMn0:wkPool[8]1(i+1) = sigma( + 1,0 * VARIMn0:wkPooldId(i) - 0,5000000000007 )
VARIMn0:wkPool[8]2(i+1) = sigma( + 2E13 * VARIMn0:wkPool[8]1(i) )
VARIMn0:wkPool[8]3(i+1) = sigma( + 1,0 * VARIMn0:wkPoold3V(i) + 1,0 *
            VARIMn0:wkPool[8]2(i) - 1,0 * VARIMn0:wkPool[9]2(i) - 1,0 )
VARIMn0:wkPool[8]4(i+1) = sigma( + 1,0 * VARIMn0:wkPooldVO(i) - 0,50000000000071 )
VARIMn0:wkPool[8]5(i+1) = sigma( + 2E13 * VARIMn0:wkPool[8]4(i) )
VARIMn0:wkPool[8]6(i+1) = sigma( + 1,0 * VARIMn0:wkPool[8](i) + 1,0 *
            VARIMn0:wkPool[8]5(i) - 1,0 * VARIMn0:wkPool[9]5(i) - 1,0 )
VARIMn0:wkPool[9](i+1) = sigma( + 1,0 * VARIMn0:wkPool[9](i) - 1,0 *
            VARIMn0:wkPool[9]2(i) + 1,0 * VARIMn0:wkPool[9]3(i) + 1,0 *
            VARIMn0:wkPool[10]2(i) )
VARIMn0:wkPool[9]1(i+1) = sigma( + 1,0 * VARIMn0:wkPooldId(i) - 0,5000000000008 )
VARIMn0:wkPool[9]2(i+1) = sigma( + 2E13 * VARIMn0:wkPool[9]1(i) )
VARIMn0:wkPool[9]3(i+1) = sigma( + 1,0 * VARIMn0:wkPoold3V(i) + 1,0 *
            VARIMn0:wkPool[9]2(i) - 1,0 * VARIMn0:wkPool[10]2(i) - 1,0 )
VARIMn0:wkPool[9]4(i+1) = sigma( + 1,0 * VARIMn0:wkPooldVO(i) - 0,50000000000081 )
VARIMn0:wkPool[9]5(i+1) = sigma( + 2E13 * VARIMn0:wkPool[9]4(i) )
VARIMn0:wkPool[9]6(i+1) = sigma( + 1,0 * VARIMn0:wkPool[9](i) + 1,0 *
            VARIMn0:wkPool[9]5(i) - 1,0 * VARIMn0:wkPool[10]5(i) - 1,0 )
VARIMn0:wkPool[10](i+1) = sigma( + 1,0 * VARIMn0:wkPool[10](i) - 1,0 *
            VARIMn0:wkPool[10]2(i) + 1,0 * VARIMn0:wkPool[10]3(i) )
VARIMn0:wkPool[10]1(i+1) = sigma( + 1,0 * VARIMn0:wkPooldId(i) - 0,5000000000009 )
VARIMn0:wkPool[10]2(i+1) = sigma( + 2E13 * VARIMn0:wkPool[10]1(i) )
VARIMn0:wkPool[10]3(i+1) = sigma( + 1,0 * VARIMn0:wkPoold3V(i) + 1,0 *
            VARIMn0:wkPool[10]2(i) - 1,0 )
VARIMn0:wkPool[10]4(i+1) = sigma( + 1,0 * VARIMn0:wkPooldVO(i) - 0,50000000000091 )
VARIMn0:wkPool[10]5(i+1) = sigma( + 2E13 * VARIMn0:wkPool[10]4(i) )
VARIMn0:wkPool[10]6(i+1) = sigma( + 1,0 * VARIMn0:wkPool[10](i) + 1,0 *
            VARIMn0:wkPool[10]5(i) - 1,0 )
VARIMn0:j(i+1) = sigma( + 1,0 * VARIMn0:j(i) - 1,0 * CALL1Out(i) + 1,0 *
            ATR7ExpR(i) )
VARIMn0:i(i+1) = sigma( + 1,0 * VARIMn0:i(i) - 1,0 * SUM1Out(i) + 1,0 * ATR6ExpR(i)
            )
VARIMn0:sizePool(i+1) = sigma( + 1,0 * VARIMn0:sizePool(i) - 1,0 * VI7Out(i) + 1,0
            * ATR4ExpR(i) )
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VARIMn0:lastTask(i+1) = sigma( + 1,0 * VARIMn0:lastTask(i) - 1,0 * VI6Out(i) + 1,0
            * ATR3ExpR(i) - 1,0 * CALL2Out(i) + 1,0 * ATR8ExpR(i) )
VARIMn0:firstTask(i+1) = sigma( + 1,0 * VARIMn0:firstTask(i) - 1,0 * VI5Out(i) +
            1,0 * ATR2ExpR(i) - 1,0 * CALL3Out(i) + 1,0 * ATR12ExpR(i) )
VARIMn0:nWorkers(i+1) = sigma( + 1,0 * VARIMn0:nWorkers(i) - 1,0 * VI32Out(i) + 1,0
            * ATR19ExpR(i) )
VARIMn0:workCount(i+1) = sigma( + 1,0 * VARIMn0:workCount(i) - 1,0 * PRE1Out(i) +
            1,0 * ATR13ExpR(i) - 1,0 * SUC1Out(i) + 1,0 * ATR14ExpR(i) - 1,0 *
            VI31Out(i) + 1,0 * ATR18ExpR(i) )
VARBMn0:b(i+1) = sigma( + 1,0 * VARBMn0:b(i) + 1,0 * ATR15ExpR(i) - 1,0 *
            VB25Out(i) + 1,0 * ATR16ExpR(i) )
FI:modIn(i+1) = sigma( + 1,0 * CALL1Bgn(i) + 1,0 * CALL2Bgn(i) + 1,0 * CALL3Bgn(i)
            )
FI:modOut(i+1) = sigma( + 1,0 * FI:modddOut(i) )
FI:modResl(i+1) = sigma( + 1,0 * FI:modddRes(i) )
FI:moddOut(i+1) = sigma( + 1,0 * SEQ1Out(i) )
FI:modddOut(i+1) = sigma( + 1,0 * FI:moddOut(i) )
FI:moddRes(i+1) = sigma( + 1,0 * SEQ1Resl(i) )
FI:modddRes(i+1) = sigma( + 1,0 * FI:moddRes(i) )
VARILFI:mod:x(i+1) = sigma( - 1,0 * FI:modddOut(i) + 1,0 * VARILFI:mod:x(i) + 1,0 *
            FI:modArg1(i) - 1,0 * SUB1Out(i) + 1,0 * ATR1ExpR(i) )
FI:modArg1(i+1) = sigma( + 1,0 * CALL1dVl1(i) + 1,0 * CALL2dVl1(i) + 1,0 *
            CALL3dVl1(i) )
VARILFI:mod:y(i+1) = sigma( - 1,0 * FI:modddOut(i) + 1,0 * VARILFI:mod:y(i) + 1,0 *
            FI:modArg2(i) )
FI:modArg2(i+1) = sigma( + 1,0 * CALL1dVl2(i) + 1,0 * CALL2dVl2(i) + 1,0 *
            CALL3dVl2(i) )
FI:mod0(i+1) = sigma( + 1,0 * Mn0In(i) + 1,0 * FI:mod3d(i) )
FI:mod0d(i+1) = sigma( + 1,0 * FI:mod0(i) )
SEQ1In(i+1) = sigma( + 1,0 * FI:modIn(i) )
SEQ1Out(i+1) = sigma( + 1,0 * SEQ1dAbr(i) )
SEQ1Reset(i+1) = sigma( + 1,0 * SEQ1Abort(i) )
SEQ1Abort(i+1) = sigma( + 1,0 * RET1In(i) )
SEQ1Resl(i+1) = sigma( + 1,0 * RET1ddRs(i) )
SEQ1dAbr(i+1) = sigma( + 1,0 * SEQ1Abort(i) )
WHL1In(i+1) = sigma( + 1,0 * SEQ1In(i) - 1,0 * SEQ1Reset(i) + 1,0 * ATR1Out(i) )
WHL1ExpR(i+1) = sigma( - 1,0 * SEQ1Reset(i) + 1,0 * GE1Out(i) + 1,0 * GE1Resl(i) -
            1,0 )
WHL1Out(i+1) = sigma( - 1,0 * SEQ1Reset(i) + 1,0 * GE1Out(i) - 1,0 * GE1Resl(i) )
VV1In(i+1) = sigma( - 1,0 * SEQ1Reset(i) + 1,0 * GE1In(i) )
VV1Out(i+1) = sigma( - 1,0 * SEQ1Reset(i) + 1,0 * VV1In(i) )
VV1Resl(i+1) = sigma( + 1,0 * VARILFI:mod:x(i) - 1,0 * SEQ1Reset(i) + 1,0 *
            VV1In(i) - 1,0 )
VV2In(i+1) = sigma( - 1,0 * SEQ1Reset(i) + 1,0 * GE1In(i) )
VV2Out(i+1) = sigma( - 1,0 * SEQ1Reset(i) + 1,0 * VV2In(i) )
VV2Resl(i+1) = sigma( + 1,0 * VARILFI:mod:y(i) - 1,0 * SEQ1Reset(i) + 1,0 *
            VV2In(i) - 1,0 )
GE1In(i+1) = sigma( - 1,0 * SEQ1Reset(i) + 1,0 * WHL1In(i) )
GE1Out(i+1) = sigma( - 1,0 * SEQ1Reset(i) + 1,0 * GE1d3Wt(i) )
GE1Resl(i+1) = sigma( - 1,0 * SEQ1Reset(i) - 1,0 * GE1ddRs(i) + 1,0 * GE1d3Wt(i) )
GE1dRs(i+1) = sigma( - 1,0 * GE1dLf(i) + 1,0 * GE1dRg(i) )
GE1ddRs(i+1) = sigma( + 2E13 * GE1dRs(i) )
GE1ddWt(i+1) = sigma( + 1,0 * GE1dWt(i) )
GE1d3Wt(i+1) = sigma( + 1,0 * GE1ddWt(i) )
GE1wait(i+1) = sigma( - 1,0 * SEQ1Reset(i) - 1,0 * GE1wait(i) + 1,0 * GE1wLf(i) +
            1,0 * GE1wRg(i) - 1,0 )
GE1dWt(i+1) = sigma( - 1,0 * SEQ1Reset(i) + 1,0 * GE1wait(i) )
GE1vLf(i+1) = sigma( - 1,0 * SEQ1Reset(i) + 1,0 * VV1Resl(i) - 1,0 * GE1wait(i) +
            1,0 * GE1vLf(i) )
GE1wLf(i+1) = sigma( - 1,0 * SEQ1Reset(i) + 1,0 * VV1Out(i) - 1,0 * GE1wait(i) +
