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This book is written for experienced C++ programmers who build event stream processing applications using SAS Event Stream Processing. Open $DFESP_HOME/doc/html/index.html in a web browser to access the complete class and method documentation for C++ modeling objects.
Chapter 1
C++ Modeling Objects for SAS
Event Stream Processing

Overview to the C++ Modeling API

The C++ Modeling API provides a set of classes with member functions for each of the
modeling objects. These classes enable event stream processing application developers
to build event stream processing engines as a stand-alone event stream processing server.
Each engine contains one or more projects.

Alternatively, you can embed an event stream processing engine into the process space
of either an existing application or a new application. In that case, the main application
thread is focused on its own chores. It interacts with the embedded engine as needed.
Each project in the engine has its own dedicated thread pool.
The following sections describe common C++ modeling objects. On UNIX systems, open `$DFESP_HOME/doc/html/index.html` in a web browser to access the complete class and method documentation for C++ modeling objects. On Windows systems, open `%DFESP_HOME%/doc/html/index.html`.

### Requirements When Writing a C++ Server Application

When you write a C++ server application, you must follow these requirements for the `main()` function:

1. Create an `args_t` structure:
   ```c
   struct args_t {
     int argc;
     char *argv[];
     int rc;
   };
   ```

2. Create the following generic `main()` function:
   ```c
   int main(int argc, char *argv[]) {
     tkAPI_t *tk = tkAPI_t::get_instance();
     args_t args;
     args.argc = argc;
     args.argv = argv;
     tk->run(main_tk, (void *)&args);
     tkAPI_t::destroy(tk);
     return args.rc
   }
   ```

3. Write the `main()` function using the following signature:
   ```c
   size_t main_tk(void *args) {
     int argc = ((args_t *)args)->argc;
     char **argv = ((args_t *)args)->argv;
     // place your code here; use argc and argv as in a standard main()
     ...
   }
   ```

4. Generate a return value from your code as follows:
   ```c
   ((args_t *)args)->rc = 1;  // return a value of 1 from main()
   return 0;
   ```

### Dictionary

**dfESPengine**

specifies the top-level container or manager of an event stream processing instance. An engine can be a stand-alone executable or embedded in a C++ application. Engines contain one or more projects. dfESPengine is a singleton class instance; any process can have at most one dfESPengine within it.
Syntax

```
DFESP_API static dfESPengine *dfESPengine::initialize(int argc, char *argv[],
dfESPstring id, pubsubSpec_t pubsub, dfESPLoggingLevel logLevel=dfESPLLInfo,
const char *logConfigFile=NULL,
const char *licKeyFile=NULL);
```

**Required Arguments**

- **id**
  - specifies the engine ID

- **argc**
  - argument count as passed into main

- **argv**
  - argument vector as passed into main.

  Accepts the following options:
  - `-t textfile.name` to write output
  - `-b badevent.name` to write events that failed to be applied to a window index
  - `-r restore.path` to restore a previously persisted engine state.
  - `-h http-pubsub-port` to specify a port for a restful publish/subscribe interface.
    Use this to access the server from Streamviewer.

- **pubsub**
  - indicates whether to enable `(pubsub_ENABLE(port_number))` or disable `(pubsub_DISABLE)` publish/subscribe for the engine.

**Optional Arguments**

- **logLevel**
  - the lower threshold for displayed log messages. The default value is `dfESPLLInfo`.

- **logConfigFile**
  - a logging facility configuration file. The default is to configure logging to go to standard output.

- **licKeyFile**
  - a fully qualified pathname to a license file. The default is `$DFESP_HOME/etc/license/esp.lic`.

**Details**

You can use the following method to tell an engine how to handle fatal errors that occur in a project.

```
static DFESP_API void dfESPengine::setProjectFatalDisposition (projectFatal_t dispositionFlag)
```
Set the `dispositionFlag` to one of the following values:

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>dfESPengine::projectFatal_EX</code></td>
<td><code>IT_ENGINE</code> exit with the engine process</td>
</tr>
<tr>
<td><code>dfESPengine::projectFatal_EX</code></td>
<td><code>IT_ENGINE_WITH_CORE</code> exit and generate a core file for debugging, and stop all processing</td>
</tr>
<tr>
<td><code>dfESPengine::projectFatal_EX</code></td>
<td><code>IT_PROJECT</code> disconnect publish/subscribe, clean up all threads and memory, and remove the process from the engine while leaving the engine up and processing other projects</td>
</tr>
</tbody>
</table>

### Example

The following example creates, starts, stops, and shuts down an engine.

```cpp
// Create the engine container.
dfESPengine *engine;
engine = dfESPengine::initialize(argc, argv, "engine", pubsub_DISABLE);

// Create the rest of the model and then start the projects.
// Creating the rest of the model is covered in the subsequent sections.
engine->startProjects();

// The project is running in the background and you can begin publishing event streams into the project for execution.

/* Now cleanup and shutdown gracefully */

// First, stop the projects.
engine->stopProjects();

// Next, shutdown the engine and its services (this frees all the modeling resources from the engine down through the windows).
engine->shutdown();
```

**dfESPdatavar**

represents a variable that can hold any data type that the event stream processing engine supports. It is essentially a C union of event stream processing data types.

### Syntax

```cpp
// construct a new NULL datavar type
DFESP_API dfESPdatavar(dfESPdatatype data_type);
// construct a new NULL datavar type from an existing datavar
DFESP_API dfESPdatavar(dfESPdatavar *dv);
```
// construct a new NULL datavar type from binary data
DFESP_API dfESPdatavar(dfESPdatatype data_type, void *b);
// construct a new NULL datavar type from a string
DFESP_API dfESPdatavar(dfESPdatatype data_type, const char *s);
// construct a new NULL datavar type from a string
dfESP_API dfESPdatavar(char *dateFormat, dfESPdatatype data_type, const char *s);

**Required Arguments**

*data_type*

can be one of the following values:

- ESP_INT32
- ESP_INT64
- ESP_DOUBLE (IEEE)
- ESP_UTF8STR
- ESP_DATETIME (second granularity)
- ESP_TIMESTAMP (microsecond granularity)
- ESP_MONEY (192-bit fixed decimal)
- ESP_BINARY (binary large object or blob for short)
- ESP_RUTF8STR (reference-counted string or rstring for short)
- ESP_ARRAY (array)

A dfESPdatavar of any of these types can be NULL. Two dfESPdatavars that are each NULL are not considered equal if the respective types do not match.

*dateFormat*

specifies the date format to use — if unspecified, the field value is interpreted as an integer number of seconds (ESP_DATETIME) or microseconds (ESP_TIMESTAMP) since epoch

*s*

specifies the string used to convert to the new data type

*dv*

specifies the existing data variable to replicate

*b*

specifies the binary data to convert

**Example**

Create an empty dfESPdatavar and then set the value as follows:

```c
dfESPdatavar *dv = new dfESPdatavar(dfESPdatavar::ESP_INT32);
dv->setI32(13);
```

Get access to raw data in the dfESPdatavar using code like this:

```c
void *p = dv->getRawdata(dfESPdatavar::ESP_INT32);
```

This returns a pointer to actual data, so in this int32 example, you can follow with code like this:

```c
int32_t x;
```
memcpy((void *)&x, p, sizeof(int32_t));

This copies the data out of the `dfESPdatavar`. You can also use the `getI32` member function (a get and set function exists for each data type) as follows:

```cpp
int32_t x;
x = dv->getI32();
```

 Blobs are easily created and assigned to `dfESPdatavar` objects. Suppose that the `uint64_t` variable `blobLen` is the length of your binary data and the pointer to the binary data is held in the `void*` variable `blobData`. You can write the following code:

```cpp
dfESPblob *myBlob = dfESPblob::create(blobLen, blobData);
dv->setDataCopy(myBlob);
dfESPblob::destroy(myBlob);
```

 An alternate blob creation function can be useful when the data that you have is already encoded `base64`, perhaps in a NULL-terminated `char*` variable `base64Data`. You can write the following code:

```cpp
dfESPblob *myBlob = dfESPblob::create(base64Data);
dv->setDataCopy(myBlob);
dfESPblob::destroy(myBlob);
```

 If a blob data type is in the internal field index 1 for an event (for example, the `dfESPevent *ev` variable), then the following method extracts the blob data type for use:

```cpp
dfESPblob *field_1 = (dfESPblob *)ev->getPtrByIntIndex(1);
```

 For public methods on `dfESPblob` objects, see `dfESPvblob.h` and `dfESPblob.h`.

 Extracting a `rstring` data type is similar to extracting a blob data type. For example, if an `rstring` data type is in internal field index 1 for an event (for example, the `dfESPevent *ev` variable), then the following method extracts the `rstring` data type for use:

```cpp
dfESPstrstring *field_1 = (dfESPstrstring *)ev->getPtrByIntIndex(1);
```

 For public methods on `dfESPstrstring` objects, see `dfESPvblob.h` and `dfESPstrstring.h`.

 Many convenience functions are available and a complete list is available in the modeling API documentation included with the installation.

### `dfESPschema`

represents a set of fields that together define event structures. Schemas include the specification of one or more key fields for the event structure that it defines. Each schema field has a name, a data type, and an indication as to whether it is part of the event key.

#### Syntax

```
DFESP_API dfESPschema(dfESPstring id);
DFESP_API dfESPschema(dfESPstring id, dfESPstring schemaString);
```

#### Required Arguments

- **id**
  
  user-supplied ID of the schema
**schemaString**

specify a serialized representation of the schema. Use the following form:

\[
\text{field1[*]}:\text{type}, \ldots, \text{fieldn[*]}:\text{type}
\]

**Details**

A `dfESPschema` never represents field data, only the structure of the fields. When a `dfESPschema` object is created, it maintains the field names, fields types, and field key designation in the original order the fields (called the external order) and in the packing order (called the internal order) for the fields.

SAS Event Stream Processing does not put restrictions on the field names in a schema. Even so, you need to keep in mind that many times field names are used externally. For example, there could be connectors or adapters that read the schema and use field names to reference external columns in databases or in other data sources. It is therefore highly recommended that you start field names with an alphanumeric character, and use no special characters within the name.

In external order, you specify the keys to be on any fields in the schema. In internal order, the key fields are shifted left to be packed at the start of the schema. For example, using a compact character representation where an "*" marks key fields, you specify this:

"ID1*:int32,symbol:string,ID2*:int64,price:double"

This represents a valid schema in external order. If you use this to create a `dfESPschema` object, then the object also maintains the following:

"ID1*:int32, ID2*:int64,symbol:string,price:double"

This is the same schema in internal order. It also maintains the permutation vectors required to transform the external form to the internal form and vice versa.

Creating a `dfESPschema` object is usually completed by passing the character representation of the schema to the constructor in external order, for example:

```c
dfESPschema *s = new
dfESPschema("mySchema","ID1*:int32,symbol:string,ID2*:int64,price:double");
```

A variety of methods are available to get the names, types, and key information of the fields in either external or internal order. There are also methods to serialize the schema back to the compact string form from its internal representation.

---

**dfESPeventblock**

An event block typically contains one or more events. Event blocks are published into Source windows and maintained as a container with a unique ID throughout the processing of it within continuous queries. Events within event blocks usually are transformed as event blocks are processed by windows within a continuous query.

**Syntax**

```c
// create an event block containing this single event
DFESP_API static dfESPeventblockPtr
*dfESPeventblock::newEventBlock(dfESPeventPtr ep);

// create an event block of this type for the event pointer list provided
DFESP_API static dfESPeventblockPtr
```
*dfESPeventblock::newEventBlock(dfESPptrList<dfESPeventPtr> *lst, dfESPeventblocktype type);
// create an event block of this type for the event pointer vector provided
DFESP_API static dfESPeventblockPtr
*dfESPeventblock::newEventBlock(dfESPptrVect<dfESPeventPtr> *vec, dfESPeventblocktype type);
// create a duplicate event block
DFESP_API static dfESPeventblockPtr
*dfESPeventblock::newEventBlock(dfESPeventblockPtr eb);

**Required Arguments**

ep
  specifies an event pointer
type
  specifies the event block type (dfESPeventblock::ebtTRANS | ebtNORMAL)
lst
  specifies the event pointer list
vec
  specifies the event pointer vector
eb
  specifies the event block pointer

**Details**

Publishing clients can use this object to generate a *dfESPeventblock* object. An event block is maintained as it is passed between windows in an application, as well as to subscribing clients. The *dfESPeventblock* object can report the number of items that it contains and return a pointer to a contained *dfESPevent* when given an index.

A unique embedded transaction ID is generated for event blocks as they are absorbed into a continuous query. Event blocks can also be assigned a unique ID by the publisher. In addition to the event block ID, the publisher can set a host and port field in event blocks to establish where the event block is coming from. This meta information is used by the guaranteed delivery feature to ensure that event blocks make their way from a publisher.

Event blocks progress through the continuous queries and on to one or more guaranteed subscribers. The event block meta information is carried with the event block from the start of processing at a Source window. The meta information progresses through all stages of computation in derived windows and on to any subscribing clients. You can use the publisher assigned ID, host, and port to tie an output *dfESPeventblock* back to an input *dfESPeventblock*.

