Classad Tutorial

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Classads: 3 uses

Description of entities in Condor

describes machines, jobs, services

Query language to select entities in Condor

“show me all the busy machines”

“show me idle jobs needing > 32 Gb ram”

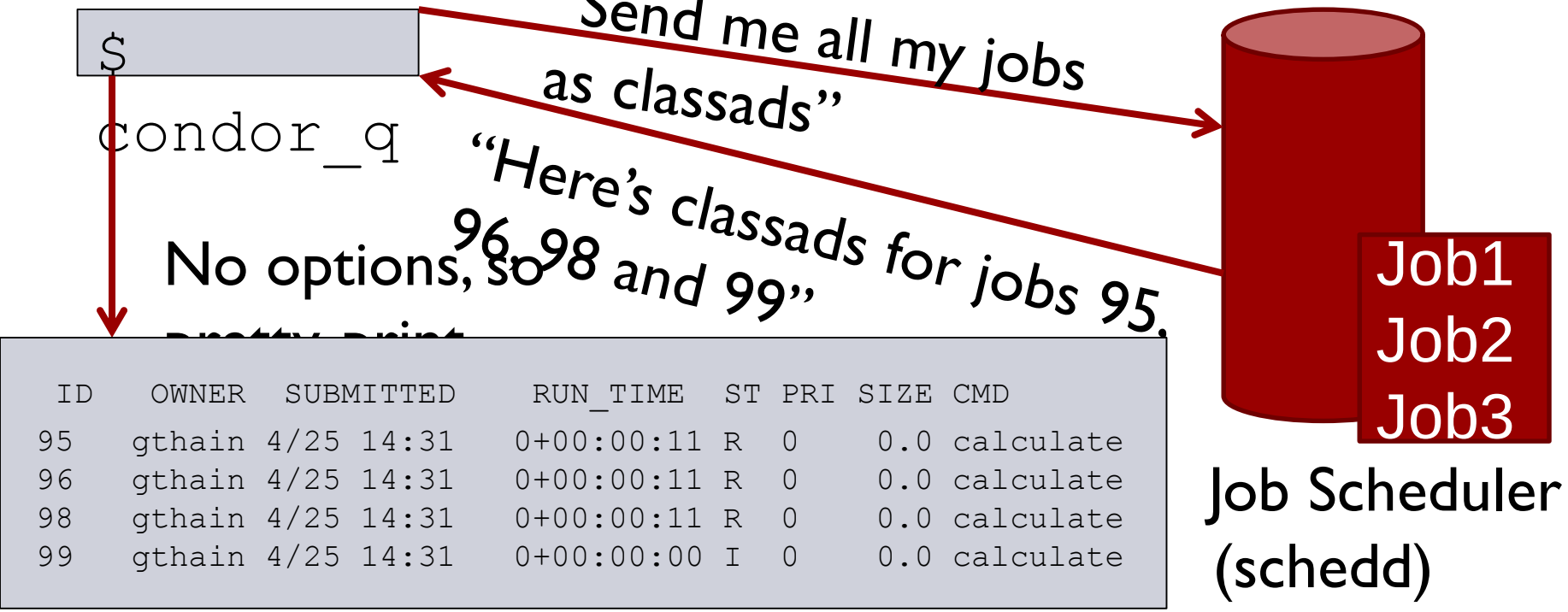
2 way matching

Given jobs & machines, find matches

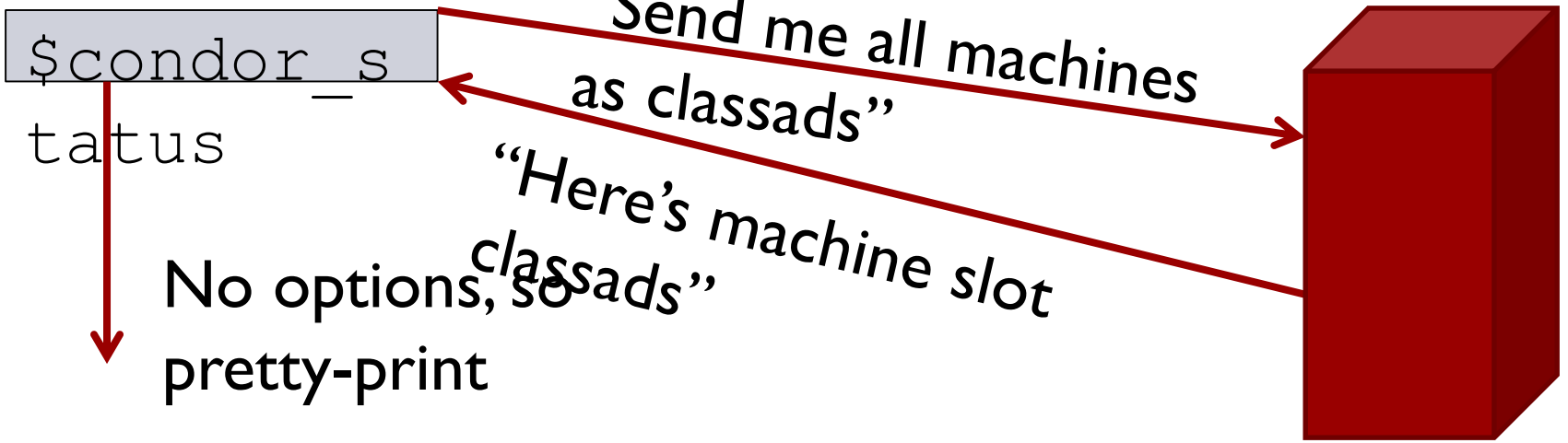
Classads *describe* all Entities

- Jobs
- Machines
- Users
- Accounting
- Etc.

Sometimes behind the scenes…



Sometimes behind the scenes…




```
Name   OpSys   Arch   State     Activit Mem   ActvtyTime

s1@c   LINUX   X86_64 Claimed   Busy    2048  0+00:30:23
s2@c   LINUX   X86_64 Claimed   Busy    2048  0+00:30:23
s3@c   LINUX   X86_64 Claimed   Busy    2048  0+00:30:23
```

Classad database (collector)

Other times, explicitly…

- “In addition to the usual stuff, add to the machine description classad the following site-specific information…”

Entity	How to display full classad
Active Jobs	`$ condor_q -l`
Terminated Jobs	`$ condor_history -l`
Machines (slots)	`$ condor_status -l`
Finished jobs on machine	`$ condor_history -l -file $(condor_config_val STARTD_HISTORY)`
Active submitters	`$ condor_status -submitter -l`
Accounting records	`$ condor_userprio -l`