            1,0 * GE1wLf(i) )
GE1dLf(i+1) = sigma( - 1,0 * SEQ1Reset(i) + 1,0 * GE1wait(i) + 1,0 * GE1vLf(i) -
            1,0 )
GE1vRg(i+1) = sigma( - 1,0 * SEQ1Reset(i) + 1,0 * VV2Resl(i) - 1,0 * GE1wait(i) +
            1,0 * GE1vRg(i) )
GE1wRg(i+1) = sigma( - 1,0 * SEQ1Reset(i) + 1,0 * VV2Out(i) - 1,0 * GE1wait(i) +
            1,0 * GE1wRg(i) )
GE1dRg(i+1) = sigma( - 1,0 * SEQ1Reset(i) + 1,0 * GE1wait(i) + 1,0 * GE1vRg(i) -
            1,0 )
VV3In(i+1) = sigma( - 1,0 * SEQ1Reset(i) + 1,0 * SUB1In(i) )
VV3Out(i+1) = sigma( - 1,0 * SEQ1Reset(i) + 1,0 * VV3In(i) )
VV3Resl(i+1) = sigma( + 1,0 * VARILFI:mod:x(i) - 1,0 * SEQ1Reset(i) + 1,0 *
            VV3In(i) - 1,0 )
VV4In(i+1) = sigma( - 1,0 * SEQ1Reset(i) + 1,0 * SUB1In(i) )
VV4Out(i+1) = sigma( - 1,0 * SEQ1Reset(i) + 1,0 * VV4In(i) )
VV4Resl(i+1) = sigma( + 1,0 * VARILFI:mod:y(i) - 1,0 * SEQ1Reset(i) + 1,0 *
            VV4In(i) - 1,0 )
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SUB1In(i+1) = sigma( - 1,0 * SEQ1Reset(i) + 1,0 * ATR1In(i) )
SUB1Out(i+1) = sigma( - 1,0 * SEQ1Reset(i) + 1,0 * SUB1dWt(i) )
SUB1Resl(i+1) = sigma( - 1,0 * SEQ1Reset(i) + 1,0 * SUB1dWt(i) + 1,0 * SUB1dLf(i) -
            1,0 * SUB1dRg(i) - 0,5 )
SUB1wait(i+1) = sigma( - 1,0 * SEQ1Reset(i) - 1,0 * SUB1wait(i) + 1,0 * SUB1wLf(i)
            + 1,0 * SUB1wRg(i) - 1,0 )
SUB1dWt(i+1) = sigma( - 1,0 * SEQ1Reset(i) + 1,0 * SUB1wait(i) )
SUB1vLf(i+1) = sigma( - 1,0 * SEQ1Reset(i) + 1,0 * VV3Resl(i) - 1,0 * SUB1wait(i) +
            1,0 * SUB1vLf(i) )
SUB1wLf(i+1) = sigma( - 1,0 * SEQ1Reset(i) + 1,0 * VV3Out(i) - 1,0 * SUB1wait(i) +
            1,0 * SUB1wLf(i) )
SUB1dLf(i+1) = sigma( - 1,0 * SEQ1Reset(i) + 1,0 * SUB1wait(i) + 1,0 * SUB1vLf(i) -
            1,0 )
SUB1vRg(i+1) = sigma( - 1,0 * SEQ1Reset(i) + 1,0 * VV4Resl(i) - 1,0 * SUB1wait(i) +
            1,0 * SUB1vRg(i) )
SUB1wRg(i+1) = sigma( - 1,0 * SEQ1Reset(i) + 1,0 * VV4Out(i) - 1,0 * SUB1wait(i) +
            1,0 * SUB1wRg(i) )
SUB1dRg(i+1) = sigma( - 1,0 * SEQ1Reset(i) + 1,0 * SUB1wait(i) + 1,0 * SUB1vRg(i) -
            1,0 )
ATR1In(i+1) = sigma( - 1,0 * SEQ1Reset(i) + 1,0 * WHL1ExpR(i) )
ATR1ExpR(i+1) = sigma( - 1,0 * SEQ1Reset(i) + 1,0 * SUB1Out(i) + 1,0 * SUB1Resl(i)
            - 1,0 )
ATR1Out(i+1) = sigma( - 1,0 * SEQ1Reset(i) + 1,0 * SUB1Out(i) )
RET1In(i+1) = sigma( - 1,0 * SEQ1Reset(i) + 1,0 * WHL1Out(i) )
RET1dRs(i+1) = sigma( + 1,0 * VARILFI:mod:x(i) - 1,0 * SEQ1Reset(i) + 1,0 *
            RET1In(i) - 1,0 )
RET1ddRs(i+1) = sigma( - 1,0 * SEQ1Reset(i) + 1,0 * RET1dRs(i) )
F_:iniWPIn(i+1) = sigma( + 1,0 * CALL9Bgn(i) )
F_:iniWPOut(i+1) = sigma( + 1,0 * F_:iniWPddOut(i) )
F_:iniWPdOut(i+1) = sigma( + 1,0 * SEQ2Out(i) )
F_:iniWPddOut(i+1) = sigma( + 1,0 * F_:iniWPdOut(i) )
F_:iniWP0(i+1) = sigma( + 1,0 * Mn0In(i) + 1,0 * F_:iniWP1d(i) )
F_:iniWP0d(i+1) = sigma( + 1,0 * F_:iniWP0(i) )
SEQ2In(i+1) = sigma( + 1,0 * F_:iniWPIn(i) )
SEQ2Out(i+1) = sigma( + 1,0 * ATR5Out(i) )
VI5In(i+1) = sigma( + 1,0 * ATR2In(i) )
VI5Out(i+1) = sigma( + 1,0 * VI5In(i) )
VI5Resl(i+1) = sigma( + 1,0 * VI5In(i) - 0,4999999999999 )
ATR2In(i+1) = sigma( + 1,0 * SEQ2In(i) )
ATR2ExpR(i+1) = sigma( + 1,0 * VI5Out(i) + 1,0 * VI5Resl(i) - 1,0 )
ATR2Out(i+1) = sigma( + 1,0 * VI5Out(i) )
VI6In(i+1) = sigma( + 1,0 * ATR3In(i) )
VI6Out(i+1) = sigma( + 1,0 * VI6In(i) )
VI6Resl(i+1) = sigma( + 1,0 * VI6In(i) - 0,4999999999999 )
ATR3In(i+1) = sigma( + 1,0 * ATR2Out(i) )
ATR3ExpR(i+1) = sigma( + 1,0 * VI6Out(i) + 1,0 * VI6Resl(i) - 1,0 )
ATR3Out(i+1) = sigma( + 1,0 * VI6Out(i) )
VI7In(i+1) = sigma( + 1,0 * ATR4In(i) )
VI7Out(i+1) = sigma( + 1,0 * VI7In(i) )
VI7Resl(i+1) = sigma( + 1,0 * VI7In(i) - 0,499999999999 )
ATR4In(i+1) = sigma( + 1,0 * ATR3Out(i) )
ATR4ExpR(i+1) = sigma( + 1,0 * VI7Out(i) + 1,0 * VI7Resl(i) - 1,0 )
ATR4Out(i+1) = sigma( + 1,0 * VI7Out(i) )
VI8In(i+1) = sigma( + 1,0 * ATR5In(i) )
VI8Out(i+1) = sigma( + 1,0 * VI8In(i) )
VI8Resl(i+1) = sigma( + 1,0 * VI8In(i) - 0,4999999999745 )
ATR5In(i+1) = sigma( + 1,0 * ATR4Out(i) )
ATR5ExpR(i+1) = sigma( + 1,0 * VI8Out(i) + 1,0 * VI8Resl(i) - 1,0 )
ATR5Out(i+1) = sigma( + 1,0 * VI8Out(i) )
F_:putTaskIn(i+1) = sigma( + 1,0 * CALL5Bgn(i) + 1,0 * CALL8Bgn(i) + 1,0 *
            CALL10Bgn(i) )
F_:putTaskOut(i+1) = sigma( + 1,0 * F_:putTaskddOut(i) )
F_:putTaskdOut(i+1) = sigma( + 1,0 * SEQ3Out(i) )
F_:putTaskddOut(i+1) = sigma( + 1,0 * F_:putTaskdOut(i) )
VARILF_:putTask:Task(i+1) = sigma( - 1,0 * F_:putTaskddOut(i) + 1,0 *
            VARILF_:putTask:Task(i) + 1,0 * F_:putTaskArg1(i) )
F_:putTaskArg1(i+1) = sigma( + 1,0 * CALL5dVl1(i) + 1,0 * CALL8dVl1(i) + 1,0 *
            CALL10dVl1(i) )
F_:putTask0(i+1) = sigma( + 1,0 * Mn0In(i) + 1,0 * F_:putTask3d(i) )
F_:putTask0d(i+1) = sigma( + 1,0 * F_:putTask0(i) )
SEQ3In(i+1) = sigma( + 1,0 * F_:putTaskIn(i) + 1,0 * SEQ3dRet(i) )
SEQ3Out(i+1) = sigma( + 1,0 * IF1Out(i) )
SEQ3Reset(i+1) = sigma( + 1,0 * SEQ3Retry(i) )
SEQ3Retry(i+1) = sigma( + 1,0 * RTRY1In(i) )
SEQ3dRet(i+1) = sigma( + 1,0 * SEQ3Retry(i) )
VV9In(i+1) = sigma( - 1,0 * SEQ3Reset(i) + 1,0 * SUM1In(i) )
VV9Out(i+1) = sigma( - 1,0 * SEQ3Reset(i) + 1,0 * VV9In(i) )
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VV9Resl(i+1) = sigma( + 1,0 * VARIMn0:lastTask(i) - 1,0 * SEQ3Reset(i) + 1,0 *
           VV9In(i) - 1,0 )
VI10In(i+1) = sigma( - 1,0 * SEQ3Reset(i) + 1,0 * SUM1In(i) )
VI10Out(i+1) = sigma( - 1,0 * SEQ3Reset(i) + 1,0 * VI10In(i) )
VI10Resl(i+1) = sigma( - 1,0 * SEQ3Reset(i) + 1,0 * VI10In(i) - 0,4999999999999 )
SUM1In(i+1) = sigma( - 1,0 * SEQ3Reset(i) + 1,0 * ATR6In(i) )
SUM1Out(i+1) = sigma( - 1,0 * SEQ3Reset(i) + 1,0 * SUM1dWt(i) )
SUM1Resl(i+1) = sigma( - 1,0 * SEQ3Reset(i) + 1,0 * SUM1dLf(i) + 1,0 * SUM1dRg(i) -
           0,5 )
SUM1wait(i+1) = sigma( - 1,0 * SEQ3Reset(i) - 1,0 * SUM1wait(i) + 1,0 * SUM1wLf(i)
           + 1,0 * SUM1wRg(i) - 1,0 )