Create new *dfESPeventblock* objects with either transactional (*dfESPeventblock::ebt_TRANS*) or normal (*dfESPeventblock::ebt_NORMAL*) event semantics. Transaction semantics imply that each *dfESPevent* contained in the block must be able to be applied to the index in a given window. Otherwise, none of the events are applied to the index.

For example, suppose an *dfESPeventblock* has 100 events and the first event is a delete event. Further suppose that the delete event fails to be applied because the underlying event to be deleted is not present. In that case, the remaining 99 events are ignored, logged, and written to a bad records file (optional). Normal semantics imply that each event in a *dfESPeventblock* is treated as an individual event. Therefore, the
failure for one event to apply to an index causes only that event to not be incorporated into the window.

A dfESPeventblock with more than one event, but without transactional properties set, can be used to improve performance during the absorption of the event block into the appropriate Source window. You use this to trade off a little bit of latency for a large gain in throughput. It is best to test the event block optimal size trade-off. For example, placing 256 events into an event block gives both great latency and throughput. This performance varies depending on the width of the events.

---

### dfESPproject

specifies a container that typically holds one or more continuous queries. A project is backed by a thread pool of user-defined size and an optional port.

#### Syntax

```c
// create project with given id, tagged token off, and no depot location for caching store
DFESP_API dfESPproject *dfESPengine::newProject(dfESPstring id);

// create project with id, tagged token on or off, 
// and depot location (which could be an empty string for none)
DFESP_API dfESPproject
*dfESPengine::newProject(dfESPstring id, bool useTaggedToken, dfESPstring depotLocation);
```

#### Required Arguments

- **id**
  - specifies the project ID
- **useTaggedToken**
  - indicates whether to use project tagged token
- **depotLocation**
  - specifies where to place the project caching store or stores when a window uses a caching index (for example, piHLEVELDB). This can be an empty string for no caching store.

#### Details

The levels of determinism supported by a project are as follows:

- **full concurrency (default)** - data received by a window is processed as soon as it is received and forwarded on to any dependent window. This is the highest performing mode of computation. In this mode, a project can use any number of threads as specified by the `setNumberOfThreads(max thread)` method.

- **tagged token** - implements single-transaction in, single-transaction out semantics at each node of the model. In this mode, a window imposes a diamond pattern, splitting the output and then rejoining the split paths together. It merges outputs (per unique transaction) from each path into a single transaction. A single transaction in the top of the diamond produces a single output at the bottom.

The `newProject()` method for the `dfESPengine` class takes a final parameter (**true** | **false**) that indicates whether tagged token data flow should be enabled. If you do not specify this optional parameter, the value defaults to false.
Thus, to specify full concurrency:

```cpp
dfESPproject *project = engine->newProject("MyProject");
```

or

```cpp
dfESPproject *project = engine->newProject("MyProject", false);
```

And to specify tagged token:

```cpp
dfESPproject *project = engine->newProject("MyProject", true);
```

For easier debugging and full consistency in output for testing, run with tagged token `true`. Set the number of threads in a project to 1. This is the slowest way to run a project. Nonetheless, as long as you are using time-based retention policies, you can be assured that the output is consistent from run to run.

**Example**

The following code fragment shows how to create a project, add a memory store, set the thread pool size, and add continuous queries. It is run with a level of determinism of full consistency.

```cpp
// Create the project containers.
dfESPproject *project = engine->newProject("MyProject");

project->setNumThreads(3); //set the thread pool size for project.

// After you have started the projects using the startProjects()
// method shown in the dfESPengine section above, then you
// can publish or use dfESPproject::injectData() to inject
// event blocks into the Source windows. You can also use
// the dfESPproject::quiesce() method to block until all
// of the data in the continuous queries of the project are
// quiesced. You might also want to do this before stopping
// the projects.

project->quiesce();
project->stopProject();
```

### dfESPcontquery

specifies a container that holds one or more directed graphs of windows. Many projects have a single continuous query container. You can use continuous queries to implement functional modularity for large projects. You can use the project connector to publish event streams from a window in one continuous query to a Source window in another continuous query, in the same or in another project.

#### Syntax

```cpp
DFESP_API dfESPcontquery *dfESPproject::newContquery(dfESPstring id);
```

**Required Argument**

`id`

specifies the continuous query ID
Example

Suppose that there are two windows, $swA$ and $swB$, that are joined to form window $jwC$. Window $jwC$ is aggregated into window $awD$. Build the continuous query as follows, using the `addEdge` function:

```c
dfESPContquery *cq;
cq = project->newContquery("continuous query #1");

cq->addEdge(swA, jwC); // swA --> jwC
cq->addEdge(swB, jwC); // swB --> jwC
cq->addEdge(jwC, awD); // jwC --> awD
```

This fully specifies the continuous query with window connectivity, which is a directed graph.

dfESPwindow_source

specifies a window that is used to ingest event streams of a defined schema into a continuous query. Source windows can have retention policies. Event streams can be published only into Source windows.

Syntax

DFESP_API dfESPwindow_source
*dfESPContquery::newWindow_source(dfESPstring id, pindex_t index, dfESPstring schema);

Required Arguments

`id`

specifies the window ID

`index`

primary index. Six types of primary indexes are supported. For more information, see “Understanding Primary and Specialized Indexes” in SAS Event Stream Processing: Creating and Using Windows.

`schema`

user-supplied string that specifies the structure of the fields of event data.

Details

The Source window is the only window type to which event streams can be published. All other window types are called derived windows, which transform or analyze event streams coming into them from other windows.

Example

Here is an example of how to specify a Source window:

```c
dfESPwindow_source *sw;
dESPstring sch = dESPstring("ID*:int32,symbol:string,price:double");
sw = cq->newWindow_source("mySourceWindow, dESPindextypes::pi_HASH, sch");
```

You can set event state retention for Source windows and Copy windows only when the window is not specified to be insert-only and when the window index is not set to
pi_EMPTY. All subsequent sibling windows are affected by retention management. Events are deleted automatically by the engine when they exceed the window’s retention policy.

Set the retention type on a window with the `setRetentionParms()` call. You can set type by count or time, and as either jumping or sliding.

Under the following circumstances, a Source window can auto-generate the key value:

- the Source window is Insert only
- there is only one key for the window
- the key type is INT64 or string

When these conditions are met and the `setAutoGenerateKey()` call is made, you do not have to supply the key value for the incoming event. The Source window overwrites the value with an automatically generated key value. For INT64 keys, the value is an incremental count (0, 1, 2, ...). For STRING keys, the value is a Globally Unique Identifier (GUID).

dfESPwindow_aggregate

specifies a window that aggregates events from its incoming event stream. Aggregation is based on the key fields specified for the Aggregate window schema. The result is a collection of groups with aggregated fields.

Syntax

```cpp
DFESP_API dfESPwindow_aggregate
*dfESPcontquery::newWindow_aggregate(dfESPstring id, pindex_t index, dfESPstring schema)
```

**Required Arguments**

- `id`
  - specifies the window ID

- `index`
  - primary index. Six types of primary indexes are supported. For more information, see “Understanding Primary and Specialized Indexes” in SAS Event Stream Processing: Creating and Using Windows.

- `schema`
  - specifies an aggregate schema. The specification is the same as for any other window schema, except that key field(s) are the group-by mechanism.

**See Also**

“Creating Aggregate Windows” in SAS Event Stream Processing: Creating and Using Windows
dfESPwindow_compute

specifies a window that enables users to define projections or transformations on input events fields in order to produce new Compute window events. There is a one-to-one cardinality between input events and generated events for this window type.

Syntax

DFESP_API dfESPwindow_compute
   *dfESPcontquery::newWindow_compute(dfESPstring id, pindex_t index, dfESPstring schema);

Required Arguments

id
   user-supplied identifier of the Compute window

index
   primary index. Six types of primary indexes are supported. For more information, see “Understanding Primary and Specialized Indexes” in SAS Event Stream Processing: Creating and Using Windows.

schema
   user-supplied name of the schema as specified by dfESPstring.

Details

Usually, the keys of a Compute window are obtained from the keys of its input window. However, key values can be changed by designating the new fields as key fields in the dfESPcompute_window schema. When you change the key value in the Compute window, the new key must also form a primary key for the window. If it does not, you might encounter errors because of unsuccessful Insert, Update, and Delete operations.

Examples

Example 1

Here is an example of a specification of a Compute window:

    dfESPwindow_source *cw;
    cw = cq->newWindow_compute("myComputeWindow",
       dfESPindextypes::pi_HASH, sch);

As with the source window, you use dfESPstring to specify a schema. For example

    dfESPstring sch = dfESPstring("ID*:int32,symbol:string,price:double");

A Compute window needs a field calculation method registered for each non-key field so that it computes the field value based on incoming event field values. These field calculation methods can be specified as either of the following:

- a collection of function pointers to C or C++ functions that return dfESPdatavar values and are passed an event as input
- expressions that use the field names of the input event to compute the values for the derived event fields
Example 2
The following example creates a Compute window using a collection of function pointers.

Assume the following schema for input events:

"ID*:int32,symbol:string,quantity:int32,price:double"

The Compute window passes through the input symbol and price fields. Then it adds a computed field (called cost) to the end of the event, which multiplies the price with the quantity.

A scalar function provides the input event and computes \( \text{price} \times \text{quantity} \). Functions that take events as input and returns a scalar value as a `dfESPdatavar` use a prototype of type `dfESPscalar_func` that is defined in the header file `dfESPfuncptr.h`.

Here is the scalar function:

```cpp
dfESPdatavar *priceBYquant(dfESPschema*is, dfESPevent *nep, dfESPevent *oep, dfESPcontext *ctx) {
    //
    // If you are getting an update, then nep is the updated record, and oep is the old record.
    //
    // Create a null return value that is of type double.
    //
    dfESPdatavar *ret = new dfESPdatavar(dfESPdatavar::ESP_DOUBLE);
    // If you were called because a delete is being issued, you do not compute anything new.
    //
    if (nep->getOpcode() == dfESPeventcodes::eo_DELETE)
        return ret;
    void *qPtr = nep->getPtrByIntIndex(2); // internal index of quant is 2
    void *pPtr = nep->getPtrByIntIndex(3); // internal index of price is 3
    if ((qPtr != NULL) && (pPtr != NULL)) {
        double price;
        memcpy((void *) &price, pPtr, sizeof(double));
        int32_t quant;
        memcpy((void *) &quant, qPtr, sizeof(int32_t));
        ret->setDouble(quant*price);
    }
    return ret;
}
```

Note the `dfESPcontext` parameter. This parameter contains the input window pointer, the output schema pointer, and the ID of the field in the output schema computed by the function. Parameter values are filled in by the engine and passed to all compute functions. Go to `$DFESP_HOME/examples/cxx/compute_context` for another example that shows how to use this parameter.

The following code defines the Compute window and registers the non-key scalar functions:

```cpp
defESPstring sch =
    defESPstring("ID*:int32,symbol:string, price:double,cost:double");

defESPwindow_compute *cw;
    cw = cq->newWindow_compute("myComputeWindow",
```
// Register as many function pointers as there are non-key fields in the output schema. A null for non-key field j means copy non-key field j from the input event to non-key field j of the output event.

cw->addNonKeyFieldCalc((dfESPscalar_func)NULL); // pass through the symbol
cw->addNonKeyFieldCalc((dfESPscalar_func)NULL); // pass through the price value
cw->addNonKeyFieldCalc(priceBYquant); // compute cost = price * quantity

This leaves a fully formed Compute window that uses field expression calculation functions.

**Example 3**

The following example creates a Compute window using field calculation expressions rather than a function. It uses the same input schema and Compute window schema with the following exceptions:

1. You do not need to write field expression calculation functions.
2. You need to call `addNonKeyFieldCalc()` using expressions.

*Note:* Defining the field calculation expressions is typically easier. Field expressions can perform slower than calculation functions.

```c
dfESPstring sch =
    dfESPstring("ID*:int32,symbol:string,price:double,cost:double");

dfESPwindow_compute *cw;
cw = cq->newWindow_compute("myComputeWindow",
    dfESPindextypes::pi_HASH, sch);
```

// Register as many field expressions as there are non-key fields in the output schema.

cw->addNonKeyFieldCalc("symbol"); // pass through the symbol value
cw->addNonKeyFieldCalc("price"); // pass through the price value
cw->addNonKeyFieldCalc("price*quantity"); // compute cost = price * quantity

*Note:* The field calculation expressions can contain references to field names from the input event schema. They do not contain references to fields in the Compute window schema. Thus, you can use similarly named fields across these schemas (for example, symbol and price).

*Note:* Currently, you cannot specify both field calculation expressions and field calculation functions within a given window.

For more information, see the *Expression Language: Reference Guide.*
dfESPwindow_copy

specifies a window that maintains a copy of the events from its parent window. Copy windows inherit their parent’s schema. Copy windows are typically used to establish new retention policies.