Schedd service	`$ condor_status -schedd -l`
All services	`$ condor_status -any -l`

Classads as *Job* Description

Set of *Attributes*

Attribute:

Key = Value

Key is a name

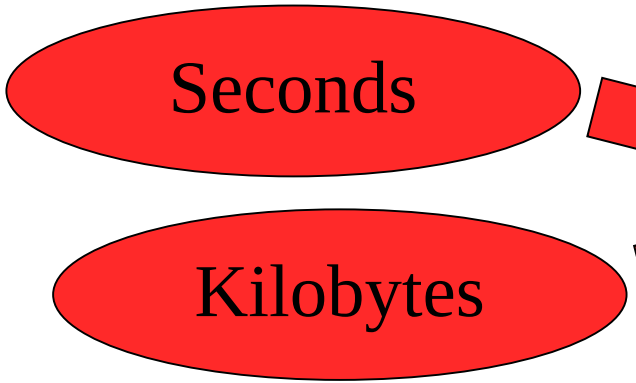
Value has a type

```
$ condor_q -l 180.0
```

```
ClusterId = 180
Cmd = "sleep"
DiskUsage = 100
ExitBySignal = false
QDate = 1535384632
RemoteUserCpu = 12.7
RequestDisk = DiskUsage
… (many attributes removed)
```

Classads as *Job* Description

Units by context




```
$ condor_q -l 180.0
```

```
ClusterId = 180
Cmd = "sleep"
DiskUsage = 100
                = false
                384632
RemoteUserCpu = 12.7
RequestDisk = DiskUsage
… (many attributes removed)
```

Manual lists all* attributes

http://htcondor.readthedocs.io

Appendix:

Lists all HTCondor-defined attributes

And Units (if any) and how used

Admins and users can add their own!*

***(Classads was No-SQL before it was cool)*

A.2 Job ClassAd Attributes

Absent: Boolean set to true `True` if the ad is absent.

AcctGroup: The accounting group name, as set in the submit description file via the **accounting_group** command. This attribute is only present if an accounting group was requested by the submission. See section 3.6.7 for more information about accounting groups.