SUM1dWt(i+1) = sigma( - 1,0 * SEQ3Reset(i) + 1,0 * SUM1wait(i) )
SUM1vLf(i+1) = sigma( - 1,0 * SEQ3Reset(i) + 1,0 * VV9Resl(i) - 1,0 * SUM1wait(i) +
           1,0 * SUM1vLf(i) )
SUM1wLf(i+1) = sigma( - 1,0 * SEQ3Reset(i) + 1,0 * VV9Out(i) - 1,0 * SUM1wait(i) +
           1,0 * SUM1wLf(i) )
SUM1dLf(i+1) = sigma( - 1,0 * SEQ3Reset(i) + 1,0 * SUM1wait(i) + 1,0 * SUM1vLf(i) -
           1,0 )
SUM1vRg(i+1) = sigma( - 1,0 * SEQ3Reset(i) + 1,0 * VI10Resl(i) - 1,0 * SUM1wait(i)
           + 1,0 * SUM1vRg(i) )
SUM1wRg(i+1) = sigma( - 1,0 * SEQ3Reset(i) + 1,0 * VI10Out(i) - 1,0 * SUM1wait(i) +
           1,0 * SUM1wRg(i) )
SUM1dRg(i+1) = sigma( - 1,0 * SEQ3Reset(i) + 1,0 * SUM1wait(i) + 1,0 * SUM1vRg(i) -
           1,0 )
ATR6In(i+1) = sigma( + 1,0 * SEQ3In(i) - 1,0 * SEQ3Reset(i) )
ATR6ExpR(i+1) = sigma( - 1,0 * SEQ3Reset(i) + 1,0 * SUM1Out(i) + 1,0 * SUM1Resl(i)
           - 1,0 )
ATR6Out(i+1) = sigma( - 1,0 * SEQ3Reset(i) + 1,0 * SUM1Out(i) )
CALL1In(i+1) = sigma( + 1,0 * CALL1In(i) - 1,0 * CALL1End(i) + 1,0 * ATR7In(i) )
CALL1Out(i+1) = sigma( + 1,0 * FI:modOut(i) + 1,0 * CALL1Work(i) - 1,0 )
CALL1Resl(i+1) = sigma( + 1,0 * FI:modResl(i) + 1,0 * CALL1Work(i) - 1,0 )
CALL1Bgn(i+1) = sigma( + 1,0 * FI:mod0d(i) + 1,0 * CALL1In(i) - 1,0 )
CALL1End(i+1) = sigma( + 1,0 * FI:modOut(i) - 1,0 * CALL1End(i) + 1,0 *
           CALL1Work(i) - 1,0 )
CALL1Work(i+1) = sigma( + 1,0 * CALL1Bgn(i) - 1,0 * CALL1End(i) + 1,0 *
           CALL1Work(i) )
FI:mod1(i+1) = sigma( + 1,0 * FI:mod0d(i) + 1,0 * CALL1End(i) )
FI:mod1d(i+1) = sigma( - 1,0 * CALL1Bgn(i) + 1,0 * FI:mod1(i) )
CALL1dVl2(i+1) = sigma( + 1,0 * VARIMn0:sizePool(i) + 1,0 * CALL1Bgn(i) - 1,0 )
CALL1dVl1(i+1) = sigma( + 1,0 * VARIMn0:i(i) + 1,0 * CALL1Bgn(i) - 1,0 )
ATR7In(i+1) = sigma( - 1,0 * SEQ3Reset(i) + 1,0 * ATR6Out(i) )
ATR7ExpR(i+1) = sigma( - 1,0 * SEQ3Reset(i) + 1,0 * CALL1Out(i) + 1,0 *
           CALL1Resl(i) - 1,0 )
ATR7Out(i+1) = sigma( - 1,0 * SEQ3Reset(i) + 1,0 * CALL1Out(i) )
VV11In(i+1) = sigma( - 1,0 * SEQ3Reset(i) + 1,0 * EQL1In(i) )
VV11Out(i+1) = sigma( - 1,0 * SEQ3Reset(i) + 1,0 * VV11In(i) )
VV11Resl(i+1) = sigma( + 1,0 * VARIMn0:j(i) - 1,0 * SEQ3Reset(i) + 1,0 * VV11In(i)
           - 1,0 )
VV12In(i+1) = sigma( - 1,0 * SEQ3Reset(i) + 1,0 * EQL1In(i) )
VV12Out(i+1) = sigma( - 1,0 * SEQ3Reset(i) + 1,0 * VV12In(i) )
VV12Resl(i+1) = sigma( + 1,0 * VARIMn0:firstTask(i) - 1,0 * SEQ3Reset(i) + 1,0 *
           VV12In(i) - 1,0 )
EQL1In(i+1) = sigma( - 1,0 * SEQ3Reset(i) + 1,0 * IF1In(i) )
EQL1Out(i+1) = sigma( - 1,0 * SEQ3Reset(i) + 1,0 * EQL1d3Wt(i) )
EQL1Resl(i+1) = sigma( - 1,0 * SEQ3Reset(i) - 1,0 * EQL1ddRs(i) + 1,0 * EQL1d3Wt(i)
           )
EQL1dRs1(i+1) = sigma( + 1,0 * EQL1dLf(i) - 1,0 * EQL1dRg(i) )
EQL1dRs2(i+1) = sigma( - 1,0 * EQL1dLf(i) + 1,0 * EQL1dRg(i) )
EQL1ddRs(i+1) = sigma( + 1E13 * EQL1dRs1(i) + 1E13 * EQL1dRs2(i) )
EQL1ddWt(i+1) = sigma( + 1,0 * EQL1dWt(i) )
EQL1d3Wt(i+1) = sigma( + 1,0 * EQL1ddWt(i) )
EQL1wait(i+1) = sigma( - 1,0 * SEQ3Reset(i) - 1,0 * EQL1wait(i) + 1,0 * EQL1wLf(i)
           + 1,0 * EQL1wRg(i) - 1,0 )
EQL1dWt(i+1) = sigma( - 1,0 * SEQ3Reset(i) + 1,0 * EQL1wait(i) )
EQL1vLf(i+1) = sigma( - 1,0 * SEQ3Reset(i) + 1,0 * VV11Resl(i) - 1,0 * EQL1wait(i)
           + 1,0 * EQL1vLf(i) )
EQL1wLf(i+1) = sigma( - 1,0 * SEQ3Reset(i) + 1,0 * VV11Out(i) - 1,0 * EQL1wait(i) +
           1,0 * EQL1wLf(i) )
EQL1dLf(i+1) = sigma( - 1,0 * SEQ3Reset(i) + 1,0 * EQL1wait(i) + 1,0 * EQL1vLf(i) -
           1,0 )
EQL1vRg(i+1) = sigma( - 1,0 * SEQ3Reset(i) + 1,0 * VV12Resl(i) - 1,0 * EQL1wait(i)
           + 1,0 * EQL1vRg(i) )
EQL1wRg(i+1) = sigma( - 1,0 * SEQ3Reset(i) + 1,0 * VV12Out(i) - 1,0 * EQL1wait(i) +
           1,0 * EQL1wRg(i) )
EQL1dRg(i+1) = sigma( - 1,0 * SEQ3Reset(i) + 1,0 * EQL1wait(i) + 1,0 * EQL1vRg(i) -
           1,0 )
RSE1In(i+1) = sigma( + 1,0 * IF1Then(i) )
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VARESEQ3:wkPoolFull(i+1) = sigma( - 1,0 * SEQ3Reset(i) + 1,0 * RSE1In(i) )
SEQ4In(i+1) = sigma( - 1,0 * SEQ3Reset(i) + 1,0 * SEQ4dRet(i) + 1,0 * IF1Else(i) )
SEQ4Out(i+1) = sigma( - 1,0 * SEQ3Reset(i) + 1,0 * SEQ4dAbr(i) + 1,0 * ATR9Out(i) )
SEQ4Reset(i+1) = sigma( + 1,0 * SEQ3Reset(i) + 1,0 * SEQ3Reset(i) + 1,0 *
            SEQ4Retry(i) + 1,0 * SEQ4Abort(i) )
SEQ4Retry(i+1) = sigma( - 1,0 * SEQ3Reset(i) )
SEQ4Abort(i+1) = sigma( - 1,0 * SEQ3Reset(i) )
SEQ4Resl(i+1) = sigma( - 1,0 * SEQ3Reset(i) )
SEQ4dRet(i+1) = sigma( + 1,0 * SEQ4Retry(i) )
SEQ4dAbr(i+1) = sigma( + 1,0 * SEQ4Abort(i) )
CALL2In(i+1) = sigma( + 1,0 * CALL2In(i) - 1,0 * CALL2End(i) + 1,0 * ATR8In(i) )
CALL2Out(i+1) = sigma( + 1,0 * FI:modOut(i) + 1,0 * CALL2Work(i) - 1,0 )
CALL2Resl(i+1) = sigma( + 1,0 * FI:modResl(i) + 1,0 * CALL2Work(i) - 1,0 )
CALL2Bgn(i+1) = sigma( + 1,0 * FI:mod1d(i) + 1,0 * CALL2In(i) - 1,0 )
CALL2End(i+1) = sigma( + 1,0 * FI:modOut(i) - 1,0 * CALL2End(i) + 1,0 *
            CALL2Work(i) - 1,0 )
CALL2Work(i+1) = sigma( + 1,0 * CALL2Bgn(i) - 1,0 * CALL2End(i) + 1,0 *
            CALL2Work(i) )
FI:mod2(i+1) = sigma( + 1,0 * FI:mod1d(i) + 1,0 * CALL2End(i) )
FI:mod2d(i+1) = sigma( - 1,0 * CALL2Bgn(i) + 1,0 * FI:mod2(i) )
CALL2dVl2(i+1) = sigma( + 1,0 * VARIMn0:sizePool(i) + 1,0 * CALL2Bgn(i) - 1,0 )
CALL2dVl1(i+1) = sigma( + 1,0 * VARIMn0:i(i) + 1,0 * CALL2Bgn(i) - 1,0 )
ATR8In(i+1) = sigma( + 1,0 * SEQ4In(i) - 1,0 * SEQ4Reset(i) )
ATR8ExpR(i+1) = sigma( - 1,0 * SEQ4Reset(i) + 1,0 * CALL2Out(i) + 1,0 *
            CALL2Resl(i) - 1,0 )
ATR8Out(i+1) = sigma( - 1,0 * SEQ4Reset(i) + 1,0 * CALL2Out(i) )
VV13In(i+1) = sigma( - 1,0 * SEQ4Reset(i) + 1,0 * ATR9In(i) )
VV13Out(i+1) = sigma( - 1,0 * SEQ4Reset(i) + 1,0 * VV13In(i) )
VV13Resl(i+1) = sigma( + 1,0 * VARIMn0:lastTask(i) - 1,0 * SEQ4Reset(i) + 1,0 *
            VV13In(i) - 1,0 )
VV14In(i+1) = sigma( - 1,0 * SEQ4Reset(i) + 1,0 * ATR9In(i) )
VV14Out(i+1) = sigma( - 1,0 * SEQ4Reset(i) + 1,0 * VV14In(i) )