**Syntax**

```cpp
DFESP_API dfESPwindow_copy *dfESPcontquery::newWindow_copy(dfESPstring id, pindex_t index);
```

**Required Arguments**

- **id**
  - specifies the window ID
- **index**
  - primary index. Six types of primary indexes are supported. For more information, see “Understanding Primary and Specialized Indexes” in *SAS Event Stream Processing: Creating and Using Windows*.

**Details**

Set the retention type on a window with the `setRetentionParms()` call. You can set type by count or time, and as either jumping or sliding. You can define retention policies only in source and Copy windows.

**Example**

Here is an example of how to specify a Copy window:

```cpp
dfESPwindow_copy *cw;
cw = cq->newWindow_copy("myCopyWindow",
    dfESPindextypes::pi_HASH);
```

You can set event state retention for Copy windows only when the window is not specified to be insert-only and when the window index is not set to `pi_EMPTY`. All subsequent sibling windows are affected by retention management. Events are deleted when they exceed the windows retention policy.

Set the retention type on a window with the `setRetentionParms()` call. You can set type by count or time, and as either jumping or sliding.

**See Also**

“Creating Copy Windows” in *SAS Event Stream Processing: Creating and Using Windows*

---

dfESPwindow_counter

specifies a window that determines event volumes and throughput rate over a defined recurring interval.
Syntax

DFESP_API dfESPwindow_counter
*dfESPcontquery::newWindow_counter(dfESPstring id, pindex_t index);

Required Arguments

id
specifies the window ID

index
primary index. Six types of primary indexes are supported. For more information, see “Understanding Primary and Specialized Indexes” in SAS Event Stream
Processing: Creating and Using Windows.

Details

The schema for counter windows is fixed as follows:

"input*:string,totalCount:int64,totalSeconds:int64,
totalRate:double,intervalCount:int64,intervalSeconds:int64,intervalRate:double"

The key field input is the input window ID, so that there is always only one event per parent input window.

Example

dfESPproject*project = engine->newProject("project");
dfESPcontquery*contquery = project->newContquery("contquery");
dfESPwindow_source*source =
    contquery->newWindow_source("source", dfESPindextypes::pi_RBTREE,
        dfESPstring("ID*:int32,symbol:string,valstr:string"));
dfESPschema *schema = source->getSchema();
dfESPwindow_counter *counter = contquery->newWindow_counter("counterWindow",
    dfESPindextypes::pi_RBTREE);

    counter->setCountInterval("2 seconds");
    counter->setClearInterval("10 seconds");
    contquery->addEdge(source,0,counter);

See Also

“Creating Counter Windows” in SAS Event Stream Processing: Creating and Using Windows

---

dfESPwindow_filter

specifies a window that filters the incoming event stream based on a filter expression or a user-defined function

Syntax

DFESP_API dfESPwindow_filter
*dfESPcontquery::newWindow_filter(dfESPstring id, pindex_t index);
**Required Arguments**

*id*

specifies the window ID

*index*

primary index. Six types of primary indexes are supported. For more information, see “Understanding Primary and Specialized Indexes” in *SAS Event Stream Processing: Creating and Using Windows*.

**Details**

The filter function or expression is set by the `dfESPwindow_filter::setFilter()` method. This function or expression is called each time that a new event block arrives in the Filter window. The function or expression uses the fields of the events that arrive to determine the Boolean result. If the function or expression evaluates to true, then the event passes through the filter. Otherwise, the event does not pass into the filter window.

There are two ways to specify the Boolean filter associated with a Filter window:

- through a C function that returns a `dfESPdatavar` of type int32 (return value != 0 ==> true; == 0 ==> false)
- by specifying an expression as a character string so that when it is evaluated it returns true or false

**Examples**

**Example 1**

The following example writes and registers a filter user-defined function:

```c
// When quantity is >= 1000, let the event pass
//
// dfESPdatavarPtr booleanScalarFunction(dfESPschema *is,
// dfESPeventPtr ep, dfESPeventPtr oep) {

// Get the input argument out of the record.
dfESPdatavar dv(dfESPdatavar::ESP_INT32);
// Declare a dfESPdatavar that is an int32.
ep->copyByIntID(2, dv); // extract field #2 into the datavar

// Create a new dfESP datavar of int32 type to hold the
// 0 or 1 that this Boolean function returns.
//
dfESPdatavarPtr prv = new dfESPdatavar(dfESPdatavar::ESP_INT32);

// If field is null, filter always fails.
//
if (dv.isNull()) {
    prv->setI32(0); // the return value to 0
} else {
    // Get the int32 value from the datavar and compare to 1000
    if (dv.getInt32() < 1000) {
        prv->setI32(0); // set return value to 0
    } else {
```

Chapter 1 • C++ Modeling Objects for SAS Event Stream Processing
Place the following code inside `main()`:
```c
dfESPwindow_filter *fw_01;
fw_01 = cq->newWindow_filter("filterWindow_01",
    dfESPindextypes::pi_RBTREE);
fw_01->setFilter(booleanScalarFunction);
// Register the filter UDF.
```

The `setFilter` function calls the filter function named booleanScalarFunction that you had previously registered.

**Example 2**
The following code example uses filter expressions.
```c
dfESPwindow_filter *fw_01;
fw_01 = cq->newWindow_filter("filterWindow_01",
    dfESPindextypes::pi_RBTREE);
fw_01->setFilter("quant>=1000");
// Register the filter expression.
```

For more information about user-supplied filter expressions, see the *Expression Language: Reference Guide*.

**See Also**

“Creating Filter Windows” in *SAS Event Stream Processing: Creating and Using Windows*

---

**dfESPwindow_functional**

specifies a window that enables a user to specify transformations and manipulations of incoming events. Transformations and manipulations are performed through specific functions, and can result in each input event generating zero or more Functional window events. Incoming event string fields could contain hierarchical data such as JSON or XML.

---

**Syntax**

```c
DFESP_API dfESPwindow_functional
    *dfESPcontquery::newWindow_functional(dfESPstring id, pindex_t index, dfESPstring schema);
```

**Required Arguments**

- `id`
  - specifies the window ID

- `index`
  - primary index. Six types of primary indexes are supported. For more information, see “Understanding Primary and Specialized Indexes” in *SAS Event Stream Processing: Creating and Using Windows*. 

---

```c
prv->setI32(1);    // set return value to 1
```

```c
return prv;        // return it.
```
schema
  user-defined functional window schema

Details
For more information about the functions that you can use to transform or manipulate incoming events, see Chapter 3, “Functional Window and Notification Window Support Functions,”.


dfESPwindow_join
specifies a window that joins two incoming event streams based on the specified join type and condition

Syntax
DFESP_API dfESPwindow_join
  *dfESPcontquery::newWindow_join(dfESPstring id, joinsub_t jt, pindex_t index,
  bool useSecondary=true | false, bool noregenerates=true | false);

Required Arguments
id
  specifies the window ID

jt
  type of join (dfESPwindow_join::dfESPjointypes) to be applied

index
  primary index. Six types of primary indexes are supported. For more information, see “Understanding Primary and Specialized Indexes” in SAS Event Stream Processing: Creating and Using Windows.

Optional Arguments
useSecondary
  a Boolean value that determines whether the Join window should auto-generate a secondary index. The default value is false.

noregenerates
  a Boolean value that, when true, implies changes to the dimensional window and does not cause a rescan of the fact window to produce a block of lookup updates. The default value is false

Details
The key values of the join-window schema are calculated depending on the join type, join condition, and input window schema keys. Join windows support equijoins 1-1 (left, right, or full outer or inner), 1-M and M-1 (left, right, outer or inner), and M-M (inner). Specify the join condition using the setJoinConditions() member function of the Join window class.
dfESPwindow_notification

species a window that enables the event stream processing engine to send notifications through email, text, or multimedia messages. It enables the creation of a number of delivery channels through which to send notifications. Notification windows do not generate events, and are workflow in nature. They have a schema that is used to support the functions used in the Notification window.

Syntax

DFESP_API dfESPwindow_notification
*dfESPcontquery::newWindow_notification(dfESPstring id, dfESPstring schema);

Required Arguments

id
specifies the window ID

schema
optional window schema that is strictly used by Notification window functions. The value can be NULL.

Details

For more information about the functions that you can use, see Chapter 3, “Functional Window and Notification Window Support Functions,”.

For more information, see “Creating Notification Windows” in SAS Event Stream Processing: Creating and Using Windows.

Example

The following code sample sets up an email notification to a broker.

defESPwindow_notification *notification =
    contquery->newWindow_notification("notify",NULL);
notification->setSmtpConnection("mailhost.fyi.orion.com");

defESPemail *email = notification->addEmail();
email->setThrottleInterval("5 minutes");
email->setSender("john.doe@orion.com");
email->setSubject("Investment Opportunity");
email->setFrom("ESP");
email->setTo("Wealthy Trader");
email->addText("You traded $quant shares of $symbol at $$price.");
email->setTesMode(true);

contquery->addEdge(joinBrokerData,0,notification);
**dfESPwindow_pattern**

specifies a window that enables the creation of one or more pattern definitions. Patterns are defined to detect correlations of multiple events across a set of events-of-interest conditions and temporal conditions.

**Syntax**

```cpp
DFESP_API dfESPwindow_pattern
*dfESPcontquery::newWindow_pattern(dfESPstring id, pindex_t index, dfESPstring schema);
```

**Required Arguments**

- `id` specifies the window ID
- `index` primary index. Six types of primary indexes are supported. For more information, see “Understanding Primary and Specialized Indexes” in *SAS Event Stream Processing: Creating and Using Windows*.
- `schema` schema of the pattern window

**See Also**

“Creating Pattern Windows” in *SAS Event Stream Processing: Creating and Using Windows*

---

**dfESPwindow_procedural**

specifies a window that enables users to register event stream input handlers for the window. The input handlers process incoming event streams using C++, DS2, or callouts to Base SAS through DATA step statements. Procedural windows can have one or more input event streams, each requiring its own input handler.

**Syntax**

```cpp
DFESP_API dfESPwindow_procedural
*dfESPcontquery::newWindow_procedural(dfESPstring id, pindex_t index, dfESPstring schema);
```

**Required Arguments**

- `id` specifies the window ID
- `index` primary index. Six types of primary indexes are supported. For more information, see “Understanding Primary and Specialized Indexes” in *SAS Event Stream Processing: Creating and Using Windows*.
schema

schema of the procedural window defined by dfESPstring

See Also


dfESPwindow_textCategory

defines a window that enables you to use a SAS Text Analytics MCO file to get the categories of a document in each event's specified string field. This window type is insert only. For each input event, the window generates zero or more category events.

Syntax

DFESP_API dfESPwindow_textCategory

*dfESPcontquery::newWindow_textCategory(dfESPstring id, pindex_t type,
  dfESPstring mcoFile,
  dfESPstring stringField, bool nullEvents=true | false);

Required Arguments

id
specifies the window ID

type
primary index. Six types of primary indexes are supported. For more information, see “Understanding Primary and Specialized Indexes” in SAS Event Stream Processing: Creating and Using Windows.

mcoFile
path to the MCO file

stringField
user-supplied name for the input string field to analyze

nullEvents
Boolean flag to determine whether to generate a NULL event when no categories are found for an incoming event. The default value is FALSE.

Details

Because this window is insert-only, the following is recommended:

• you follow the window with a copy window so that events can be retained as needed
• you use an empty index for the window

You need a SAS Contextual Analysis license so that you can provide the required mcoFile.

Text category windows generate their own schema, which is as follows:

key_fields_of_input_window, catNum*:int32, category:string, score:double

The key fields for the window are whatever key fields are streamed into the Text Category window and catNum.
See Also

“Creating Text Category Windows” in *SAS Event Stream Processing: Creating and Using Windows*

dfESPwindow_textContext

specifies a window that uses SAS Text Analytics LITI files to extract text and classify terms using a specified input event string field. This window type is insert only. For each input event, zero or more events are created for this window, depending on how many classified terms are discovered by the text engine.

Syntax

DFESP_API dfESPwindow_textContext
*dfESPcontquery::newWindow_textContext(dfESPstring id, pindex_t index,
  dfESPstring initFiles,
  dfESPstring fieldName, bool nullEvents=true | false);

Required Arguments

id
  specifies the window ID

index
  primary index. Six types of primary index are supported. For more information, see “Understanding Primary and Specialized Indexes” in *SAS Event Stream Processing: Creating and Using Windows*.

initFiles
  comma separated list of Liti file paths or a single path to an aStore.

fieldName
  user-supplied name for the string field in the input event to analyze

nullEvents
  Boolean flag to determine whether to generate a NULL event when no categories are found for an incoming event. The default value is FALSE.

Details

You need a SAS Contextual Analysis license so that you can provide the required initFiles.

The schema of events output by the textContext window is as follows:

"input event key fields*, termID*:int64, term:string, termLen:int32,
  tag:string, tagLen:int32, locStart:int32, locEnd:int32, wordStart:int32,
  wordEnd:int32"

Example

The following example uses an empty index for the textContext window, which is insert only. That way, the window does not grow endlessly. The textContext window is followed by a Copy window that uses retention to control the growth of the classified terms.