AcctGroupUser: The user name associated with the accounting group. This attribute is only present if an accounting group was requested by the submission.

AllRemoteHosts: String containing a comma-separated list of all the remote machines running a parallel or mpi universe job.

Args: A string representing the command line arguments passed to the job, when those arguments are specified using the *old* syntax, as specified in section 12.

Arguments: A string representing the command line arguments passed to the job, when those arguments are specified using the *new* syntax, as specified in section 12.

BatchQueue: For grid universe jobs destined for PBS, LSF or SGE, the name of the queue in the remote batch system.

BlockReadKbytes: The integer number of KiB read from disk for this job.

BlockReads: The integer number of disk blocks read for this job.

BlockWriteKbytes: The integer number of KiB written to disk for this job.

BlockWrites: The integer number of blocks written to disk for this job.

BoincAuthenticatorFile: Used for grid type boinc jobs; a string taken from the definition of the submit description file command **boinc_authenticator_file**. Defines the path and file name of the file containing the authenticator string to use to authenticate to the BOINC service.

CkptArch: String describing the architecture of the machine this job executed on at the time it last produced a checkpoint. If the job has never produced a checkpoint, this attribute is `undefined`.

Attribute Names (before the =)

AttributeName = *AttributeValue*

- Are like “C” (Python, R, Matlab…) identifiers
  - Must start with letter, then letters, numbers, _
  - No limit on length, but be reasonable
  - Case insensitive, but CamelCase is traditional

Attribute Values (after the =)

AttributeName = *AttributeValue*

- Are like “C” (Python, R,Matlab…) identifiers
  - Must start with letter, then letters, numbers, _
  - No limit on length, but be reasonable
  - Case insensitive, but CamelCase is traditional

Main ClassAd types

Type	Description
Boolean	*true, false*
Integers	*64 bit signed*
Reals	*64 bit IEEE 754 Double*
Strings	*"quoted"*
Reference	Lookup another attribute

Booleans

Booleans can be

- true
- false

Case-insensitive

- (True, TRUE)

Note – NO QUOTES

```
$ condor_q -l 180.0
```

```
ClusterId = 180
Cmd = "sleep"
DiskUsage = 100
ExitBySignal = false
QDate = 1535384632
RemoteUserCpu = 12.7
RequestDisk = DiskUsage
… (many attributes removed)
```

ClassAd Integers

64 bit

- Even on 32 bit binaries

Always signed

Overflow -> wrap quietly

```
$ condor_q -l 180.0
```

```
ClusterId = 180
Cmd = "sleep"
DiskUsage = 100
ExitBySignal = false
QDate = 1535384632
RemoteUserCpu = 12.7
RequestDisk = DiskUsage
… (many attributes removed)
```

ClassAd Reals

- IEEE 64 bit
  - And all the oddities
- Scientific Notation
  - -5.6e-5
- Overflow -> Infinity
- 1e990 -> real("INF")
- NaNs -> real("Nan")

```
$ condor_q -l 180.0
```

```
ClusterId = 180
Cmd = "sleep"
DiskUsage = 100
ExitBySignal = false
QDate = 1535384632
RemoteUserCpu = 12.7
RequestDisk = DiskUsage
… (many attributes removed)
```

ClassAd Strings

Must be quoted with "

Escape with backslash:

"foo\"bar"

No Other Escapes!

Hard to get newlines in strings

```
$ condor_q -l 180.0

ClusterId = 180
Cmd = "sleep"
DiskUsage = 100
ExitBySignal = false
QDate = 1535384632
RemoteUserCpu = 12.7
RequestDisk = DiskUsage
… (many attributes removed)
```

ClassAd References

- Like variable lookup
- What is RequestDisk?
- Lookup DiskUsage

- Return 100

```
$ condor_q -l 180.0

ClusterId = 180
Cmd = "sleep"
DiskUsage = 100
ExitBySignal = false
QDate = 1553284632
RemoteUserCpu = 12.7
RequestDisk = DiskUsage
… (many attributes removed)
```

Undefined

- Very Important to Grok
- Anything can be undefined
- Like null in SQL
- Rarely explicit
  - ExitBySignal -> undefined
- MissingAttr -> undefined
- Means “Don’t Know”
- Could mean “missing”

```
$ condor_q -l 180.0

ClusterId = 180
Cmd = "sleep"
DiskUsage = 100
ExitBySignal = undefined
QDate = 1535384632
RemoteUserCpu = 12.7
RequestDisk = DiskUsage
… (many attributes removed)
```

More Undefined

- Allows decisions when information missing
- Context determines trueness or falseness:

Missing vs undefined

No difference!

```
$ condor_q -l 180.0
```

```
ClusterId = 180
Cmd = "sleep"
DiskUsage = 100

QDate = 1535384632
RemoteUserCpu = 12.7
RequestDisk = DiskUsage
… (many attributes removed)
```

More Undefined

- What does missing *ExitBySignal* mean?