VV14Resl(i+1) = sigma( + 1,0 * VARILF_:putTask:Task(i) - 1,0 * SEQ4Reset(i) + 1,0 *
            VV14In(i) - 1,0 )
ATR9In(i+1) = sigma( - 1,0 * SEQ4Reset(i) + 1,0 * ATR8Out(i) )
ATR9Out(i+1) = sigma( + 1,0 * VARIMn0:wkPoolOut(i) - 1,0 * SEQ4Reset(i) + 1,0 *
            ATR9Work(i) - 1,0 )
ATR9Work(i+1) = sigma( + 1,0 * ATR9In(i) - 1,0 * ATR9Out(i) + 1,0 * ATR9Work(i) )
ATR9Wait(i+1) = sigma( - 1,0 * SEQ4Reset(i) - 1,0 * ATR9Wait(i) + 1,0 * ATR9OutE(i)
            + 1,0 * ATR9OutI(i) - 1,0 )
ATR9dW(i+1) = sigma( - 1,0 * SEQ4Reset(i) + 1,0 * ATR9Wait(i) )
ATR9Val(i+1) = sigma( - 1,0 * SEQ4Reset(i) + 1,0 * VV14Resl(i) - 1,0 * ATR9Wait(i)
            + 1,0 * ATR9Val(i) )
ATR9Id(i+1) = sigma( - 1,0 * SEQ4Reset(i) + 1,0 * VV13Resl(i) - 1,0 * ATR9Wait(i) +
            1,0 * ATR9Id(i) )
ATR9OutE(i+1) = sigma( + 1,0 * VV14Out(i) - 1,0 * ATR9Wait(i) + 1,0 * ATR9OutE(i) )
ATR9OutI(i+1) = sigma( + 1,0 * VV13Out(i) - 1,0 * ATR9Wait(i) + 1,0 * ATR9OutI(i) )
ATR9dVal(i+1) = sigma( - 1,0 * SEQ4Reset(i) + 1,0 * ATR9Wait(i) + 1,0 * ATR9Val(i)
            - 1,0 )
ATR9dId(i+1) = sigma( - 1,0 * SEQ4Reset(i) + 1,0 * ATR9Wait(i) + 1,0 * ATR9Id(i) -
            1,0 )
IF1In(i+1) = sigma( - 1,0 * SEQ3Reset(i) + 1,0 * ATR7Out(i) )
IF1ExpO(i+1) = sigma( - 1,0 * SEQ3Reset(i) + 1,0 * EQL1Out(i) )
IF1ExpR(i+1) = sigma( - 1,0 * SEQ3Reset(i) + 1,0 * EQL1Resl(i) )
IF1Out(i+1) = sigma( - 1,0 * SEQ3Reset(i) + 1,0 * SEQ4Out(i) )
IF1Then(i+1) = sigma( - 1,0 * SEQ3Reset(i) + 1,0 * IF1ExpO(i) + 1,0 * IF1ExpR(i) -
            1,0 )
IF1Else(i+1) = sigma( - 1,0 * SEQ3Reset(i) + 2,0 * IF1ExpO(i) - 1,0 * IF1ExpR(i) -
            1,0 )
RTRY1In(i+1) = sigma( - 1,0 * SEQ3Reset(i) + 1,0 * VARESEQ3:wkPoolFull(i) )
F_:getTaskIn(i+1) = sigma( + 1,0 * CALL7Bgn(i) )
F_:getTaskOut(i+1) = sigma( + 1,0 * F_:getTaskddOut(i) )
F_:getTaskdOut(i+1) = sigma( + 1,0 * SEQ5Out(i) )
F_:getTaskddOut(i+1) = sigma( + 1,0 * F_:getTaskdOut(i) )
VARIVF_:getTask:Task(i+1) = sigma( - 1,0 * F_:getTaskddOut(i) + 1,0 *
            VARIVF_:getTask:Task(i) + 1,0 * F_:getTaskArg1(i) - 1,0 * VA18Out(i) +
            1,0 * ATR10ExpR(i) )
F_:getTaskArg1(i+1) = sigma( + 1,0 * CALL7dVl1(i) )
F_:getTaskRet1(i+1) = sigma( + 1,0 * VARIVF_:getTask:Task(i) )
F_:getTask0(i+1) = sigma( + 1,0 * Mn0In(i) + 1,0 * F_:getTask1d(i) )
F_:getTask0d(i+1) = sigma( + 1,0 * F_:getTask0(i) )
SEQ5In(i+1) = sigma( + 1,0 * F_:getTaskIn(i) + 1,0 * SEQ5dRet(i) )
SEQ5Out(i+1) = sigma( + 1,0 * IF2Out(i) )
SEQ5Reset(i+1) = sigma( + 1,0 * SEQ5Retry(i) )
SEQ5Retry(i+1) = sigma( + 1,0 * RTRY2In(i) )
SEQ5dRet(i+1) = sigma( + 1,0 * SEQ5Retry(i) )
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VARISEQ5:i(i+1) = sigma( - 1,0 * SEQ5Reset(i) + 1,0 * VARISEQ5:i(i) - 1,0 *
            SUM2Out(i) + 1,0 * ATR11ExpR(i) )
VV15In(i+1) = sigma( - 1,0 * SEQ5Reset(i) + 1,0 * EQL2In(i) )
VV15Out(i+1) = sigma( - 1,0 * SEQ5Reset(i) + 1,0 * VV15In(i) )
VV15Resl(i+1) = sigma( + 1,0 * VARIMn0:lastTask(i) - 1,0 * SEQ5Reset(i) + 1,0 *
            VV15In(i) - 1,0 )
VV16In(i+1) = sigma( - 1,0 * SEQ5Reset(i) + 1,0 * EQL2In(i) )
VV16Out(i+1) = sigma( - 1,0 * SEQ5Reset(i) + 1,0 * VV16In(i) )
VV16Resl(i+1) = sigma( + 1,0 * VARIMn0:firstTask(i) - 1,0 * SEQ5Reset(i) + 1,0 *
            VV16In(i) - 1,0 )
EQL2In(i+1) = sigma( - 1,0 * SEQ5Reset(i) + 1,0 * IF2In(i) )
EQL2Out(i+1) = sigma( - 1,0 * SEQ5Reset(i) + 1,0 * EQL2d3Wt(i) )
EQL2Resl(i+1) = sigma( - 1,0 * SEQ5Reset(i) - 1,0 * EQL2ddRs(i) + 1,0 * EQL2d3Wt(i)
            )
EQL2dRs1(i+1) = sigma( + 1,0 * EQL2dLf(i) - 1,0 * EQL2dRg(i) )
EQL2dRs2(i+1) = sigma( - 1,0 * EQL2dLf(i) + 1,0 * EQL2dRg(i) )
EQL2ddRs(i+1) = sigma( + 1E13 * EQL2dRs1(i) + 1E13 * EQL2dRs2(i) )
EQL2ddWt(i+1) = sigma( + 1,0 * EQL2dWt(i) )
EQL2d3Wt(i+1) = sigma( + 1,0 * EQL2ddWt(i) )
EQL2wait(i+1) = sigma( - 1,0 * SEQ5Reset(i) - 1,0 * EQL2wait(i) + 1,0 * EQL2wLf(i)
            + 1,0 * EQL2wRg(i) - 1,0 )
EQL2dWt(i+1) = sigma( - 1,0 * SEQ5Reset(i) + 1,0 * EQL2wait(i) )
EQL2vLf(i+1) = sigma( - 1,0 * SEQ5Reset(i) + 1,0 * VV15Resl(i) - 1,0 * EQL2wait(i)
            + 1,0 * EQL2vLf(i) )
EQL2wLf(i+1) = sigma( - 1,0 * SEQ5Reset(i) + 1,0 * VV15Out(i) - 1,0 * EQL2wait(i) +
            1,0 * EQL2wLf(i) )
EQL2dLf(i+1) = sigma( - 1,0 * SEQ5Reset(i) + 1,0 * EQL2wait(i) + 1,0 * EQL2vLf(i) -
            1,0 )
EQL2vRg(i+1) = sigma( - 1,0 * SEQ5Reset(i) + 1,0 * VV16Resl(i) - 1,0 * EQL2wait(i)
            + 1,0 * EQL2vRg(i) )
EQL2wRg(i+1) = sigma( - 1,0 * SEQ5Reset(i) + 1,0 * VV16Out(i) - 1,0 * EQL2wait(i) +
            1,0 * EQL2wRg(i) )
EQL2dRg(i+1) = sigma( - 1,0 * SEQ5Reset(i) + 1,0 * EQL2wait(i) + 1,0 * EQL2vRg(i) -
            1,0 )
RSE2In(i+1) = sigma( + 1,0 * IF2Then(i) )
VARESEQ5:wkPoolEmpty(i+1) = sigma( - 1,0 * SEQ5Reset(i) + 1,0 * RSE2In(i) )
SEQ6In(i+1) = sigma( - 1,0 * SEQ5Reset(i) + 1,0 * SEQ6dRet(i) + 1,0 * IF2Else(i) )
SEQ6Out(i+1) = sigma( - 1,0 * SEQ5Reset(i) + 1,0 * SEQ6dAbr(i) + 1,0 * ATR12Out(i)
            )
SEQ6Reset(i+1) = sigma( + 1,0 * SEQ5Reset(i) + 1,0 * SEQ5Reset(i) + 1,0 *
            SEQ6Retry(i) + 1,0 * SEQ6Abort(i) )
SEQ6Retry(i+1) = sigma( - 1,0 * SEQ5Reset(i) )
SEQ6Abort(i+1) = sigma( - 1,0 * SEQ5Reset(i) )
SEQ6Resl(i+1) = sigma( - 1,0 * SEQ5Reset(i) )
SEQ6dRet(i+1) = sigma( + 1,0 * SEQ6Retry(i) )
SEQ6dAbr(i+1) = sigma( + 1,0 * SEQ6Abort(i) )
VV17In(i+1) = sigma( - 1,0 * SEQ6Reset(i) + 1,0 * VA18In(i) )
VV17Out(i+1) = sigma( - 1,0 * SEQ6Reset(i) + 1,0 * VV17In(i) )
VV17Resl(i+1) = sigma( + 1,0 * VARIMn0:firstTask(i) - 1,0 * SEQ6Reset(i) + 1,0 *
            VV17In(i) - 1,0 )
VA18In(i+1) = sigma( - 1,0 * SEQ6Reset(i) + 1,0 * ATR10In(i) )
VA18Out(i+1) = sigma( + 1,0 * VARIMn0:wkPoolOut(i) - 1,0 * SEQ6Reset(i) + 1,0 *
            VA18Work(i) - 1,0 )
VA18Resl(i+1) = sigma( + 1,0 * VARIMn0:wkPoolResl(i) - 1,0 * SEQ6Reset(i) + 1,0 *
            VA18Work(i) - 1,0 )
VA18Work(i+1) = sigma( - 1,0 * SEQ6Reset(i) + 1,0 * VA18In(i) - 1,0 * VA18Out(i) +