    // Build the Source window. We specify the window name, the schema
for events, the depot used to generate the index and handle
// event storage, and the type of primary index, in this case a
// hash tree
//
dfESPwindow_source *sw_01;
sw_01 = cq_01->newWindow_source("sourceWindow_01",
    dfESPindextypes::pi_HASH,
    dfESPstring("ID*:int32,tstamp:date,msg:string"));

// Build the textContext window. Specify the window name, the depot
// used for retained events, the type of primary index, the Liti
// files specification string, and the input string field to analyze.
//
// Note that the index for this window is an empty index. This means
// that events created in this window will not be retained in this
// window. This is because textContext windows are insert only,
// hence there is no way of deleting these events using retention
// so without using an empty index this window would grow indefinitely.
//
// To run this example, you need to have licensed SAS
// Contextual Analysis, whose install contains these Liti language files.
// You need to change the litFiles string below to point to your
// installation of the Liti files. Otherwise the text analytics engine
// will not be initialized and classified terms will not be found.
//
dfESPwindow_textContext *tcw_01;

dfESPstring initFiles = "/wire/develop/TableServer/src/common/dev/
mva-v940m1/tktg/misc/en-ne.li,
/wire/develop/TableServer/src/common/dev/
mva-v940m1/tktg/misc/ro-ne.li";

// Place a Copy window after the textContext window so that
// it can be used to hold the textContext events with an established
// retention policy. This is a design pattern for insert-only windows.
tcw_01 = cq_01->newWindow_textContext("textContextWindow_01",
    dfESPindextypes::pi_EMPTY,
    initFiles, "msg");

// Create the Copy window.
dfESPwindow_copy *cw_01;
cw_01 = cq_01->newWindow_copy("copyWindow_01",
    dfESPindextypes::pi_RBTREE);

// Now set the window's retention policy to a sliding window of 5 mins.
// This example only has 3 events being injected so the retention
// policy will not take effect, but if we published enough data
// into this model then it would start retaining older events out
// using retention deletes once they aged past 5 mins.
cw_01->setRetentionParms(dfESPindextypes::ret_BYTIME_SLIDING, 300);

Suppose you supply the following strings to the textContext window:
"i,n,1,2010-09-07 16:09:01,I love my Nissan pickup truck"
"i,n,2,2010-09-07 16:09:21,Jerry went to dinner with Renee for last Sunday"
"i,n,3,2010-09-07 16:09:43, Jennifer recently got back from Japan where
she did game design project work at a university there.”

Here are the results.

```
event[0]: <I,N: 1,0,Nissan pickup,13,VEHICLE,7,10,22,3,5>
event[1]: <I,N: 2,0,Sunday,6,DATE,4,41,46,8,9>
event[2]: <I,N: 2,1,Renee,5,PROP_MISC,9,26,30,5,6>
event[3]: <I,N: 3,0,Japan,5,LOCATION,8,32,36,5,6>
event[4]: <I,N: 3,1,game design project work,24,NOUN_GROUP,10,52,75,9,13>
event[5]: <I,N: 3,2,Jennifer,8,PROP_MISC,9,0,7,0,1>
```

dfESPwindow_textSentiment

specifies a window that uses a SAS Text Analytics SAM file to get the sentiment of a document that is in the specified incoming event string field. This window type is insert only. Each input event creates a new text sentiment event.

**Syntax**

```
DFESP_API dfESPwindow_textSentiment
*dfESPcontquery::newWindow_textSentiment(dfESPstring id, pindex_t index, 
  dfESPstring samFile, 
  dfESPstring inputFieldName);
```

**Required Arguments**

- **id**
  - specifies the window ID

- **index**
  - primary index. Six types of primary indexes are supported. For more information, see “Understanding Primary and Specialized Indexes” in *SAS Event Stream Processing: Creating and Using Windows*.

- **samFile**
  - path to the SAM file

- **inputFieldName**
  - user-supplied name of the string field in the input event to analyze

**Details**

Because this window is insert-only, the following is recommended:

- you follow the window with a copy window so that events can be retained as needed
- you use an empty index for the window

You need a SAS Sentiment Analysis license so that you can provide the required `samFile`.

The window generates its own schema, which is as follows:

```
key_fields_of_input_window, sentiment:string, 
probability:double.
```

The sentiment value is “positive”, “neutral”, or “negative”, and the probability is a value between 0 and 1.
dfESPwindow_textTopic

specifies a Text Topic window

Syntax

/** * Create a new concrete dfESPwindow_textTopic(textTopic window) instance. * @param id the unique class id string * @param type the type of primary index to use (dfESPindextypes::dfESPpindextype). * @param samFile the path pointing to the MCO file * @param stringField the input string field to analyze * @param includeTopics set to true to include the topic label string in * each produced event. If false, a null topic label is returned. * @return pointer to a new dfESPwindow_textTopic object or NULL. */
dfESPcontquery *cq;
dfESPwindow_score *cw = cq->newWindow_textTopic(dfESPstring windowID pindex_t type, dfESPstring aStoreFile, dfESPstring textBinaryDir, dfESPstring fieldName, bool includeTopics=false);

See Also

“Creating Text Topic Windows” in SAS Event Stream Processing: Creating and Using Windows

dfESPwindow_union

specifies a window that unites two or more event streams using a strict or a loose policy

Syntax

DFESP_API dfESPwindow_union
*dfESPcontquery::newWindow_union(dfESPstring id, pindex_t index, bool strict=true | false);

Required Arguments

id

specifies the window ID

index

primary index. Six types of primary indexes are supported. For more information, see “Understanding Primary and Specialized Indexes” in SAS Event Stream Processing: Creating and Using Windows .

Optional Argument

strict

the strict flag — true for strict union and false for loose unions. The default value is false.
Details

Union windows support both a strict union and a loose union of events from two or more parent windows. The loose variant (strict = false) turns Updates into Upserts and Deletes into Safe Deletes. A Safe Delete fails quietly when the event to be deleted does not exist.

Example

Here is an example of how to create a Union window:

```c++
dfESPwindow_union *uw;
uw = cq->newWindow_union("myUnionWindow",
    dfESPindextypes::pi_HASH, true);
```
Chapter 2
C++ Modeling Objects for SAS Event Stream Processing Analytics

Overview to SAS Event Stream Processing Analytics

SAS Event Stream Processing Analytics is a separately orderable and licensed package that enables the use of advanced analytics and machine learning techniques in an event stream processing model.

You use these analytics and techniques through the following window types:

<table>
<thead>
<tr>
<th>Window Type</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td><strong>score</strong></td>
<td>Enables you to score events using online algorithms packaged with SAS Event Stream Processing or with offline scoring models.</td>
</tr>
<tr>
<td><strong>train</strong></td>
<td>Enables the generation of scoring models for a class of online algorithms based on streaming event data.</td>
</tr>
<tr>
<td><strong>calculate</strong></td>
<td>Enables the transformation of data events using a variety of packaged algorithms.</td>
</tr>
<tr>
<td><strong>model reader</strong></td>
<td>Enables you to use training algorithms outside SAS Event Stream Processing. You can get algorithms through CAS actions and the score them through the analytic store (ASTORE) binary file conversion to a scoring model.</td>
</tr>
<tr>
<td><strong>model supervisor</strong></td>
<td>Enables you to manage models for scoring inside SAS Event Stream Processing.</td>
</tr>
</tbody>
</table>

For more information, see *SAS Event Stream Processing: Using SAS Event Stream Processing Analytics*. 
Dictionary

**dfESPwindow_score**

specifies a Score window.

### Syntax

```c
/** *
 * construct the window using dfESPcontquery
 * @param window_id: a user-supplied identifier.
 * @param index_type: the primary index. Currently ignored. Internally, it is set to
 * pi_EMPTY because the window is stateless.
 * @param schema: the user-supplied name of the schema as specified by dfESPstring. The train, model reader, and Model Supervisor windows ignore this and use a default
 * schema. */
 DFESP_API dfESPcontquery *cq;
 DFESP_API dfESPwindow_score *cw = cq->newWindow_score(
 window_id, index_type, schema);
/** *
 * initialize window
 * load config from YML file for an algorithm
 * @param file = the name of a YML file
 * @param mod = a data structure that encapsulates a set of online or offline models
 * *
 * */
 DFESP_API void init(const saModels& mod, std::string file="");
 where saModels is a class defined in dfESPwindow_sa.h.
 /** *
 * set the role of edges that lead to w
 * input to Score window has one of two edge types: data or model
 * call this explicitly to set the role associated with an edge
 * @param w = pointer to input window
 * @param type either "data" or "model"
 * */
 DFESP_API void setInputWindowRole(dfESPwindow *w, std::string type);
```

### See Also

*SAS Event Stream Processing: Using SAS Event Stream Processing Analytics*

**dfESPwindow_train**

specifies a Train window, which is available only when you license SAS Event Stream Processing Analytics.
**Syntax**

```c++
DFESP_API dfESPcontquery *cq;
DFESP_API dfESPwindow_train *cw = cq->newWindow_train(window_id, index_type, schema);
```

```c++
DFESP_API void init(dfESPwindow *w, std::string type)
```

```c++
DFESP_API void setInputWindowRole(dfESPwindow *w, std::string type);
```

### See Also

*SAS Event Stream Processing: Using SAS Event Stream Processing Analytics*

---

**dfESPwindow_calculate**

specifies a Calculate window.

**Syntax**

```c++
DFESP_API dfESPcontquery *cq;
DFESP_API dfESPwindow_calculate *cw = cq->newWindow_calculate(window_id, index_type, schema);
```

```c++
DFESP_API void initializewindow(dfESPwindow *w, std::string type, std::string algo);`
```
DFESP_API void init(std::string algo, std::map<std::string, std::string>& properties, std::string file="");

DFESP_API void setInputWindowRole(dfESPwindow *w, std::string type);

See Also

SAS Event Stream Processing: Using SAS Event Stream Processing Analytics

dfESPwindow_modelReader

specifies a Model Reader window.

Syntax

/** * construct the window using dfESPcontquery
 * @param window_id: a user-supplied identifier.
 * @param index_type: the primary index. Currently ignored. Internally, it is set to
 * pi_EMPTY because the window is stateless.
 * @param schema: the user-supplied name of the schema as specified by dfESPstring.
 * The train, model reader, and Model Supervisor windows ignore this and use a default
 * schema. */

DFESP_API dfESPcontquery *cq;

DFESP_API dfESPwindow_modelReader *cw = cq->newWindow_modelReader(window_id, index_type, schema);

/** *
 * initialize the window
 * @param file if not empty, the yaml configuration file
 */

DFESP_API void init(std::string file="");

/** *
 * set the role of an edge that leads to w
 * input to Model Reader window currently accepts only one edge type: request
 * call this explicitly to set the role associated with an edge
 * @param w = pointer to the input window
 * @param type = "request"
 */

DFESP_API void setInputWindowRole(dfESPwindow *w, std::string type);

See Also

SAS Event Stream Processing: Using SAS Event Stream Processing Analytics
dfESPwindow_modelSupervisor

specifies a Model Supervisor window.

Syntax

/** * construct the window using dfESPcontquery  
 * @param window_id: a user-supplied identifier.  
 * @param index_type: the primary index. Currently ignored. Internally, it is set to  
 * pi_EMPTY because the window is stateless.  
 * @param schema: the user-supplied name of the schema as specified by dfESPstring.  
 * The train, model reader, and Model Supervisor windows ignore this and use a default  
 * schema. */  
 DFESP_API dfESPcontquery *cq;  
 DFESP_API dfESPwindow_modelSupervisor *cw = cq-  
 >newWindow_modelSupervisor(window_id, index_type, schema);  
 /** * initialize the window  
 * @param file if not empty, the yaml configuration file  
 */  
 DFESP_API void init(std::string file="");  
 /** * set the role of an edge that leads to w  
 * input to Model Supervisor window currently accepts only one of two edge types:  
 * model or request  
 * call this explicitly to set the role associated with an edge  
 * @param w = pointer to the input window  
 * @param type = “model” or “request”  
 */  
 DFESP_API void setInputWindowRole(dfESPwindow *w, std::string type);

See Also

SAS Event Stream Processing: Using SAS Event Stream Processing Analytics
Chapter 3
Functional Window and Notification Window Support Functions

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**ABS**
Returns the absolute floating-point value of the supplied argument.

**Syntax**
abs(argument)

**Required Argument**

*argument*

specifies one of the following:

- a literal value, either string or numeric. Enclose string values in single or double quotation marks.
- a value to be resolved from an event field. Precede field names with the $ character.
- a value that refers to a resource. For example, when you use the `xpath` function to refer to an XML object named myXML, you would specify this: #myXML.
- a function.

**Example**

```
abs(-55) = 55
abs(44) = 44
```

**AND**

When both arguments are true, returns true. Otherwise, returns false.

**Syntax**

```
and(argument1, argument2)
```
Required Argument

argument1, argument2

specifies one of the following:

• a literal value, either string or numeric. Enclose string values in single or double quotation marks.