Neither true nor false

Job hasn't exited (yet)?
Remote Site didn't tell us?
???

```
$ condor_q -l 180.0

ClusterId = 180
Cmd = "sleep"
DiskUsage = 100

QDate = 1535384632
RemoteUserCpu = 12.7
RequestDisk = DiskUsage
… (many attributes removed)
```

ClassAd Expressions

Expressions combine values

C/Java/Python-like:

Logical: *evaluate to boolean*

Math*: +, -, /, *, <<, >>, % evaluate to number*

Functions *(builtins) depends on function*

Logical Expressions

Expression	Meaning
>	Greater Than
<	Less Than
>=	Greater Than or equal
<=	Less Than or equal
&&	Logical And (short circuited)
||	Logical Or (short circuited)
==	Equality Test
!=	Inequality Test

Examples with Logicals

```
IsASleepJob
      -> true
```

```
$ condor_q -l 180.0
```

```
ClusterId = 180
Cmd = "sleep"
DiskUsage = 100
ExitBySignal = undefined
QDate = 1535384632
RemoteUserCpu = 12.7
IsASleepJob =Cmd == “sleep”
… (many attributes removed)
```

Examples with Logicals

```
UsesSomeDisk
      -> false
```

```
$ condor_q -l 180.0
```

```
ClusterId = 180
Cmd = "sleep"
DiskUsage = 100
ExitBySignal = undefined
QDate = 1535384632
RemoteUserCpu = 12.7
UsesSomeDisk = DiskUsage >
```

```
100
```

Math Expressions

Expression	Meaning
+	Addition
-	Subtraction (or unary minus)
/	Division
%	Modulus
*	Multiplication

Examples with Math

```
DiskInBytes
      -> 102400
```

```
$ condor_q -l 180.0
```

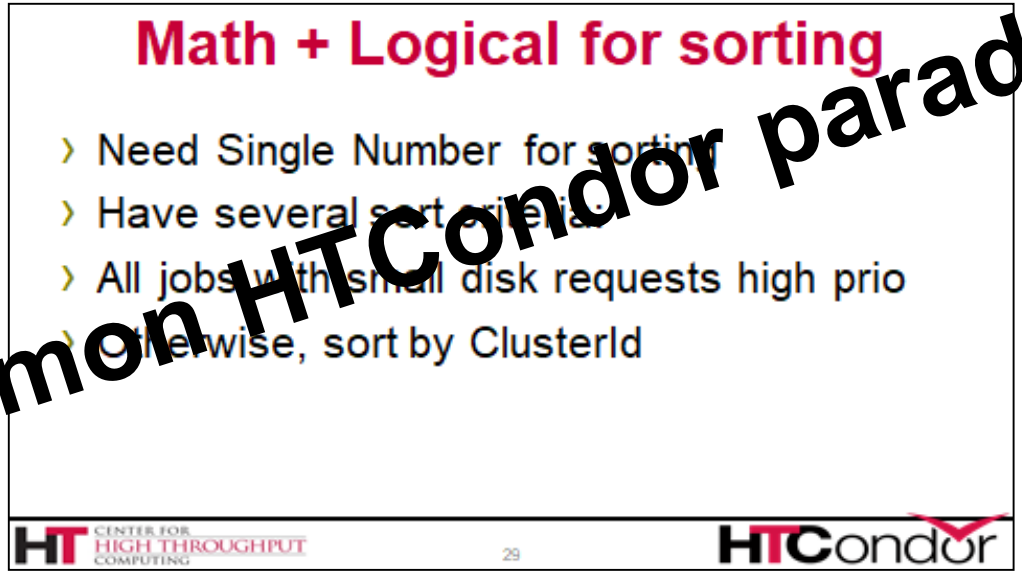
```
ClusterId = 180
Cmd = "sleep"
DiskUsage = 100
ExitBySignal = undefined
QDate = 1535384632
RemoteUserCpu = 12.7
DiskInBytes = DiskUsage *

          1024
(many attributes removed)
```

Math + Logical for sorting

- Need Single Number for sorting
- Have several sort criteria:
  - All jobs with small disk requests high prio
  - Otherwise, sort by ClusterId

Booleans expand to integers

((DiskUsage < 100) * 1000000) + ClusterId



Common HTCondor paradigm!