            1,0 * VA18Work(i) )
ATR10In(i+1) = sigma( + 1,0 * SEQ6In(i) - 1,0 * SEQ6Reset(i) )
ATR10ExpR(i+1) = sigma( - 1,0 * SEQ6Reset(i) + 1,0 * VA18Out(i) + 1,0 * VA18Resl(i)
            - 1,0 )
ATR10Out(i+1) = sigma( - 1,0 * SEQ6Reset(i) + 1,0 * VA18Out(i) )
VV19In(i+1) = sigma( - 1,0 * SEQ6Reset(i) + 1,0 * SUM2In(i) )
VV19Out(i+1) = sigma( - 1,0 * SEQ6Reset(i) + 1,0 * VV19In(i) )
VV19Resl(i+1) = sigma( + 1,0 * VARIMn0:firstTask(i) - 1,0 * SEQ6Reset(i) + 1,0 *
            VV19In(i) - 1,0 )
VI20In(i+1) = sigma( - 1,0 * SEQ6Reset(i) + 1,0 * SUM2In(i) )
VI20Out(i+1) = sigma( - 1,0 * SEQ6Reset(i) + 1,0 * VI20In(i) )
VI20Resl(i+1) = sigma( - 1,0 * SEQ6Reset(i) + 1,0 * VI20In(i) - 0,4999999999999 )
SUM2In(i+1) = sigma( - 1,0 * SEQ6Reset(i) + 1,0 * ATR11In(i) )
SUM2Out(i+1) = sigma( - 1,0 * SEQ6Reset(i) + 1,0 * SUM2dWt(i) )
SUM2Resl(i+1) = sigma( - 1,0 * SEQ6Reset(i) + 1,0 * SUM2dLf(i) + 1,0 * SUM2dRg(i) -
            0,5 )
SUM2wait(i+1) = sigma( - 1,0 * SEQ6Reset(i) - 1,0 * SUM2wait(i) + 1,0 * SUM2wLf(i)
            + 1,0 * SUM2wRg(i) - 1,0 )
SUM2dWt(i+1) = sigma( - 1,0 * SEQ6Reset(i) + 1,0 * SUM2wait(i) )
SUM2vLf(i+1) = sigma( - 1,0 * SEQ6Reset(i) + 1,0 * VV19Resl(i) - 1,0 * SUM2wait(i)
            + 1,0 * SUM2vLf(i) )
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SUM2wLf(i+1) = sigma( - 1,0 * SEQ6Reset(i) + 1,0 * VV19Out(i) - 1,0 * SUM2wait(i) +
           1,0 * SUM2wLf(i) )
SUM2dLf(i+1) = sigma( - 1,0 * SEQ6Reset(i) + 1,0 * SUM2wait(i) + 1,0 * SUM2vLf(i) -
           1,0 )
SUM2vRg(i+1) = sigma( - 1,0 * SEQ6Reset(i) + 1,0 * VI20Resl(i) - 1,0 * SUM2wait(i)
           + 1,0 * SUM2vRg(i) )
SUM2wRg(i+1) = sigma( - 1,0 * SEQ6Reset(i) + 1,0 * VI20Out(i) - 1,0 * SUM2wait(i) +
           1,0 * SUM2wRg(i) )
SUM2dRg(i+1) = sigma( - 1,0 * SEQ6Reset(i) + 1,0 * SUM2wait(i) + 1,0 * SUM2vRg(i) -
           1,0 )
ATR11In(i+1) = sigma( - 1,0 * SEQ6Reset(i) + 1,0 * ATR10Out(i) )
ATR11ExpR(i+1) = sigma( - 1,0 * SEQ6Reset(i) + 1,0 * SUM2Out(i) + 1,0 * SUM2Resl(i)
           - 1,0 )
ATR11Out(i+1) = sigma( - 1,0 * SEQ6Reset(i) + 1,0 * SUM2Out(i) )
CALL3In(i+1) = sigma( + 1,0 * CALL3In(i) - 1,0 * CALL3End(i) + 1,0 * ATR12In(i) )
CALL3Out(i+1) = sigma( + 1,0 * FI:modOut(i) + 1,0 * CALL3Work(i) - 1,0 )
CALL3Resl(i+1) = sigma( + 1,0 * FI:modResl(i) + 1,0 * CALL3Work(i) - 1,0 )
CALL3Bgn(i+1) = sigma( + 1,0 * FI:mod2d(i) + 1,0 * CALL3In(i) - 1,0 )
CALL3End(i+1) = sigma( + 1,0 * FI:modOut(i) - 1,0 * CALL3End(i) + 1,0 *
           CALL3Work(i) - 1,0 )
CALL3Work(i+1) = sigma( + 1,0 * CALL3Bgn(i) - 1,0 * CALL3End(i) + 1,0 *
           CALL3Work(i) )
FI:mod3(i+1) = sigma( + 1,0 * FI:mod2d(i) + 1,0 * CALL3End(i) )
FI:mod3d(i+1) = sigma( - 1,0 * CALL3Bgn(i) + 1,0 * FI:mod3(i) )
CALL3dVl2(i+1) = sigma( + 1,0 * VARIMn0:sizePool(i) + 1,0 * CALL3Bgn(i) - 1,0 )
CALL3dVl1(i+1) = sigma( + 1,0 * VARISEQ5:i(i) + 1,0 * CALL3Bgn(i) - 1,0 )
ATR12In(i+1) = sigma( - 1,0 * SEQ6Reset(i) + 1,0 * ATR11Out(i) )
ATR12ExpR(i+1) = sigma( - 1,0 * SEQ6Reset(i) + 1,0 * CALL3Out(i) + 1,0 *
           CALL3Resl(i) - 1,0 )
ATR12Out(i+1) = sigma( - 1,0 * SEQ6Reset(i) + 1,0 * CALL3Out(i) )
IF2In(i+1) = sigma( + 1,0 * SEQ5In(i) - 1,0 * SEQ5Reset(i) )
IF2ExpO(i+1) = sigma( - 1,0 * SEQ5Reset(i) + 1,0 * EQL2Out(i) )
IF2ExpR(i+1) = sigma( - 1,0 * SEQ5Reset(i) + 1,0 * EQL2Resl(i) )
IF2Out(i+1) = sigma( - 1,0 * SEQ5Reset(i) + 1,0 * SEQ6Out(i) )
IF2Then(i+1) = sigma( - 1,0 * SEQ5Reset(i) + 1,0 * IF2ExpO(i) + 1,0 * IF2ExpR(i) -
           1,0 )
IF2Else(i+1) = sigma( - 1,0 * SEQ5Reset(i) + 2,0 * IF2ExpO(i) - 1,0 * IF2ExpR(i) -
           1,0 )
RTRY2In(i+1) = sigma( - 1,0 * SEQ5Reset(i) + 1,0 * VARESEQ5:wkPoolEmpty(i) )
F_:updateCountIn(i+1) = sigma( + 1,0 * CALL4Bgn(i) + 1,0 * CALL6Bgn(i) )
F_:updateCountOut(i+1) = sigma( + 1,0 * F_:updateCountddOut(i) )
F_:updateCountdOut(i+1) = sigma( + 1,0 * IF3Out(i) )
F_:updateCountddOut(i+1) = sigma( + 1,0 * F_:updateCountdOut(i) )
VARBLF_:updateCount:isGe(i+1) = sigma( - 1,0 * F_:updateCountddOut(i) + 1,0 *
           VARBLF_:updateCount:isGe(i) + 1,0 * F_:updateCountArg1(i) )
F_:updateCountArg1(i+1) = sigma( + 1,0 * CALL4dVl1(i) + 1,0 * CALL6dVl1(i) )
F_:updateCount0(i+1) = sigma( + 1,0 * Mn0In(i) + 1,0 * F_:updateCount2d(i) )
F_:updateCount0d(i+1) = sigma( + 1,0 * F_:updateCount0(i) )
VV21In(i+1) = sigma( + 1,0 * IF3In(i) )
VV21Out(i+1) = sigma( + 1,0 * VV21In(i) )
VV21Resl(i+1) = sigma( + 1,0 * VARBLF_:updateCount:isGe(i) + 1,0 * VV21In(i) - 1,0
           )
VV22In(i+1) = sigma( + 1,0 * PRE1In(i) )
VV22Out(i+1) = sigma( + 1,0 * VV22In(i) )
VV22Resl(i+1) = sigma( + 1,0 * VARIMn0:workCount(i) + 1,0 * VV22In(i) - 1,0 )
PRE1In(i+1) = sigma( + 1,0 * ATR13In(i) )
PRE1Out(i+1) = sigma( + 1,0 * VV22Out(i) )
PRE1Resl(i+1) = sigma( + 1,0 * VV22Resl(i) - 1E-13 )
ATR13In(i+1) = sigma( + 1,0 * IF3Then(i) )
ATR13ExpR(i+1) = sigma( + 1,0 * PRE1Out(i) + 1,0 * PRE1Resl(i) - 1,0 )
ATR13Out(i+1) = sigma( + 1,0 * PRE1Out(i) )
VV23In(i+1) = sigma( + 1,0 * SUC1In(i) )
VV23Out(i+1) = sigma( + 1,0 * VV23In(i) )
VV23Resl(i+1) = sigma( + 1,0 * VARIMn0:workCount(i) + 1,0 * VV23In(i) - 1,0 )
SUC1In(i+1) = sigma( + 1,0 * ATR14In(i) )
SUC1Out(i+1) = sigma( + 1,0 * VV23Out(i) )
SUC1Resl(i+1) = sigma( + 1,0 * VV23Out(i) + 1,0 * VV23Resl(i) - 0,9999999999999 )
ATR14In(i+1) = sigma( + 1,0 * IF3Else(i) )
ATR14ExpR(i+1) = sigma( + 1,0 * SUC1Out(i) + 1,0 * SUC1Resl(i) - 1,0 )
ATR14Out(i+1) = sigma( + 1,0 * SUC1Out(i) )
IF3In(i+1) = sigma( + 1,0 * F_:updateCountIn(i) )
IF3ExpO(i+1) = sigma( + 1,0 * VV21Out(i) )
IF3ExpR(i+1) = sigma( + 1,0 * VV21Resl(i) )
IF3Out(i+1) = sigma( + 1,0 * ATR13Out(i) + 1,0 * ATR14Out(i) )
IF3Then(i+1) = sigma( + 1,0 * IF3ExpO(i) + 1,0 * IF3ExpR(i) - 1,0 )
IF3Else(i+1) = sigma( + 2,0 * IF3ExpO(i) - 1,0 * IF3ExpR(i) - 1,0 )
F_:putWorkOut(i+1) = sigma( + 1,0 * F_:putWorkddOut(i) )