• a value to be resolved from an event field. Precede field names with the $ character.

• a value that refers to a resource. For example, when you use the xpath function to refer to an XML object named myXML, you would specify this: #myXML.

• a function.

• If the argument returns a numeric value, then the function returns true when the numeric value is nonzero, otherwise it returns false.

• If the argument returns a string value:
  • When the string value is 'true', the function returns true.
  • When the string value is 'false', the function returns false.
  • Else, when the length of the string is > 0, the function returns true, otherwise false.

Example

\text{and}(\text{gt}(3,2),\text{gt}(2,5))=0
\text{and}(\text{gt}(3,2),\text{gt}(12,5))=1
\text{and}(0,1)=0
\text{and}('\text{non empty string}',55)=1
\text{and}('\text{true}',55)=1
\text{and}('',4)=0

BASE64DECODE

Decodes the supplied base64-encoded string.

Syntax

\text{base64Decode}(\text{string})

Required Argument

\text{string}

specifies a base64-encoded string. There is no length limit to this string.

Example

\text{base64Decode('dGhpcyBpcyBhIHRlc3Q=')}=\text{this is a test}
BASE64ENCODE
Encodes the supplied string into a base64–encoded string.

Syntax

\[
\text{base64Encode}(\text{string})
\]

Required Argument

\textit{string}

specifies a text string. There is no length limit to this string.

Example

\[
\text{base64Encode('this is a test')} = dGhpcyBpcyBhIHRlYXItc2V0
\]

BETWEEN
If the first argument is greater than the second and less than the third, returns true. Otherwise, returns false.

Syntax

\[
\text{between}(\text{argument1, argument2, argument3})
\]

Required Argument

\textit{argument1, argument2, argument3}

specifies one of the following:

- a literal value, either string or numeric. Enclose string values in single or double quotation marks.
- a value to be resolved from an event field. Precede field names with the $ character.
- a value that refers to a resource. For example, when you use the \texttt{xpath} function to refer to an XML object named myXML, you would specify this: \#myXML.
- a function.

Example

\[
\text{between}(20, 17, 30) = 1
\]
\[
\text{between}(20, 17, 15) = 0
\]
**BOOLEAN**

If the supplied argument is a string, returns true when the string has length greater than 0. If the supplied argument is numeric, returns true when value is not equal to 0. If the supplied argument is a Boolean expression, returns true when the value is true. Otherwise, returns false.

**Syntax**

`boolean(argument)`

**Required Argument**

*argument*

specifies one of the following:

- a literal value, either string or numeric. Enclose string values in single or double quotation marks.
- a value to be resolved from an event field. Precede field names with the `$` character.
- a value that refers to a resource. For example, when you use the `xpath` function to refer to an XML object named `myXML`, you would specify this: `#myXML`.
- a function.

*Note:* The special string values `true` and `false` are handled outside the string length > 0. If `true`, the function returns 1. If `false`, the function returns 0.

**Example**

```plaintext
boolean('my string')=1
boolean('')=0
boolean(10)=1
boolean(0)=0
boolean(gt(4,7))=0
boolean(gt(7,5))=1
```

**CEILING**

Returns the integer value above the numeric value of the supplied argument.

**Syntax**

`ceiling(argument)`

**Required Argument**

*argument*

specifies one of the following:
• a literal value, either string or numeric. Enclose string values in single or double quotation marks.
• a value to be resolved from an event field. Precede field names with the $ character.
• a value that refers to a resource. For example, when you use the xpath function to refer to an XML object named myXML, you would specify this: $myXML.
• a function.

Example

\[
\text{ceiling(product\{4,4.1\})=17}
\]

**COMPARE**

Compares the first argument to the second. If the first argument is less than the second, then it returns -1. If the first is greater than the second, then it returns 1. If the first is equal to the second, then it returns 0.

**Syntax**

\[
\text{compare}(\text{argument1}, \text{argument2})
\]

**Required Argument**

\[
\text{argument1, argument2}
\]

specifies one of the following:

• a literal value, either string or numeric. Enclose string values in single or double quotation marks.
• a value to be resolved from an event field. Precede field names with the $ character.
• a value that refers to a resource. For example, when you use the xpath function to refer to an XML object named myXML, you would specify this: $myXML.
• a function.

The type of the first argument determines whether equality is determined by a string or numeric comparison.

**Example**

\[
\begin{align*}
\text{compare('bears','lions')}&=-1 \\
\text{compare('lions','bears')}&=1 \\
\text{compare('bears','bears')}&=0 \\
\text{compare(10,20)}&=-1 \\
\text{compare(20,10)}&=1 \\
\text{compare(10,10)}&=0
\end{align*}
\]

**CONCAT**

Returns a string that is the concatenation of the string values of the supplied arguments.
Syntax

concat(argument1, argument2,...<argumentN>)

Required Argument

argument1, ...argumentN

specifies one of the following:

- a literal value, either string or numeric. Enclose string values in single or double quotation marks.
- a value to be resolved from an event field. Precede field names with the $ character.
- a value that refers to a resource. For example, when you use the xpath function to refer to an XML object named myXML, you would specify this: #myXML.
- a function.

A minimum of two arguments is required.

Example

concat('Name: ','Joe',', Age: ',floor(sum(25,10)),'.') = Name: Joe, Age: 35.

CONCATDELIM

Returns a string that is the concatenation of the supplied values separated by the specified delimiter.

Syntax

concatDelim('delimiter', argument1, argument2,...<argumentN>)

Required Arguments

'delimiter'

specifies a character used as a delimiter.

argument1, ...argumentN

specifies one of the following:

- a literal value, either string or numeric. Enclose string values in single or double quotation marks.
- a value to be resolved from an event field. Precede field names with the $ character.
- a value that refers to a resource. For example, when you use the xpath function to refer to an XML object named myXML, you would specify this: #myXML.
- a function.

Example

concatDelim('.','www','sas','com') = www.sas.com
CONTAINS
If the string value of the first argument contains the string value of the second, then it returns true. Otherwise, it returns false.

Syntax
contains(argument1, argument2)

Required Argument
argument1, argument2
specifies one of the following:
• a literal value, either string or numeric. Enclose string values in single or double quotation marks.
• a value to be resolved from an event field. Precede field names with the $ character.
• a value that refers to a resource. For example, when you use the xpath function to refer to an XML object named myXML, you would specify this: #myXML.
• a function.

Example
contains('www.sas.com','sas') = true
contains('www.google.com','sas') = false

CONTQUERYNAME
Returns the name of the continuous query that contains the current event.

Syntax
contqueryName()

Example
contqueryName()=cq_1
contqueryName()=myquery

DECREMENT
Returns the numeric value of the supplied argument minus 1. This function supports only integers.
Syntax

decrement(argument)

Required Argument

argument

specifies an integer.

Example

decrement(10)=9

DIFF

Returns the value of the first argument minus the second.

Syntax

diff(argument1, argument2)

Required Argument

argument1, argument2

specifies one of the following:

• a literal value, either string or numeric. Enclose string values in single or double quotation marks.

• a value to be resolved from an event field. Precede field names with the $ character.

• a value that refers to a resource. For example, when you use the xpath function to refer to an XML object named myXML, you would specify this: #myXML.

• a function.

Example

diff(sum(8,7),22)=-7.0

EQUALS

Returns true if the first argument is equal to the second. Otherwise, it returns false.

Syntax

equals(argument1, argument2)
Required Argument

_argument1, argument2_

specifies one of the following:

- a literal value, either string or numeric. Enclose string values in single or double quotation marks.
- a value to be resolved from an event field. Precede field names with the $ character.
- a value that refers to a resource. For example, when you use the **xpath** function to refer to an XML object named myXML, you would specify this: `#myXML`.
- a function.

The type of the comparison depends on the type of the first argument.

Example

```
equals('sas.com',string('sas','.'))=1
equals('sas.com','google.com')=0
equals(10,sum(5,5))=1
```

EVENTCOUNTER

Return the 0-based number of events generated by a functional window.

Syntax

```
eventCounter()
```

Example

```
string($id,'-',eventCounter())=eventid-0
string($id,'-',eventCounter())=eventid-1
string($id,'-',eventCounter())=eventid-2
```

EVENTNUMBER

Returns the 0–based number of events that are generated by the current incoming event. The number is incremented each time that the function is invoked.

Syntax

```
eventNumber()
```

Example

```
string($id,'-',eventNumber())=eventid-0
string($id,'-',eventNumber())=eventid-1
string($id,'-',eventNumber())=eventid-2
```
EVENTTIMESTAMP

Returns the timestamp of the current event.

Syntax

```plaintext
eventTimestamp()
```

Example

```plaintext
eventTimestamp()=1506347669000000
```

FALSE

Returns true if the Boolean value of the argument is false. Otherwise, it returns true.

Syntax

```plaintext
false(argument)
```

Required Argument

- **argument**

  specifies one of the following:
  - a literal value, either string or numeric. Enclose string values in single or double quotation marks.
  - a value to be resolved from an event field. Precede field names with the $ character.
  - a value that refers to a resource. For example, when you use the `xpath` function to refer to an XML object named myXML, you would specify this: `#myXML`.
  - a function.

Example

```plaintext
false(0)=1
false(equals(10,10))=0
```

FLOOR

Returns the integer value below the numeric value of the supplied argument.

Syntax

```plaintext
floor(argument)
```
**Required Argument**

*argument*

specifies one of the following:

- a literal value, either string or numeric. Enclose string values in single or double quotation marks.
- a value to be resolved from an event field. Precede field names with the $ character.
- a value that refers to a resource. For example, when you use the `xpath` function to refer to an XML object named myXML, you would specify this: `#myXML`.
- a function.

**Example**

```plaintext
floor(product(3.5,7))=24
```

---

**GT**

Returns true if the first argument is greater than the second. Otherwise, it returns false.

---

**Syntax**

```plaintext
gt(argument, argument2)
```

**Required Argument**

*argument, argument2*

specifies one of the following:

- a literal value, either string or numeric. Enclose string values in single or double quotation marks.
- a value to be resolved from an event field. Precede field names with the $ character.
- a value that refers to a resource. For example, when you use the `xpath` function to refer to an XML object named myXML, you would specify this: `#myXML`.
- a function.

The type of the comparison depends on the type of the first argument.

**Example**

```plaintext
gt(sum(10,4),13)=true
gt('internet explorer','internet explorer')=false
gt('internet explorer','netscape')=false
```

---

**GTE**

Returns true if the first argument is greater than or equal to the second. Otherwise, it returns false.
Syntax

gt(argument, argument2)

**Required Argument**

*argument, argument2*

specifies one of the following:

- a literal value, either string or numeric. Enclose string values in single or double quotation marks.
- a value to be resolved from an event field. Precede field names with the $ character.
- a value that refers to a resource. For example, when you use the *xpath* function to refer to an XML object named myXML, you would specify this: `#myXML`.
- a function.

The type of the comparison depends on the type of the first argument.

**Example**

gte(sum(10,4),13)=true  
gte('internet explorer','internet explorer')=true  
gte('netscape','internet explorer')=true

**GUID**

Returns a globally unique identifier.

**Syntax**

`guid()`

**Example**

`guid()=46ca7b9e-b11d-41be-a3eb-be8bc8553aed`
`guid()=319cd2a6-1b30-4c1b-8ac7-55e9465ea066`

**INCREMENT**

Returns the numeric value of the first argument + 1. This function only supports integers.

**Syntax**

`increment(argument)`

**Required Argument**

*argument*

specifies an integer value or a function that returns an integer value.
Example

increment(10)=11

IF

If the Boolean value of the first argument is true, returns the second argument. Otherwise, it returns the third argument if specified.

Syntax

```
if(argument1 , argument2, <argument3>)
```

Required Arguments

- **argument1** specifies a Boolean expression
- **argument2**, specifies one of the following:
  - a literal value, either string or numeric. Enclose string values in single or double quotation marks.
  - a value to be resolved from an event field. Precede field names with the $ character.
  - a value that refers to a resource. For example, when you use the `xpath` function to refer to an XML object named `myXML`, you would specify this: `#myXML`.
  - a function.

Optional Argument

- **argument3** specifies one of the following:
  - a literal value, either string or numeric. Enclose string values in single or double quotation marks.
  - a value to be resolved from an event field. Precede field names with the $ character.
  - a value that refers to a resource. For example, when you use the `xpath` function to refer to an XML object named `myXML`, you would specify this: `#myXML`.
  - a function.