Classad Builtin Functions

Expression	Returns
time()	Current time in seconds from epoch
substr(str, offset, len)	Extract substring
regexp(pattern, str)	Regexp match (pcre based)
random(x)	Random number from 0 to x
IsUndefined(expr)	True if expr is undefined
StringListMember(s, l)	Is s in list l, where l like "a, b, c"
toUpper(s)	Upper-case s

Examples with Functions

```
(QDate + 3600) > time()
      -> true (maybe)

regexp("^s", Cmd)
      -> true

IsUndefined(foo)
      -> true
```

```
$ condor_q -l 180.0

ClusterId = 180
Cmd = "sleep"
DiskUsage = 100
ExitBySignal = undefined
QDate = 1535384632
RemoteUserCpu = 12.7
RequestDisk = DiskUsage
… (many attributes removed)
```

Replace Examples

New in 8.9!

```
replace("[A-Z]",
    Args, "C")
        -> "Cob Bob”

replaceall("[A-Z]",
    Args, "C")
        -> "Cob Cob”
```

```
$ condor_q -l 180.0

ClusterId = 180
Cmd = "names"
Args = "Rob Bob"
DiskUsage = 100
ExitBySignal = undefined
RemoteUserCpu = 12.7
RequestDisk = DiskUsage
… (many attributes removed)
```

Control Flow

- Expr ? tExpr : fExpr
  - If expr evals to True, use tExpr, else fExpr
- IfThenElse(expr, tExpr, fExpr)
  - ditto
- (Expr ?: UseThisIfExprWasUndefined)

Greg's Favorite Function: Debug()

- Debug(anyExpression) -> anyExpression
- Thus Debug is a no-op
- Has a side effect:
  - DaemonLog traces expression evaluation

```
Requirements = WantGluster && (1024 > Memory)
```

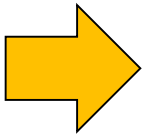
```
Requirements = debug(WantGluster && (1024 > Memory))
```

Negotiator Log shows:

```
13:32:12 Classad debug: WantGluster --> UNDEFINED
13:32:12 Classad debug: 409600 --> 409600
13:32:12 Classad debug: [0.01001ms] Memory --> 409600
13:32:12 Classad debug: [0.03791ms] WantGluster &&
(1024 > Memory) --> FALSE
```

condor_status -json

```
Name = "fastmachine"
ChildSlot =[
      Name = "slot1"
      Cpus = 4
]
Cpus = 40
ChildCpus = {1, 2, 3, 4}
slotId = 3
```



```
{
 "Name": "fastmachine",
 "ChildSlot": {
   "Name": "slot1”
   "Cpus": 4,
},
 "Cpus": 40,
 "ChildCpus": [
    1, 2, 3, 4 ],
 "slotId": 3
}
```

Testing and debugging exprs

```
$ condor_status -limit 1
```

› <just one ad>

```
$ condor_status -limit 1 -af "1+1"
   2
$ condor_status -limit 1 -af
'regexp("foo","f.*")
```

Classads: On to 2nd use

Description of entities in Condor

describes machines, jobs, services

***Query language* to select entities in Condor**

"show me all the busy machines"

"show me idle jobs needing > 32 Gb ram"

2 way matching

Given jobs & machines, find matches

Query language

- Users can write *expressions* as *queries*
- These *select* a subset of ads from a larger set
- If condor evaluates expression to *TRUE*

Query Language example

```
$ condor_status -const 'some classad expr'
```

```
$ condor_q -const 'some classad expr'
```

Classad expression in a submit file

```
Universe = vanilla
Executable = gronkulate
Requirements = has_avx && FloorNumber > 4

queue
```

Classad expression in a config file

```
EXECUTE = /var/condor/execute

START = cmd == “foo”
PREEMPT = EnteredCurrentState > 600


queue
```

Example query

```
$ condor_status -const 'Activity == "Busy"'
$ condor_status -const 'Activity != "Busy"'
```

```
MachineName = "Machine1"
Activity = "Busy"
MemoryUsage = 1024
***
MachineName = "Machine2"
Activity = "Idle"
***
MachineName = "Machine3"
Activity = "Busy"
MemoryUsage = 2048
```