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F_:putWorkdOut(i+1) = sigma( + 1,0 * SEQ7Out(i) )
F_:putWorkddOut(i+1) = sigma( + 1,0 * F_:putWorkdOut(i) )
VARILF_:putWork:Task(i+1) = sigma( - 1,0 * F_:putWorkddOut(i) + 1,0 *
            VARILF_:putWork:Task(i) )
F_:putWork0(i+1) = sigma( + 1,0 * Mn0In(i) )
F_:putWork0d(i+1) = sigma( + 1,0 * F_:putWork0(i) )
SEQ7Out(i+1) = sigma( + 1,0 * CALL5Out(i) )
VB24Resl(i+1) = sigma( - 1,0 )
ATR15ExpR(i+1) = sigma( + 1,0 * VB24Resl(i) - 1,0 )
CALL4In(i+1) = sigma( + 1,0 * CALL4In(i) - 1,0 * CALL4End(i) )
CALL4Out(i+1) = sigma( + 1,0 * F_:updateCountOut(i) + 1,0 * CALL4Work(i) - 1,0 )
CALL4Resl(i+1) = sigma( + 1,0 * CALL4Work(i) - 1,0 )
CALL4Bgn(i+1) = sigma( + 1,0 * F_:updateCount0d(i) + 1,0 * CALL4In(i) - 1,0 )
CALL4End(i+1) = sigma( + 1,0 * F_:updateCountOut(i) - 1,0 * CALL4End(i) + 1,0 *
            CALL4Work(i) - 1,0 )
CALL4Work(i+1) = sigma( + 1,0 * CALL4Bgn(i) - 1,0 * CALL4End(i) + 1,0 *
            CALL4Work(i) )
F_:updateCount1(i+1) = sigma( + 1,0 * F_:updateCount0d(i) + 1,0 * CALL4End(i) )
F_:updateCount1d(i+1) = sigma( - 1,0 * CALL4Bgn(i) + 1,0 * F_:updateCount1(i) )
CALL4dVl1(i+1) = sigma( + 1,0 * VARBMn0:b(i) + 1,0 * CALL4Bgn(i) - 1,0 )
CALL5In(i+1) = sigma( + 1,0 * CALL4Out(i) + 1,0 * CALL5In(i) - 1,0 * CALL5End(i) )
CALL5Out(i+1) = sigma( + 1,0 * F_:putTaskOut(i) + 1,0 * CALL5Work(i) - 1,0 )
CALL5Resl(i+1) = sigma( + 1,0 * CALL5Work(i) - 1,0 )
CALL5Bgn(i+1) = sigma( + 1,0 * F_:putTask0d(i) + 1,0 * CALL5In(i) - 1,0 )
CALL5End(i+1) = sigma( + 1,0 * F_:putTaskOut(i) - 1,0 * CALL5End(i) + 1,0 *
            CALL5Work(i) - 1,0 )
CALL5Work(i+1) = sigma( + 1,0 * CALL5Bgn(i) - 1,0 * CALL5End(i) + 1,0 *
            CALL5Work(i) )
F_:putTask1(i+1) = sigma( + 1,0 * F_:putTask0d(i) + 1,0 * CALL5End(i) )
F_:putTask1d(i+1) = sigma( - 1,0 * CALL5Bgn(i) + 1,0 * F_:putTask1(i) )
CALL5dVl1(i+1) = sigma( + 1,0 * VARILF_:putWork:Task(i) + 1,0 * CALL5Bgn(i) - 1,0 )
F_:getWorkIn(i+1) = sigma( + 1,0 * CALL11Bgn(i) + 1,0 * CALL12Bgn(i) )
F_:getWorkOut(i+1) = sigma( + 1,0 * F_:getWorkddOut(i) )
F_:getWorkdOut(i+1) = sigma( + 1,0 * SEQ8Out(i) )
F_:getWorkddOut(i+1) = sigma( + 1,0 * F_:getWorkdOut(i) )
VARIVF_:getWork:Task(i+1) = sigma( - 1,0 * F_:getWorkddOut(i) + 1,0 *
            VARIVF_:getWork:Task(i) + 1,0 * F_:getWorkArg1(i) + 1,0 * CALL7dRet1(i)
            )
F_:getWorkArg1(i+1) = sigma( + 1,0 * CALL11dVl1(i) + 1,0 * CALL12dVl1(i) )
F_:getWorkRet1(i+1) = sigma( + 1,0 * VARIVF_:getWork:Task(i) )
F_:getWork0(i+1) = sigma( + 1,0 * Mn0In(i) + 1,0 * F_:getWork2d(i) )
F_:getWork0d(i+1) = sigma( + 1,0 * F_:getWork0(i) )
SEQ8In(i+1) = sigma( + 1,0 * F_:getWorkIn(i) )
SEQ8Out(i+1) = sigma( + 1,0 * IF4Out(i) )
SEQ8Reset(i+1) = sigma( + 1,0 * SEQ9Out(i) )
VARISEQ8:i(i+1) = sigma( - 1,0 * SEQ8Reset(i) + 1,0 * VARISEQ8:i(i) - 1,0 *
            VI28Out(i) + 1,0 * ATR17ExpR(i) )
VB25In(i+1) = sigma( - 1,0 * SEQ8Reset(i) + 1,0 * ATR16In(i) )
VB25Out(i+1) = sigma( - 1,0 * SEQ8Reset(i) + 1,0 * VB25In(i) )
VB25Resl(i+1) = sigma( - 1,0 * SEQ8Reset(i) + 1,0 * VB25In(i) )
ATR16In(i+1) = sigma( + 1,0 * SEQ8In(i) - 1,0 * SEQ8Reset(i) )
ATR16ExpR(i+1) = sigma( - 1,0 * SEQ8Reset(i) + 1,0 * VB25Out(i) + 1,0 * VB25Resl(i)
            - 1,0 )
ATR16Out(i+1) = sigma( - 1,0 * SEQ8Reset(i) + 1,0 * VB25Out(i) )
CALL6In(i+1) = sigma( + 1,0 * ATR16Out(i) + 1,0 * CALL6In(i) - 1,0 * CALL6End(i) )
CALL6Out(i+1) = sigma( + 1,0 * F_:updateCountOut(i) + 1,0 * CALL6Work(i) - 1,0 )
CALL6Resl(i+1) = sigma( + 1,0 * CALL6Work(i) - 1,0 )
CALL6Bgn(i+1) = sigma( + 1,0 * F_:updateCount1d(i) + 1,0 * CALL6In(i) - 1,0 )
CALL6End(i+1) = sigma( + 1,0 * F_:updateCountOut(i) - 1,0 * CALL6End(i) + 1,0 *
            CALL6Work(i) - 1,0 )
CALL6Work(i+1) = sigma( + 1,0 * CALL6Bgn(i) - 1,0 * CALL6End(i) + 1,0 *
            CALL6Work(i) )
F_:updateCount2(i+1) = sigma( + 1,0 * F_:updateCount1d(i) + 1,0 * CALL6End(i) )
F_:updateCount2d(i+1) = sigma( - 1,0 * CALL6Bgn(i) + 1,0 * F_:updateCount2(i) )
CALL6dVl1(i+1) = sigma( + 1,0 * VARBMn0:b(i) + 1,0 * CALL6Bgn(i) - 1,0 )
VV26In(i+1) = sigma( - 1,0 * SEQ8Reset(i) + 1,0 * EQL3In(i) )
VV26Out(i+1) = sigma( - 1,0 * SEQ8Reset(i) + 1,0 * VV26In(i) )
VV26Resl(i+1) = sigma( + 1,0 * VARIMn0:workCount(i) - 1,0 * SEQ8Reset(i) + 1,0 *
            VV26In(i) - 1,0 )
VV27In(i+1) = sigma( - 1,0 * SEQ8Reset(i) + 1,0 * NEG1In(i) )
VV27Out(i+1) = sigma( - 1,0 * SEQ8Reset(i) + 1,0 * VV27In(i) )
VV27Resl(i+1) = sigma( + 1,0 * VARIMn0:nWorkers(i) - 1,0 * SEQ8Reset(i) + 1,0 *
            VV27In(i) - 1,0 )
NEG1In(i+1) = sigma( - 1,0 * SEQ8Reset(i) + 1,0 * EQL3In(i) )
NEG1Out(i+1) = sigma( - 1,0 * SEQ8Reset(i) + 1,0 * VV27Out(i) )
NEG1Resl(i+1) = sigma( - 1,0 * SEQ8Reset(i) + 1,0 * VV27Out(i) - 1,0 * VV27Resl(i)
            )
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EQL3In(i+1) = sigma( - 1,0 * SEQ8Reset(i) + 1,0 * IF4In(i) )
EQL3Out(i+1) = sigma( - 1,0 * SEQ8Reset(i) + 1,0 * EQL3d3Wt(i) )
EQL3Resl(i+1) = sigma( - 1,0 * SEQ8Reset(i) - 1,0 * EQL3ddRs(i) + 1,0 * EQL3d3Wt(i)
            )
EQL3dRs1(i+1) = sigma( + 1,0 * EQL3dLf(i) - 1,0 * EQL3dRg(i) )
EQL3dRs2(i+1) = sigma( - 1,0 * EQL3dLf(i) + 1,0 * EQL3dRg(i) )
EQL3ddRs(i+1) = sigma( + 1E13 * EQL3dRs1(i) + 1E13 * EQL3dRs2(i) )
EQL3ddWt(i+1) = sigma( + 1,0 * EQL3dWt(i) )
EQL3d3Wt(i+1) = sigma( + 1,0 * EQL3ddWt(i) )
EQL3wait(i+1) = sigma( - 1,0 * SEQ8Reset(i) - 1,0 * EQL3wait(i) + 1,0 * EQL3wLf(i)
            + 1,0 * EQL3wRg(i) - 1,0 )
EQL3dWt(i+1) = sigma( - 1,0 * SEQ8Reset(i) + 1,0 * EQL3wait(i) )
EQL3vLf(i+1) = sigma( - 1,0 * SEQ8Reset(i) + 1,0 * VV26Resl(i) - 1,0 * EQL3wait(i)
            + 1,0 * EQL3vLf(i) )
EQL3wLf(i+1) = sigma( - 1,0 * SEQ8Reset(i) + 1,0 * VV26Out(i) - 1,0 * EQL3wait(i) +
            1,0 * EQL3wLf(i) )
EQL3dLf(i+1) = sigma( - 1,0 * SEQ8Reset(i) + 1,0 * EQL3wait(i) + 1,0 * EQL3vLf(i) -
            1,0 )
EQL3vRg(i+1) = sigma( - 1,0 * SEQ8Reset(i) + 1,0 * NEG1Resl(i) - 1,0 * EQL3wait(i)