Example

```
if(equals('x','x'),'one','two')=one
if(equals('x','y'),'one','two')=two
```

```
IFNEXT
Evaluates the first argument in a pair. When the argument evaluates to true, the function returns the value of the second argument in the pair.

Syntax
ifNext(argument, argument2, ...<argumentN>, <argumentN+1>)

Required Arguments
argument
specifies a Boolean expression.

argument2
specifies one of the following:

- a literal value, either string or numeric. Enclose string values in single or double quotation marks.
- a value to be resolved from an event field. Precede field names with the $ character.
- a value that refers to a resource. For example, when you use the xpath function to refer to an XML object named myXML, you would specify this: #myXML.
- a function.

Example
ifNext(gt(20,10), 'value 1', lt(20,10), 'value 2') = value 1
ifNext(gt(20,100), 'value 1', lt(20,100), 'value 2') = value 2

IN
Returns TRUE if expr0 matches expr1, or any expression between expr1 and exprN, inclusive. Otherwise, returns FALSE.

Syntax
in(expr0, expr1<, ...exprN>)

Required Argument
expr0, expr1
specifies the expressions to be evaluated. The minimum number of expressions is 2.

Optional Argument
exprN
specifies additional expressions to be evaluated
INDEX

Returns the value of argumentN, where N is the numeric value of specified index.

Syntax

\[ \text{index}(\text{index} , \text{argument0} , \ldots , \text{argumentN}) \]

Required Arguments

\text{index}

specifies an integer or a function that returns an integer.

\text{argument0}, \text{argument1}, \ldots, \text{argumentN}

specifies one of the following:

- a literal value, either string or numeric. Enclose string values in single or double quotation marks.
- a value to be resolved from an event field. Precede field names with the $ character.
- a value that refers to a resource. For example, when you use the \text{xpath} function to refer to an XML object named myXML, you would specify this: \#myXML.
- a function.

The minimum number of arguments is 2.

Example

\[ \text{index}(1,'larry','moe','curly')=\text{moe} \]
\[ \text{index}(\text{random}(0,4),10,20,30,40,50)=40 \]
\[ \text{index}(\text{random}(0,4),10,20,30,40,50)=20 \]

INDEXOF

Returns the 0–based index of the string value of the first argument in the string value of the second argument. Returns -1 if the value is not found.

Syntax

\[ \text{indexOf}(\text{argument1} , \text{argument2}) \]

Required Argument

\text{argument1}, \text{argument2}

specifies a string.

Example

\[ \text{indexOf}('\text{SAS Event Stream Processing}', 'Stream')=10 \]
INPUT

Returns the name of the event stream processing input window.

Syntax

input()

Example

input() = sourceWindow

INTEGER

Returns the integer value of the argument.

Syntax

integer(argument)

Required Argument

argument specifies one of the following:

- a literal value, either string or numeric. Enclose string values in single or double quotation marks.
- a value to be resolved from an event field. Precede field names with the $ character.
- a value that refers to a resource. For example, when you use the xpath function to refer to an XML object named myXML, you would specify this: #myXML.
- a function.

Example

integer('88.45') = 88
integer(111.23) = 111

INTERVAL

Takes the numeric value of the first argument and compares it to the numeric values of all remaining arguments. If the numeric value of the first argument is less than one of the arguments that follow, then the value of the argument that follows that one is returned.
Syntax
interval(argument , argument2 , argument3 , ...<argumentN>)

Required Argument
arguments
specifies one of the following:

• a literal value, either string or numeric. Enclose string values in single or double quotation marks.

• a value to be resolved from an event field. Precede field names with the $ character.

• a value that refers to a resource. For example, when you use the xpath function to refer to an XML object named myXML, you would specify this: #myXML.

• a function.

Example
interval(85,60,'F',70,'D',80,'C',90,'B','A')=B
interval(90,60,'F',70,'D',80,'C',90,'B','A')=A

ISNOTRETENTION
Returns true if this event is not generated by a retention policy. Returns false if this event is generated by a retention policy.

Syntax
isNotRetention()

Example
isNotRetention()=true

ISNULL
Returns true if the argument is not set, otherwise it returns false.

Syntax
isNull(argument )

Required Argument
argument
specifies one of the following:

• a literal value, either string or numeric. Enclose string values in single or double quotation marks.
- a value to be resolved from an event field. Precede field names with the $ character.
- a value that refers to a resource. For example, when you use the xpath function to refer to an XML object named myXML, you would specify this: #myXML
- a function.

Example

isNull($unresolved)=1
isNull('my string')=0

ISRETENTION
Returns true if the event is generated by a retention policy. Returns false if the event is not generated by a retention policy.

Syntax

isRetention()

Example

isRetention()=true

ISSET
Returns true if the argument is set, otherwise it returns false.

Syntax

isSet(argument )

Required Argument

argument  
  specifies one of the following:
  - a literal value, either string or numeric. Enclose string values in single or double quotation marks.
  - a value to be resolved from an event field. Precede field names with the $ character.
  - a value that refers to a resource. For example, when you use the xpath function to refer to an XML object named myXML, you would specify this: #myXML.
  - a function.

Example

isSet($unresolved)=0
JSON

Parses the JSON object specified in the first argument and returns a value as a function of the second argument.

Syntax

\texttt{json(\texttt{argument} \texttt{, argument2})}

\textbf{Required Arguments}

\texttt{argument} specifies a JSON object.

\texttt{argument2} specifies an evaluation string. In a name value pair, specify the name of the object whose value you want to return.

\textbf{Example}

\begin{verbatim}
\texttt{json('\{first:'john',last:'smith',hobbies:['running','reading','golf']\}', 'first')=john}
\texttt{json('\{first:'john',last:'smith',hobbies:['running','reading','golf']\}', 'last')=smith}
\texttt{json('\{first:'john',last:'smith',hobbies:['running','reading','golf']\}', 'hobbies[1]')=reading}
\texttt{json(#myJson,'hobbies[1]')=reading}
\end{verbatim}

LASTINDEXOF

Returns the last index of the string value of the second argument in the string value of the first, or -1 if the value is not found.

Syntax

\texttt{lastIndexOf(\texttt{argument} \texttt{, argument2})}

\textbf{Required Argument}

\texttt{argument, argument2} specifies one of the following:

- a literal value, either string or numeric. Enclose string values in single or double quotation marks.
- a value to be resolved from an event field. Precede field names with the $ character.
- a value that refers to a resource. For example, when you use the \texttt{xpath} function to refer to an XML object named myXML, you would specify this: \texttt{#myXML}. 
• a function.

Example

```
lastIndexOf('http://www.sas.com/products/webanalytics','/')=27
```

LISTITEM

This function has two uses. 1) Parses the first argument using the specified delimiter and then returns the value at the specified index. 2) References an existing list in the specified function context and returns its value at the specified index.

Syntax

```
listItem(argument , delimiter , index)

listItem(reference , index)
```

Required Arguments

- `argument` specifies a delimited string.
- `delimiter` specifies a character used as a delimiter.
- `index` specifies a numeric value used as an index.
- `reference` specifies a reference to a function context.

Example

```
listItem('one,two,three,four',',',2)=three
listItem(#myList,0)=one
```

LISTSIZE

This function has two uses. 1) Parses the first argument using the specified delimiter and then returns its size. 2) References an existing list in the specified function context and returns its size.

Syntax

```
listSize(argument , delimiter)

listSize(reference )
```

Required Arguments

- `argument` specifies a delimited string.
**delimiter**
specifies a character used as a delimiter.

**reference**
specifies a reference to a function context.

**Example**

```
listSize('one,two,three,four','|')=4
listSize(#myList)=4
```

---

### LONG

Returns the long value of the argument.

**Syntax**

```plaintext
long(argument)
```

**Required Argument**

*argument*

specifies one of the following:

- a literal value, either string or numeric. Enclose string values in single or double quotation marks.
- a value to be resolved from an event field. Precede field names with the $ character.
- a value that refers to a resource. For example, when you use the `xpath` function to refer to an XML object named myXML, you would specify this: `#myXML`.
- a function.

**Example**

```
long('88.45')=88
long(111.23)=111
```

---

### LT

Returns true if the first argument is less than the second. Otherwise, returns false.

**Syntax**

```plaintext
lt(argument, argument2)
```

**Required Arguments**

*argument*

specifies one of the following:
- a literal value, either string or numeric. Enclose string values in single or double quotation marks.

- a value to be resolved from an event field. Precede field names with the $ character.

- a value that refers to a resource. For example, when you use the `xpath` function to refer to an XML object named `myXML`, you would specify this: `#myXML`.

- a function.

`argument2` specifies one of the following:

- a literal value, either string or numeric. Enclose string values in single or double quotation marks.

- a value to be resolved from an event field. Precede field names with the $ character.

- a value that refers to a resource. For example, when you use the `xpath` function to refer to an XML object named `myXML`, you would specify this: `#myXML`.

- a function.

**Example**

```plaintext
lt(sum(10,4),13)=false
lt('internet explorer','internet explorer')=true
lt('internet explorer','netscape')=true
```

---

**LTE**

Returns true if the first argument is less than or equal to the second. Otherwise, returns false.

---

**Syntax**

```plaintext
lt(argument , argument2)
```

**Required Argument**

- `argument, argument2`

  Specifies one of the following:

  - a literal value, either string or numeric. Enclose string values in single or double quotation marks.

  - a value to be resolved from an event field. Precede field names with the $ character.

  - a value that refers to a resource. For example, when you use the `xpath` function to refer to an XML object named `myXML`, you would specify this: `#myXML`.

  - a function.

**Example**

```plaintext
lte(sum(10,3),13)=true
```
This function has two uses. 1) Parses name-value pairs from the first argument using the specified outer delimiter and the specified inner delimiter, and then extracts the value for the specified name. 2) References an existing value map in the referenced function context, and then extracts the value for the name.

Syntax

mapValues(argument, outerdelimiter, innerdelimiter, delimiter, name)
mapValues(#reference, name)

Required Arguments

argument
    specifies a delimited string of name-value pairs.
outerdelimiter, innerdelimiter, delimiter
    specifies characters used as delimiters.
name
    specifies the name in the name-value pair specified in argument.
#reference
    specifies a reference to a function context.

Example

mapValue('first:John;last:Doe;occupation:plumber',';',':','occupation')=plumber
mapValue(#myMap,'occupation')=plumber
outer_delimiter, inner_delimiter

specifies characters used as delimiters.

name1, …nameN

specifies the name in the name-value pair specified in argument.

#reference

specifies a reference to a function context.

Example

mapValues('first=John,last=Doe','','=','','first','last')=John:Doe
mapValues(#myMap,'first','last')=John:Doe

MAX

Returns the largest numeric value of all specified arguments.

Syntax

max(argument, argument2, …<argumentN>)

Required Argument

argument, argument2, …argumentN

specifies one of the following:

• a literal value, either string or numeric. Enclose string values in single or double quotation marks.

• a value to be resolved from an event field. Precede field names with the $ character.

• a value that refers to a resource. For example, when you use the xpath function to refer to an XML object named myXML, you would specify this: #myXML.

• a function.

The minimum number of arguments is 1.

Example

max(33, 44.2, sum(1, 3, 2, 12), -33.21)=44.2

MEAN

Returns the mean value of all specified arguments.

Syntax

mean(argument, argument2, …<argumentN>)


**Required Argument**

(argument, argument2, ...argumentN)

specifies one of the following:

- a literal value, either string or numeric. Enclose string values in single or double quotation marks.
- a value to be resolved from an event field. Precede field names with the $ character.
- a value that refers to a resource. For example, when you use the xpath function to refer to an XML object named myXML, you would specify this: #myXML.
- a function.

**Example**

\[
\text{mean}(33, 44.2, \text{sum}(1, 3, 2, 12), -33.21) = 15.4975
\]

**MIN**

Returns the smallest numeric value of all specified arguments.

**Syntax**

\[
\text{min}(\text{argument}, \text{argument2}, ...<\text{argumentN}>)
\]

**Required Argument**

(argument, argument2, ...argumentN)

specifies one of the following:

- a literal value, either string or numeric. Enclose string values in single or double quotation marks.
- a value to be resolved from an event field. Precede field names with the $ character.
- a value that refers to a resource. For example, when you use the xpath function to refer to an XML object named myXML, you would specify this: #myXML.
- a function.

The minimum number of arguments is 1.

**Example**

\[
\text{min}(33, 44.2, \text{sum}(1, 3, 2, 12), -33.21) = -33.21
\]

**MOD**

Returns the remainder of the first argument divided by the second.
Syntax
mod(argument , argument2)

Required Argument

argument , argument2
specifies one of the following:
- a literal value, either string or numeric. Enclose string values in single or double quotation marks.
- a value to be resolved from an event field. Precede field names with the $ character.
- a value that refers to a resource. For example, when you use the xpath function to refer to an XML object named myXML, you would specify this: #myXML.
- a function.

Example
mod(10,3)=1.0

NEG
Returns the negative numeric value of the specified argument.

Syntax
neg(argument )

Required Argument

argument
specifies one of the following:
- a literal value, either string or numeric. Enclose string values in single or double quotation marks.
- a value to be resolved from an event field. Precede field names with the $ character.
- a value that refers to a resource. For example, when you use the xpath function to refer to an XML object named myXML, you would specify this: #myXML.
- a function.

Example
neg(55)=-55
**NORMALIZESPACE**

Returns a string that is created by replacing any extra white space in the specified argument with a single space.

---

**Syntax**

\( \text{normalizeSpace}(\text{argument}) \)

**Required Argument**

\( \text{argument} \)

specifies a string.

**Example**

\( \text{normalizeSpace('Sentence with many spaces')} = \text{Sentence with many spaces} \)

---

**NEQUALS**

Returns true if the first argument is not equal to the second. Otherwise, returns false.

---

**Syntax**

\( \text{nequals}(\text{argument}, \text{argument2}) \)

**Required Argument**

\( \text{argument}, \text{argument2} \)

specifies one of the following:

- a literal value, either string or numeric. Enclose string values in single or double quotation marks.
- a value to be resolved from an event field. Precede field names with the $ character.
- a value that refers to a resource. For example, when you use the \text{xpath} function to refer to an XML object named myXML, you would specify this: \#myXML.
- a function.

**Example**

\( \text{nequals('sas.com',string('sas','.com'))}=0 \)
\( \text{nequals('sas.com','google.com')}=1 \)
\( \text{nequals(10,sum(5,5))}=0 \)
NOT
Returns true if the Boolean value of the argument is false. Otherwise, returns false.

Syntax
not(argument)

Required Argument
argument
  specifies one of the following:
  * a literal value, either string or numeric. Enclose string values in single or double quotation marks.
  * a value to be resolved from an event field. Precede field names with the $ character.
  * a value that refers to a resource. For example, when you use the xpath function to refer to an XML object named myXML, you would specify this: #myXML.
  * a function.

Example
not(0)=1
not(equals(10,10))=0

NUMBER
Returns the numeric value of the argument.

Syntax
number(argument)

Required Argument
argument
  specifies one of the following:
  * a literal value, either string or numeric. Enclose string values in single or double quotation marks.
  * a value to be resolved from an event field. Precede field names with the $ character.
  * a value that refers to a resource. For example, when you use the xpath function to refer to an XML object named myXML, you would specify this: #myXML.
  * a function.
Example

number('88.45') = 88.45
number(111.23) = 111.23
number(gt(2, 1)) = 1

**OPCODE**

Returns the opcode of the current event.

**Syntax**

opcode()

**Example**

opcode() = insert
opcode() = upsert
opcode() = delete

**OR**

Returns true if any of the supplied arguments are true. Otherwise, returns false.

**Syntax**

or(argument, argument2, ...<argumentN>)

**Required Argument**

*argument, argument2, ...argumentN*

specifies one of the following:

- a literal value, either string or numeric. Enclose string values in single or double quotation marks.
- a value to be resolved from an event field. Precede field names with the $ character.
- a value that refers to a resource. For example, when you use the `xpath` function to refer to an XML object named myXML, you would specify this: `#myXML`.
- a function.

The minimum number of arguments is 1.

**Example**

or(equals('a', 'b'), nequals('a', 'b')) = 1
or(equals('a', 'b'), nequals('a', 'a')) = 0
OUTPUT
Returns the name of the event stream processing output window.

Syntax
output()

Example
input()=myFunctionalWindow

OUTSTR
If the argument contains a string or one of a group of strings, returns the associated value. If there are no matches, returns a specified default value.

Syntax
outstr(argument, string1, value_associated_with_string1, ...
<stringN>, <value_associated_with_stringN>, default)

Required Arguments
argument
specifies a string.
string1...stringN
specifies a string or group of strings.
value-associated-with-string1...value-associated-with-stringN
specifies a string or group of strings.
default
specifies a string or group of strings.

Example
outstr('government spending','govern','Government','Other')=Government
outstr('spending',('govern','spend'),
    'Government or Spending','Other')=Government or Spending
outstr('bob',('govern','spend'),
    'Government or Spending',
    ('john','jack','bob'),
    'Names','Other')=Names
outstr('stream processing',('govern','spend'),
    'Government or Spending',
    ('john','jack','bob'),
    'Names','Other')=Other

PRECISION
Sets the decimal point precision of the first argument to the second argument.
Syntax
precision(argument, argument2)

**Required Argument**

*argument, argument2*
  specifies a numeric value.

**Example**