            + 1,0 * EQL3vRg(i) )
EQL3wRg(i+1) = sigma( - 1,0 * SEQ8Reset(i) + 1,0 * NEG1Out(i) - 1,0 * EQL3wait(i) +
            1,0 * EQL3wRg(i) )
EQL3dRg(i+1) = sigma( - 1,0 * SEQ8Reset(i) + 1,0 * EQL3wait(i) + 1,0 * EQL3vRg(i) -
            1,0 )
RSE3In(i+1) = sigma( + 1,0 * IF4Then(i) )
VARESEQ8:TerminateWP(i+1) = sigma( - 1,0 * SEQ8Reset(i) + 1,0 * RSE3In(i) )
CALL7In(i+1) = sigma( + 1,0 * CALL7In(i) - 1,0 * CALL7End(i) + 1,0 * IF4Else(i) )
CALL7Out(i+1) = sigma( + 1,0 * F_:getTaskOut(i) + 1,0 * CALL7Work(i) - 1,0 )
CALL7Resl(i+1) = sigma( + 1,0 * CALL7Work(i) - 1,0 )
CALL7Bgn(i+1) = sigma( + 1,0 * F_:getTask0d(i) + 1,0 * CALL7In(i) - 1,0 )
CALL7End(i+1) = sigma( + 1,0 * F_:getTaskOut(i) - 1,0 * CALL7End(i) + 1,0 *
            CALL7Work(i) - 1,0 )
CALL7Work(i+1) = sigma( + 1,0 * CALL7Bgn(i) - 1,0 * CALL7End(i) + 1,0 *
            CALL7Work(i) )
F_:getTask1(i+1) = sigma( + 1,0 * F_:getTask0d(i) + 1,0 * CALL7End(i) )
F_:getTask1d(i+1) = sigma( - 1,0 * CALL7Bgn(i) + 1,0 * F_:getTask1(i) )
CALL7dVl1(i+1) = sigma( + 1,0 * VARIVF_:getWork:Task(i) + 1,0 * CALL7Bgn(i) - 1,0 )
CALL7dRet1(i+1) = sigma( + 1,0 * F_:getTaskRet1(i) - 1,0 )
IF4In(i+1) = sigma( - 1,0 * SEQ8Reset(i) + 1,0 * CALL6Out(i) )
IF4ExpO(i+1) = sigma( - 1,0 * SEQ8Reset(i) + 1,0 * EQL3Out(i) )
IF4ExpR(i+1) = sigma( - 1,0 * SEQ8Reset(i) + 1,0 * EQL3Resl(i) )
IF4Out(i+1) = sigma( - 1,0 * SEQ8Reset(i) + 1,0 * CALL7Out(i) )
IF4Then(i+1) = sigma( - 1,0 * SEQ8Reset(i) + 1,0 * IF4ExpO(i) + 1,0 * IF4ExpR(i) -
            1,0 )
IF4Else(i+1) = sigma( - 1,0 * SEQ8Reset(i) + 2,0 * IF4ExpO(i) - 1,0 * IF4ExpR(i) -
            1,0 )
SEQ9In(i+1) = sigma( - 1,0 * SEQ8Reset(i) + 1,0 * VARESEQ8:TerminateWP(i) + 1,0 *
            SEQ9dRet(i) )
SEQ9Out(i+1) = sigma( - 1,0 * SEQ8Reset(i) + 1,0 * SEQ9dAbr(i) + 1,0 * WHL2Out(i) )
SEQ9Reset(i+1) = sigma( + 1,0 * SEQ8Reset(i) + 1,0 * SEQ9Retry(i) + 1,0 *
            SEQ9Abort(i) )
SEQ9Retry(i+1) = sigma( - 1,0 * SEQ8Reset(i) )
SEQ9Abort(i+1) = sigma( - 1,0 * SEQ8Reset(i) + 1,0 * ABRT1In(i) )
SEQ9Resl(i+1) = sigma( - 1,0 * SEQ8Reset(i) )
SEQ9dRet(i+1) = sigma( + 1,0 * SEQ9Retry(i) )
SEQ9dAbr(i+1) = sigma( + 1,0 * SEQ9Abort(i) )
VI28In(i+1) = sigma( - 1,0 * SEQ9Reset(i) + 1,0 * ATR17In(i) )
VI28Out(i+1) = sigma( - 1,0 * SEQ9Reset(i) + 1,0 * VI28In(i) )
VI28Resl(i+1) = sigma( - 1,0 * SEQ9Reset(i) + 1,0 * VI28In(i) - 0,4999999999999 )
ATR17In(i+1) = sigma( + 1,0 * SEQ9In(i) - 1,0 * SEQ9Reset(i) )
ATR17ExpR(i+1) = sigma( - 1,0 * SEQ9Reset(i) + 1,0 * VI28Out(i) + 1,0 * VI28Resl(i)
            - 1,0 )
ATR17Out(i+1) = sigma( - 1,0 * SEQ9Reset(i) + 1,0 * VI28Out(i) )
WHL2In(i+1) = sigma( - 1,0 * SEQ9Reset(i) + 1,0 * ATR17Out(i) + 1,0 * CALL8Out(i) )
WHL2ExpR(i+1) = sigma( - 1,0 * SEQ9Reset(i) + 1,0 * LT1Out(i) + 1,0 * LT1Resl(i) -
            1,0 )
WHL2Out(i+1) = sigma( - 1,0 * SEQ9Reset(i) + 1,0 * LT1Out(i) - 1,0 * LT1Resl(i) )
VV29In(i+1) = sigma( - 1,0 * SEQ9Reset(i) + 1,0 * LT1In(i) )
VV29Out(i+1) = sigma( - 1,0 * SEQ9Reset(i) + 1,0 * VV29In(i) )
VV29Resl(i+1) = sigma( + 1,0 * VARISEQ8:i(i) - 1,0 * SEQ9Reset(i) + 1,0 * VV29In(i)
            - 1,0 )
VV30In(i+1) = sigma( - 1,0 * SEQ9Reset(i) + 1,0 * LT1In(i) )
VV30Out(i+1) = sigma( - 1,0 * SEQ9Reset(i) + 1,0 * VV30In(i) )
VV30Resl(i+1) = sigma( + 1,0 * VARIMn0:nWorkers(i) - 1,0 * SEQ9Reset(i) + 1,0 *
            VV30In(i) - 1,0 )
LT1In(i+1) = sigma( - 1,0 * SEQ9Reset(i) + 1,0 * WHL2In(i) )
LT1Out(i+1) = sigma( - 1,0 * SEQ9Reset(i) + 1,0 * LT1ddWt(i) )
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LT1Resl(i+1) = sigma( - 1,0 * SEQ9Reset(i) + 2E13 * LT1dRs(i) )
LT1dRs(i+1) = sigma( - 1,0 * LT1dLf(i) + 1,0 * LT1dRg(i) - 1E-14 )
LT1ddWt(i+1) = sigma( + 1,0 * LT1dWt(i) )
LT1wait(i+1) = sigma( - 1,0 * SEQ9Reset(i) - 1,0 * LT1wait(i) + 1,0 * LT1wLf(i) +
            1,0 * LT1wRg(i) - 1,0 )
LT1dWt(i+1) = sigma( - 1,0 * SEQ9Reset(i) + 1,0 * LT1wait(i) )
LT1vLf(i+1) = sigma( - 1,0 * SEQ9Reset(i) + 1,0 * VV29Resl(i) - 1,0 * LT1wait(i) +
            1,0 * LT1vLf(i) )
LT1wLf(i+1) = sigma( - 1,0 * SEQ9Reset(i) + 1,0 * VV29Out(i) - 1,0 * LT1wait(i) +
            1,0 * LT1wLf(i) )
LT1dLf(i+1) = sigma( - 1,0 * SEQ9Reset(i) + 1,0 * LT1wait(i) + 1,0 * LT1vLf(i) -
            1,0 )
LT1vRg(i+1) = sigma( - 1,0 * SEQ9Reset(i) + 1,0 * VV30Resl(i) - 1,0 * LT1wait(i) +
            1,0 * LT1vRg(i) )
LT1wRg(i+1) = sigma( - 1,0 * SEQ9Reset(i) + 1,0 * VV30Out(i) - 1,0 * LT1wait(i) +
            1,0 * LT1wRg(i) )
LT1dRg(i+1) = sigma( - 1,0 * SEQ9Reset(i) + 1,0 * LT1wait(i) + 1,0 * LT1vRg(i) -
            1,0 )
CALL8In(i+1) = sigma( + 1,0 * WHL2ExpR(i) + 1,0 * CALL8In(i) - 1,0 * CALL8End(i) )
CALL8Out(i+1) = sigma( + 1,0 * F_:putTaskOut(i) + 1,0 * CALL8Work(i) - 1,0 )
CALL8Resl(i+1) = sigma( + 1,0 * CALL8Work(i) - 1,0 )
CALL8Bgn(i+1) = sigma( + 1,0 * F_:putTask1d(i) + 1,0 * CALL8In(i) - 1,0 )
CALL8End(i+1) = sigma( + 1,0 * F_:putTaskOut(i) - 1,0 * CALL8End(i) + 1,0 *
            CALL8Work(i) - 1,0 )
CALL8Work(i+1) = sigma( + 1,0 * CALL8Bgn(i) - 1,0 * CALL8End(i) + 1,0 *
            CALL8Work(i) )
F_:putTask2(i+1) = sigma( + 1,0 * F_:putTask1d(i) + 1,0 * CALL8End(i) )
F_:putTask2d(i+1) = sigma( - 1,0 * CALL8Bgn(i) + 1,0 * F_:putTask2(i) )
CALL8dVl1(i+1) = sigma( + 1,0 * CONI:endWork(i) + 1,0 * CALL8Bgn(i) - 1,0 )
ABRT1In(i+1) = sigma( - 1,0 * SEQ9Reset(i) + 1,0 * WHL2Out(i) )
SEQ10In(i+1) = sigma( + 1,0 * Mn0In(i) )
SEQ10Out(i+1) = sigma( + 1,0 * PAR2Out(i) )
VARISEQ10:Task1(i+1) = sigma( + 1,0 * VARISEQ10:Task1(i) + 1,0 * CALL11dRet1(i) +
            1,0 * CALL12dRet1(i) )
VARISEQ10:iniTask(i+1) = sigma( + 1,0 * VARISEQ10:iniTask(i) )
PAR1In(i+1) = sigma( + 1,0 * SEQ10In(i) )
PAR1Out(i+1) = sigma( + 1,0 * PAR1Wait(i) )
PAR1Wait(i+1) = sigma( - 1,0 * PAR1Wait(i) + 1,0 * PAR1WPr1(i) + 1,0 * PAR1WPr2(i)
            + 1,0 * PAR1WPr3(i) - 2,0 )
VI31In(i+1) = sigma( + 1,0 * ATR18In(i) )