```
precision(123.44567,2)=123.45
```

---

**PRODUCT**

Returns the product of the supplied arguments.

**Syntax**

```
product(argument, argument2…<argumentN>)
```

**Required Argument**

*argument, argument2, … argumentN*
  specifies a numeric value or a function that returns a numeric value.

**Example**

```
product(3, sum(2,4), 2)=36
```

---

**PROJECTNAME**

Returns the name of the project containing the current event.

**Syntax**

```
projectName()
```

**Example**

```
projectName()=project_1
projectName()=myproject
```

---

**QUOTIENT**

Returns the quotient of the supplied arguments.
**Syntax**

\[ \text{quotient}(\text{argument}, \text{argument2}, ... \text{argumentN}) \]

**Required Argument**

\[ \text{argument}, \text{argument2}, ..., \text{argumentN} \]

specifies a numeric value or a function that returns a numeric value.

**Example**

\[ \text{quotient}(3, \text{sum}(2, 4), 2) = 0.25 \]

---

**RANDOM**

Returns a random number between the first argument and the second.

**Syntax**

\[ \text{random}(\text{argument}, \text{argument2}) \]

**Required Argument**

\[ \text{argument}, \text{argument2} \]

specifies a numeric value.

**Example**

\[ \text{random}(100, 1000) = 741 \]
\[ \text{random}(100, 1000) = 356 \]
\[ \text{random}(100, 1000) = 452 \]
\[ \text{precision}(\text{random}(0, .5), 2) = 0.17 \]

---

**RGX**

Runs the specified regular expression on a supplied string and returns the result. If a group is specified, the result is the content of the specified numeric regular expression group.

**Syntax**

\[ \text{rgx}(\text{regular_expression}, \text{string}...<\text{group}>) \]

**Required Arguments**

\[ \text{regular_expression} \]

specifies a regular expression or a reference to a regular expression in the function context.
**String**

specifies a string.

**Optional Argument**

**group**

specifies a numeric reference to the regular expression.

**Example**

```plaintext
rgx('.*/view/([0-9]*)/([0-9]*)',
    1)=23
rgx(#myExpr,
    'http://cistore-dev.unx.sas.com/products/view/23/4'
    ,2)=4
```

---

**RGXINDEX**

Runs the specified regular expression on a supplied string. When a match is found, returns the index of the match. If no match is found, returns -1.

**Syntax**

```plaintext
rgxIndex(regular_expression , string...<stringN>)
```

**Required Arguments**

**regular_expression**

specifies a regular expression or a reference to a regular expression in the function context.

**string...stringN**

specifies a string.

**Example**

```plaintext
rgxIndex('developer','larry - manager','moe - tester','curly - developer')=2
```

---

**RGXLASTTOKEN**

Uses the regular expression in the first argument as a delimiter within the regular expression of the second to find all strings separated by that expression.

**Syntax**

```plaintext
rgxLastToken(regular_expression1 , regular_expression2...<index_value>)
```
Required Arguments

regular_expression1
specifies a regular expression or a reference to a regular expression in the function context.

regular_expression2
specifies a regular expression.

Optional Argument

index_value
specifies an index value (defaults to 0) that counts from the last token in the expression. When this value is greater than 0 and less than or equal to the number of tokens in the regular expression, the token at the value is returned. Otherwise, null is returned.

Example

\[
\text{rgxLastToken('\\/', 'data/opt/sas/dataflux')} = \text{dataflux} \\
\text{rgxLastToken('\\/', 'data/opt/sas/dataflux', 2)} = \text{opt} \\
\text{rgxLastToken('\\.', 'www.sas.com')} = \text{com}
\]

RGXMATCH

Compares the regular expression in the first argument to the second argument and returns a Boolean value that indicates whether a match is found.

Syntax

\[
\text{rgxMatch(regular_expression1 , string}...<\text{group}>)
\]

Required Arguments

regular_expression1
specifies a regular expression or a reference to a regular expression in the function context.

string
specifies a string.

Optional Argument

group
specifies a numeric reference to the regular expression. When specified, the result is the content of the specified numeric regular expression group.

Example

\[
\text{rgxMatch('google|yahoo|bing', 'http://www.google.com')} = 1 \\
\text{rgxMatch('google|yahoo|bing', 'http://www.sas.com')} = 0
\]
RGXREPLACE

Parses the regular expression in the first argument against the string in the second argument and replaces
the first match with the string in the third argument.

Syntax

rgxReplace(regular_expression1, string1, string2)

Required Arguments

regular_expression1
  specifies a regular expression or a reference to a regular expression in the function
  context.

string
  specifies a string.

string2
  specifies a string.

Example

rgxReplace('(google|yahoo|bing)','http://www.google.com','sas')=http://www.sas.com

RGXREPLACEALL

Parses the regular expression in the first argument against the string in the second argument and replaces
any match with the string in the third argument.

Syntax

rgxReplaceAll(regular_expression1, string1, string2)

Required Arguments

regular_expression1
  specifies a regular expression or a reference to a regular expression in the function
  context.

string
  specifies a string.

string2
  specifies a string.

Example

rgxReplaceAll('google|yahoo|bing','http://www.google.com/google/products','sas')=http://www.sas.com/sas/products
**RGXTOken**

Uses the first argument as a delimiter within the second argument to find all strings separated by that delimiter.

**Syntax**

\[
\text{rgxToken}(\text{delimiter}, \text{string}, <\text{index}>)
\]

**Required Arguments**

- **delimiter**
  - specifies a regular expression or a reference to a regular expression in the function context.

- **string**
  - specifies a string.

- **index**
  - specifies a numeric value that serves as an index when parsing the string. If the index is less than or equal to the number of tokens in the string, the token at the index value is returned. Otherwise, null is returned. The default value is 0.

**Example**

\[
\begin{align*}
\text{rgxToken}('/','data/opt/sas/dataflux') &= \text{data} \\
\text{rgxToken}('/','data/opt/sas/dataflux',2) &= \text{sas} \\
\text{rgxToken}('\.','www.sas.com') &= \text{www}
\end{align*}
\]

**RGXV**

Parses the regular expression in the first argument against the string in the second argument and returns all matches delimited by the specified delimiter.

**Syntax**

\[
\text{rgxV}(\text{regular_expression}, \text{string}, \text{delimiter}<\text{group}>)
\]

**Required Arguments**

- **regular_expression**
  - specifies a regular expression or a reference to a regular expression in the function context.

- **string**
  - specifies a string.

- **delimiter**
  - specifies a character value that serves as a delimiter when parsing \text{string}.
**Optional Argument**

*group*

specifies a numeric reference to the regular expression. When specified, the result is the content of the specified numeric regular expression group.

**Example**

```python
gxV('(jerry|scott|vince)',
   'The ESP product has jerry, scott, and vince working on it',
   ' : ')=jerry : scott : vince
```

---

**ROUND**

Returns the rounded numeric value of the argument.

**Syntax**

`round(argument)`

**Required Argument**

*argument*

specifies one of the following:

- a literal value, either string or numeric. Enclose string values in single or double quotation marks.
- a value to be resolved from an event field. Precede field names with the `$` character.
- a value that refers to a resource. For example, when you use the `xpath` function to refer to an XML object named `myXML`, you would specify this: `#myXML`.
- a function.

**Example**

```plaintext
round(34.56)=35
round(34.46)=34
```

---

**SETCONTAINS**

This function has two uses. 1) Parses a specified set of tokens containing the specified delimiter to check whether a specified string appears within the set. 2) References an existing set of tokens in the function context to check whether a specified string appears in the set.

**Syntax**

```plaintext
setContains(set_of_tokens , delimiter , string)
setContains(#reference string)
```
**Required Arguments**

set_of_tokens
  specifies a string of tokens.

delimiter
  specifies a character value used as a delimiter.

string
  specifies a string.

reference
  specifies a reference to a function context.

**Example**

setContains('one,two,three,four','','two')=1
setContains(#mySet,'five')=0

---

**STARTSWITH**

Returns true if the first argument starts with the second. Otherwise, returns false.

**Syntax**

startsWith(argument1 , argument2)

**Required Argument**

argument1, argument2
  specifies one of the following:
  - a literal value, either string or numeric. Enclose string values in single or double quotation marks.
  - a value to be resolved from an event field. Precede field names with the $ character.
  - a value that refers to a resource. For example, when you use the xpath function to refer to an XML object named myXML, you would specify this: #myXML.
  - a function.

**Example**

startsWith('www.sas.com','www.')=1
startsWith('www.sas.com','sww.')=0

---

**STRING**

Returns a concatenated single string value from one or more arguments.
Syntax

\texttt{string(\textit{argument}<, \textit{argument2},...\textit{argumentN}>)}

\textbf{Required Argument}

\textit{argument(s)}

specifies one of the following:

- a literal value, either string or numeric. Enclose string values in single or double quotation marks.
- a value to be resolved from an event field. Precede field names with the \$ character.
- a value that refers to a resource. For example, when you use the \texttt{xpath} function to refer to an XML object named myXML, you would specify this: \#myXML.
- a function.

\textbf{Example}

\begin{itemize}
\item \texttt{string(33.9)=33.9}
\item \texttt{string($id,'-',eventNumber())=eventid-0}
\end{itemize}

\textbf{STRINGLENGTH}

Returns the length of the string value of the argument.

Syntax

\texttt{stringLength(\textit{argument })}

\textbf{Required Argument}

\textit{argument}

specifies one of the following:

- a literal value, either string or numeric. Enclose string values in single or double quotation marks.
- a value to be resolved from an event field. Precede field names with the \$ character.
- a value that refers to a resource. For example, when you use the \texttt{xpath} function to refer to an XML object named myXML, you would specify this: \#myXML.
- a function.

\textbf{Example}

\begin{itemize}
\item \texttt{stringLength('SAS ESP XML')=11}
\end{itemize}
STRIP
Returns the string created after removing leading or trailing white space from the argument.

Syntax
strip(argument )

Required Argument
argument specifies a string.

Example
strip('          SAS ESP XML     ')=SAS ESP XML

SUBSTRING
Returns the string created by taking the substring of the value of the first argument at the specified index.

Syntax
substring(argument , index, <length>)

Required Arguments
argument specifies a string.
index specifies a numeric value that defines an index with which to parse the argument.

Optional Argument
length specifies a numeric value. If specified, the substring is length size, otherwise it contains all characters to the end of the string.

Example
substring('www.sas.com',4,3)=sas
substring('www.sas.com',4)=sas.com

SUBSTRINGAFTER
Returns the string that results from taking the value of the first argument after an occurrence of the value of the second argument.
Syntax

substringAfter(argument1, argument2, <index>)

Required Argument

argument1, argument2
specifies a string.

Optional Argument

index
specifies a numeric value that defines an index with which to parse argument1. When specified, the content after that occurrence is returned.

Example

substringAfter('www.sas.com','.')=sas.com
substringAfter('www.sas.com','.',2)=com

SUBSTRINGBEFORE

Returns the string that results from taking the value of the first argument before an occurrence of the value of the second argument.

Syntax

substringBefore(argument1, argument2, <index>)

Required Argument

argument1, argument2
specifies a string.

Optional Argument

index
specifies a numeric value that defines an index with which to parse argument1. When specified, the content after that occurrence is returned.

Example

substringBefore('www.sas.com','.')=www
substringBefore('www.sas.com','.',2)=www.sas

SUM

Returns the sum of the numeric values of all arguments.
Syntax

\texttt{sum}(\texttt{argument}, \texttt{argument2}...<\texttt{argumentN}>)

\textbf{Required Argument}

\texttt{argument}, \texttt{argument2}, ... \texttt{argumentN}

specifies one of the following:

\begin{itemize}
  \item a literal value, either string or numeric. Enclose string values in single or double quotation marks.
  \item a value to be resolved from an event field. Precede field names with the $ character.
  \item a value that refers to a resource. For example, when you use the \texttt{xpath} function to refer to an XML object named \texttt{myXML}, you would specify this: \texttt{#myXML}.
  \item a function.
\end{itemize}

\textbf{Example}

\texttt{sum}(33,22,55.4,34,\texttt{min}(0,4,-9))=135.4

\textbf{SWITCH}

Parses arguments beginning with the second one. When an argument matches the first, it returns the following argument. If no match is found, it returns null.

Syntax

\texttt{switch}(\texttt{argument}, \texttt{argument2}, ...<\texttt{argumentN}>, <\texttt{argumentN+1}>)

\textbf{Required Argument}

\texttt{argument}, \texttt{argument2}...\texttt{argumentN+1}

specifies one of the following:

\begin{itemize}
  \item a literal value, either string or numeric. Enclose string values in single or double quotation marks.
  \item a value to be resolved from an event field. Precede field names with the $ character.
  \item a value that refers to a resource. For example, when you use the \texttt{xpath} function to refer to an XML object named \texttt{myXML}, you would specify this: \texttt{#myXML}.
  \item a function.
\end{itemize}

\textbf{Example}

\texttt{switch}(\texttt{‘bob’}, \texttt{‘jerry’}, \texttt{‘manager’}, \texttt{‘bob’}, \texttt{‘developer’})=developer
\texttt{switch}(\texttt{‘jerry’}, \texttt{‘jerry’}, \texttt{‘manager’}, \texttt{‘bob’}, \texttt{‘developer’})=manager
\texttt{switch}(\texttt{‘moe’}, \texttt{‘jerry’}, \texttt{‘manager’}, \texttt{‘bob’}, \texttt{‘developer’})=
SYSTEMMICRO
Returns the number of microseconds since Jan 1, 1970.

Syntax
systemMicro()

Example
systemMicro()=1420557039483912

SYSTEMMILLI
Returns the number of milliseconds since Jan 1, 1970.

Syntax
systemMilli()

Example
systemMilli()=1420557039483

TIMECURRENT
Returns the current time.

Syntax
timeCurrent()

Example
timeCurrent()=1421157236
timeString(timeCurrent())=Tue Jan 13 08:53:56 2015

TIMEDAYOFMONTH
Returns the day of the month of the current or specified time.

Syntax
timeDayOfMonth(<argument>)
**Optional Argument**

*argument*

specifies an expression that defines a specific time, or a function that returns a specific time.

**Example**

\[
\text{timeDayOfMonth()} = 13 \\
\text{timeDayOfMonth(timeParse('06/21/2015 00:00:00', 'm/d/yyyy H:M:S'))} = 21
\]

---

**TIMEDAYOFWEEK**

Returns the day of the week of the current or specified time.

**Syntax**

```
timeDayOfWeek(<argument>)
```

**Optional Argument**

*argument*

specifies an expression that defines a specific time, or a function that returns a specific time. Returns a value of 0 through 6 (Sunday through Saturday).

**Example**

\[
\text{timeDayOfWeek()} = 2 \\
\text{timeDayOfWeek(timeParse('06/21/2015 00:00:00', 'm/d/yyyy H:M:S'))} = 0
\]

---

**TIMEDAYOFYEAR**

Returns the day of the year of the current or specified time.

**Syntax**

```
timeDayOfYear(<argument>)
```

**Optional Argument**

*argument*

specifies an expression that defines a specific time, or a function that returns a specific time.

**Example**

\[
\text{timeDayOfYear()} = 12 \\
\text{timeDayOfYear(timeParse('06/21/2015 00:00:00', 'm/d/yyyy H:M:S'))} = 171
\]
TIMEGHTTOLOCAL
Converting the GMT that is specified in the argument to local time.

Syntax
\texttt{timeGmtToLocal(\textit{argument})}

\textbf{Required Argument}
\textit{argument}
specifies a time value or a function that returns a time value.

Example
\texttt{timeString(timeGmtToLocal(timeCurrent()))=}Tue Jan 13 02:10:08 2015

TIMEGMTSTRING
Outputs the GMT time represented by the first argument.

Syntax
\texttt{timeGmtString(\textit{argument}, <\textit{argument2}>)}

\textbf{Required Argument}
\textit{argument}
specifies a time value or a function that returns a time value.

\textbf{Optional Argument}
\textit{argument2}
specifies a time format.

Example
\texttt{timeString(timeCurrent(),’%Y-%m-%d %H:%M:%S %Z’)=2015-02-20 07:57:18 EST}
\texttt{timeGmtString(timeCurrent(),’%Y-%m-%d %H:%M:%S %Z’)=2015-02-20 12:57:18 GMT}

TIMEHOUR
Returns the hour of the day of the current or specified time.

Syntax
\texttt{timeHour(<\textit{argument}>)}
Optional Argument

argument

specifies an expression that defines a specific time, or a function that returns a specific time.

Example

timeHour() = 9

timeHour(timeParse('06/21/2015 13:45:15', '%m/%d/%Y %H:%M:%S')) = 14

TIMEMINUTE

Returns the minute of the hour of the current or specified time.

Syntax

timeMinute(<argument>)

Optional Argument

argument

specifies an expression that defines a specific time, or a function that returns a specific time.

Example

timeMinute() = 22

timeMinute(timeParse('06/21/2015 13:45:15', '%m/%d/%Y %H:%M:%S')) = 45

TIMEMINUTEOFDAY

Returns the minute of the day of the current or specified time.

Syntax

timeMinuteOfDay(<argument>)

Optional Argument

argument

specifies an expression that defines a specific time, or a function that returns a specific time.

Example

timeMinuteOfDay() = 563

timeMinuteOfDay(timeParse('06/21/2015 13:45:15', '%m/%d/%Y %H:%M:%S')) = 885
**TIMEPARSE**
Returns a string that represents the time specified in the first argument.

**Syntax**
timeParse(time,<format>)

**Required Argument**
time
specifies a time specification or a function that returns a time specification.

**Optional Argument**
format
specifies a time format that is supported by the UNIX strftime function.

**Example**
timeParse(timeString())=1421159135
timeParse('01/01/2015 00:00:00','%m/%d/%Y %H:%M:%S')=1420088400

**TIMESECOND**
Returns the second of the minute of the current or specified time.

**Syntax**
timeSecond(<argument>)

**Optional Argument**
argument
specifies an expression that defines a specific time, or a function that returns a specific time.

**Example**
timeSecond()=37
timeSecond(timeParse('06/21/2015 13:45:15','%m/%d/%Y %H:%M:%S'))=15

**TIMESTAMP**
Returns the current time as a string.
Syntax

timeStamp(<format>)

Optional Argument

format

specifies a time format that is supported by the UNIX strftime function.

Example

timeStamp()=Thu Feb 19 15:09:35 2015
timeStamp('%m-%d-%Y')=02-19-2015

TIMESTRING

Returns the time represented by the first argument.

Syntax

timeString(time,<format>)

Required Argument

time

specifies a time specification or a function that returns a time specification.

Optional Argument

format

specifies a time format. If you do not specify format, the system default time format is used.

Example

timeString(timeCurrent())=Thu Feb 19 15:09:35 2015
timeString(timeCurrent(),'%m-%d-%Y')=02-19-2015

TIMESECONDOFDAY

Returns the second of the day of the current or specified time.

Syntax

timeSecondofDay(<argument>)
Optional Argument

argumemt
specifies an expression that defines a specific time, or a function that returns a specific time.

Example

timeSecondOfDay()=34035
timeSecondOfDay(timeParse('06/21/2015 13:45:15','%m/%d/%Y %H:%M:%S'))=53115

TOLOWER
Converts the value of the argument to lowercase.
Syntax
toLower(string)

Required Argument
toUpper(string)

Example
toLower('Http://Www.Sas.Com/Products/Esp')=http://www.sas.com/products/esp

TOUPPER
Converts the value of the argument to uppercase.

Syntax
toUpper(string)

Required Argument
toUpper(string)

Example
toUpper('Http://Www.Sas.Com/Products/Esp')=HTTP://WWW.SAS.COM/PRODUCTS/ESP

TRANSLATE
For each character in the second argument, finds the corresponding characters in the first argument and replaces them with the corresponding characters in the third.

Syntax
translate(argument1, argument2, argument3)

Required Argument
translate(argument1, argument2, argument3)

Example
translate('replace all vowels with its capital equivalent','aeiou','ARIOU')
=rEpIAcE AIl vOwEIs wIthIts cApItAl EqUIvAlEnt
TRUE

Returns true if the Boolean value of the argument is true. Otherwise, it returns false.

Syntax

true(argument)

Required Argument

argument

specifies one of the following:

- a literal value, either string or numeric. Enclose string values in single or double quotation marks.
- a value to be resolved from an event field. Precede field names with the $ character.
- a value that refers to a resource. For example, when you use the xpath function to refer to an XML object named myXML, you would specify this: #myXML.
- a function.

Example

true('testing')=1
true('')=0
true(gt(10,5))=1

URLDECODE

Decodes the URL represented by the argument.

Syntax

urlDecode(argument)

Required Argument

argument

specifies a string.

Details

For more information to encoding and decoding URLs, see this reference.

Example

urlDecode('http%3A%2F%2Fwww%2Esas%2Ecom%2Fproducts%2Fevent%20stream%20processing')
=http://www.sas.com/products/event_stream_processing
**URLENCODE**

Encodes the URL represented by the argument.

**Syntax**

```
urlEncode(argument)
```

**Required Argument**

*argument* specifies a string.

**Details**

For more information to encoding and decoding URLs, see this reference.

**Example**

```plaintext
urlEncode('http://www.sas.com/products/event stream processing')
```

```
=http%3a%2f%2fwww%2esas%2ecom%2fproducts%2fevent%20stream%20processing
```

---

**XPATH**

Parses the XML in the first argument, evaluating the second argument in the XML context.

**Syntax**

```
xpath(argument1, argument2, <argument3>)
```

**Required Arguments**

*argument1*

specifies an instance of XML, represented by valid XML textual context or by a reference to XML elsewhere.

*argument2*

specifies an evaluation string.

**Optional Argument**

*argument3*

specifies a separator used when the function returns multiple results.

**Example**

```plaintext
xpath('<info><name>john smith</name><hobby>running</hobby><hobby>reading</hobby><hobby>golf</hobby></info>', './/name/text()')=john smith
```

```plaintext
xpath(#myXml,'.//hobby/text()',',')=running,reading,golf
```
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