VI31Out(i+1) = sigma( + 1,0 * VI31In(i) )
VI31Resl(i+1) = sigma( + 1,0 * VI31In(i) - 0,4999999999999 )
ATR18In(i+1) = sigma( + 1,0 * PAR1In(i) )
ATR18ExpR(i+1) = sigma( + 1,0 * VI31Out(i) + 1,0 * VI31Resl(i) - 1,0 )
ATR18Out(i+1) = sigma( + 1,0 * VI31Out(i) )
PAR1WPr1(i+1) = sigma( - 1,0 * PAR1Wait(i) + 1,0 * ATR18Out(i) + 1,0 * PAR1WPr1(i)
            )
VI32In(i+1) = sigma( + 1,0 * ATR19In(i) )
VI32Out(i+1) = sigma( + 1,0 * VI32In(i) )
VI32Resl(i+1) = sigma( + 1,0 * VI32In(i) - 0,4999999999999 )
ATR19In(i+1) = sigma( + 1,0 * PAR1In(i) )
ATR19ExpR(i+1) = sigma( + 1,0 * VI32Out(i) + 1,0 * VI32Resl(i) - 1,0 )
ATR19Out(i+1) = sigma( + 1,0 * VI32Out(i) )
PAR1WPr2(i+1) = sigma( - 1,0 * PAR1Wait(i) + 1,0 * ATR19Out(i) + 1,0 * PAR1WPr2(i)
            )
CALL9In(i+1) = sigma( + 1,0 * PAR1In(i) + 1,0 * CALL9In(i) - 1,0 * CALL9End(i) )
CALL9Out(i+1) = sigma( + 1,0 * F_:iniWPOut(i) + 1,0 * CALL9Work(i) - 1,0 )
CALL9Resl(i+1) = sigma( + 1,0 * CALL9Work(i) - 1,0 )
CALL9Bgn(i+1) = sigma( + 1,0 * F_:iniWP0d(i) + 1,0 * CALL9In(i) - 1,0 )
CALL9End(i+1) = sigma( + 1,0 * F_:iniWPOut(i) - 1,0 * CALL9End(i) + 1,0 *
            CALL9Work(i) - 1,0 )
CALL9Work(i+1) = sigma( + 1,0 * CALL9Bgn(i) - 1,0 * CALL9End(i) + 1,0 *
            CALL9Work(i) )
F_:iniWP1(i+1) = sigma( + 1,0 * F_:iniWP0d(i) + 1,0 * CALL9End(i) )
F_:iniWP1d(i+1) = sigma( - 1,0 * CALL9Bgn(i) + 1,0 * F_:iniWP1(i) )
PAR1WPr3(i+1) = sigma( - 1,0 * PAR1Wait(i) + 1,0 * CALL9Out(i) + 1,0 * PAR1WPr3(i)
            )
CALL10In(i+1) = sigma( + 1,0 * PAR1Out(i) + 1,0 * CALL10In(i) - 1,0 * CALL10End(i)
            )
CALL10Out(i+1) = sigma( + 1,0 * F_:putTaskOut(i) + 1,0 * CALL10Work(i) - 1,0 )
CALL10Resl(i+1) = sigma( + 1,0 * CALL10Work(i) - 1,0 )
CALL10Bgn(i+1) = sigma( + 1,0 * F_:putTask2d(i) + 1,0 * CALL10In(i) - 1,0 )
CALL10End(i+1) = sigma( + 1,0 * F_:putTaskOut(i) - 1,0 * CALL10End(i) + 1,0 *
            CALL10Work(i) - 1,0 )
CALL10Work(i+1) = sigma( + 1,0 * CALL10Bgn(i) - 1,0 * CALL10End(i) + 1,0 *
            CALL10Work(i) )
F_:putTask3(i+1) = sigma( + 1,0 * F_:putTask2d(i) + 1,0 * CALL10End(i) )
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F_:putTask3d(i+1) = sigma( - 1,0 * CALL10Bgn(i) + 1,0 * F_:putTask3(i) )
CALL10dVl1(i+1) = sigma( + 1,0 * VARISEQ10:iniTask(i) + 1,0 * CALL10Bgn(i) - 1,0 )
PAR2In(i+1) = sigma( + 1,0 * CALL10Out(i) )
PAR2Out(i+1) = sigma( + 1,0 * PAR2Wait(i) )
PAR2Wait(i+1) = sigma( - 1,0 * PAR2Wait(i) + 1,0 * PAR2WPr1(i) )
SEQ11In(i+1) = sigma( + 1,0 * PAR2In(i) )
SEQ11Out(i+1) = sigma( + 1,0 * WHL3Out(i) )
PAR2WPr1(i+1) = sigma( - 1,0 * PAR2Wait(i) + 1,0 * SEQ11Out(i) + 1,0 * PAR2WPr1(i)
            )
CALL11In(i+1) = sigma( + 1,0 * SEQ11In(i) + 1,0 * CALL11In(i) - 1,0 * CALL11End(i)
            )
CALL11Out(i+1) = sigma( + 1,0 * F_:getWorkOut(i) + 1,0 * CALL11Work(i) - 1,0 )
CALL11Resl(i+1) = sigma( + 1,0 * CALL11Work(i) - 1,0 )
CALL11Bgn(i+1) = sigma( + 1,0 * F_:getWork0d(i) + 1,0 * CALL11In(i) - 1,0 )
CALL11End(i+1) = sigma( + 1,0 * F_:getWorkOut(i) - 1,0 * CALL11End(i) + 1,0 *
            CALL11Work(i) - 1,0 )
CALL11Work(i+1) = sigma( + 1,0 * CALL11Bgn(i) - 1,0 * CALL11End(i) + 1,0 *
            CALL11Work(i) )
F_:getWork1(i+1) = sigma( + 1,0 * F_:getWork0d(i) + 1,0 * CALL11End(i) )
F_:getWork1d(i+1) = sigma( - 1,0 * CALL11Bgn(i) + 1,0 * F_:getWork1(i) )
CALL11dVl1(i+1) = sigma( + 1,0 * VARISEQ10:Task1(i) + 1,0 * CALL11Bgn(i) - 1,0 )
CALL11dRet1(i+1) = sigma( + 1,0 * F_:getWorkRet1(i) - 1,0 )
WHL3In(i+1) = sigma( + 1,0 * CALL11Out(i) + 1,0 * SEQ12Out(i) )
WHL3ExpR(i+1) = sigma( + 1,0 * NEQ1Out(i) + 1,0 * NEQ1Resl(i) - 1,0 )
WHL3Out(i+1) = sigma( + 1,0 * NEQ1Out(i) - 1,0 * NEQ1Resl(i) )
VV33In(i+1) = sigma( + 1,0 * NEQ1In(i) )
VV33Out(i+1) = sigma( + 1,0 * VV33In(i) )
VV33Resl(i+1) = sigma( + 1,0 * VARISEQ10:Task1(i) + 1,0 * VV33In(i) - 1,0 )
VV34In(i+1) = sigma( + 1,0 * NEQ1In(i) )
VV34Out(i+1) = sigma( + 1,0 * VV34In(i) )
VV34Resl(i+1) = sigma( + 1,0 * CONI:endWork(i) + 1,0 * VV34In(i) - 1,0 )
NEQ1In(i+1) = sigma( + 1,0 * WHL3In(i) )
NEQ1Out(i+1) = sigma( + 1,0 * NEQ1ddWt(i) )
NEQ1Resl(i+1) = sigma( + 1E13 * NEQ1dRs1(i) + 1E13 * NEQ1dRs2(i) )
NEQ1dRs1(i+1) = sigma( + 1,0 * NEQ1dLf(i) - 1,0 * NEQ1dRg(i) )
NEQ1dRs2(i+1) = sigma( - 1,0 * NEQ1dLf(i) + 1,0 * NEQ1dRg(i) )
NEQ1ddWt(i+1) = sigma( + 1,0 * NEQ1dWt(i) )
NEQ1wait(i+1) = sigma( - 1,0 * NEQ1wait(i) + 1,0 * NEQ1wLf(i) + 1,0 * NEQ1wRg(i) -
            1,0 )
NEQ1dWt(i+1) = sigma( + 1,0 * NEQ1wait(i) )
NEQ1vLf(i+1) = sigma( + 1,0 * VV33Resl(i) - 1,0 * NEQ1wait(i) + 1,0 * NEQ1vLf(i) )
NEQ1wLf(i+1) = sigma( + 1,0 * VV33Out(i) - 1,0 * NEQ1wait(i) + 1,0 * NEQ1wLf(i) )
NEQ1dLf(i+1) = sigma( + 1,0 * NEQ1wait(i) + 1,0 * NEQ1vLf(i) - 1,0 )
NEQ1vRg(i+1) = sigma( + 1,0 * VV34Resl(i) - 1,0 * NEQ1wait(i) + 1,0 * NEQ1vRg(i) )
NEQ1wRg(i+1) = sigma( + 1,0 * VV34Out(i) - 1,0 * NEQ1wait(i) + 1,0 * NEQ1wRg(i) )
NEQ1dRg(i+1) = sigma( + 1,0 * NEQ1wait(i) + 1,0 * NEQ1vRg(i) - 1,0 )
SEQ12In(i+1) = sigma( + 1,0 * WHL3ExpR(i) )
SEQ12Out(i+1) = sigma( + 1,0 * CALL12Out(i) )
CALL12In(i+1) = sigma( + 1,0 * SEQ12In(i) + 1,0 * CALL12In(i) - 1,0 * CALL12End(i)
            )
CALL12Out(i+1) = sigma( + 1,0 * F_:getWorkOut(i) + 1,0 * CALL12Work(i) - 1,0 )
CALL12Resl(i+1) = sigma( + 1,0 * CALL12Work(i) - 1,0 )
CALL12Bgn(i+1) = sigma( + 1,0 * F_:getWork1d(i) + 1,0 * CALL12In(i) - 1,0 )
CALL12End(i+1) = sigma( + 1,0 * F_:getWorkOut(i) - 1,0 * CALL12End(i) + 1,0 *
            CALL12Work(i) - 1,0 )
CALL12Work(i+1) = sigma( + 1,0 * CALL12Bgn(i) - 1,0 * CALL12End(i) + 1,0 *
            CALL12Work(i) )
F_:getWork2(i+1) = sigma( + 1,0 * F_:getWork1d(i) + 1,0 * CALL12End(i) )
F_:getWork2d(i+1) = sigma( - 1,0 * CALL12Bgn(i) + 1,0 * F_:getWork2(i) )
CALL12dVl1(i+1) = sigma( + 1,0 * VARISEQ10:Task1(i) + 1,0 * CALL12Bgn(i) - 1,0 )
CALL12dRet1(i+1) = sigma( + 1,0 * F_:getWorkRet1(i) - 1,0 )
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