Example query

```
$ condor_status -const 'Activity == "Busy"'
$ condor_status -const 'Activity != "Busy"'
```

```
MachineName = "Machine1"
Activity = "Busy"
MemoryUsage = 1024
***
MachineName = "Machine2"
Activity = "Idle"
***
MachineName = "Machine3"
Activity = "Busy"
MemoryUsage = 2048
```

Example query

```
$ condor_status -const 'Activity == "Busy"'
$ condor_status -const 'Activity != "Busy"'
```

```
MachineName = "Machine1"
Activity = "Busy"
MemoryUsage = 1024
***
MachineName = "Machine2"
Activity = "Idle"
***
MachineName = "Machine3"
Activity = "Busy"
MemoryUsage = 2048
```

Example query

```
$ condor_status -const 'MemoryUsage > 2000'
```

```
MachineName = "Machine1"
Activity = "Busy"
MemoryUsage = 1024
***
MachineName = "Machine2"
Activity = "Idle"
***
MachineName = "Machine3"
Activity = "Busy"
MemoryUsage = 2048
```

Example query

```
$ condor_status -const 'MemoryUsage > 2000'
```

```
MachineName = "Machine1"
Activity = "Busy"
MemoryUsage = 1024
***
MachineName = "Machine2"
Activity = "Idle"
***
MachineName = "Machine3"
Activity = "Busy"
MemoryUsage = 2048
```

Strict Equality Operators

- What does the expression

  "Some String" == undefined

  Or

  "Some String" == MissingAttribute

  Evaluate to?

- "foo" == undefined -> undefined
- "foo" != undefined -> undefined

- Sometimes you want
- "foo" != undefined to mean false.

Strict Equality Operators

- =?= and =!= are *Strict Equality* comparisons
- “exactly equal” or “exactly not equal”
- And NEVER return undefined:
- "Some String" =?= undefined -> false
- "Some String" =!= undefined -> true

Example Strict Equality

```
$ condor_status -const 'Activity != "Busy"'
$ condor_status -const 'Activity =!= "Busy"'
```

```
MachineName = "Machine1"
Activity = "Busy"
MemoryUsage 1024
***
MachineName = "Machine2"
***
MachineName = "Machine3"
Activity = "Busy"
MemoryUsage = 2048
```

Example Strict Equality

```
$ condor_status -const 'Activity != "Busy"'
$ condor_status -const 'Activity =!= "Busy"'
```

```
MachineName = "Machine1"
Activity = "Busy"
MemoryUsage 1024
***
MachineName = "Machine2"
***
MachineName = "Machine3"
Activity = "Busy"
MemoryUsage = 2048
```

Example Strict Equality

```
$ condor_status -const 'Activity != "Busy"'
$ condor_status -const 'Activity =!= "Busy"'
```

```
MachineName = "Machine1"
Activity = "Busy"
MemoryUsage 1024
***
MachineName = "Machine2"
***
MachineName = "Machine3"
Activity = "Busy"
MemoryUsage = 2048
```

More On Strict Equality

- Undefined is just another value
  - Undefined == undefined -> undefined
  - Undefined =?= undefined -> true

More On Strict Equality

- String == is case **IN**sensitive
- String =?=, =!= is case sensitive (!)
- No conversion between types
  - 42 == 42.0 -> true
  - 42 =?= 42.0 -> false

Classads: 3rd use

Description of entities in Condor

describes machines, jobs, services

Query language to select entities in Condor

“show me all the busy machines”

“show me idle jobs needing > 32 Gb ram”

2 way matching

Given jobs & machines, find matches

Matchmaking

Requires *TWO ads*, returns *true* or *false*

“In the context of ad1 and ad2”

With a selection expression in the

Requirements value of both ads

Commonly used to match jobs and machines

For 2 ads to match, both Requirements -> true

- Evaluate Requirements of one, if true
- Evaluate Requirements of other.
- Note My and Target are relative

Job Ad

```
Type  = "Job"
Requirements =
    HasMatlabLicense
      =?= True
Cmd= "/bin/sleep"
Args = "3600"
Owner = "gthain"
NumJobStarts = 8
```

Slot Ad

```
Type = "Machine"
Cpus  = 40
Memory = 2048
Requirements =
  (Owner == "gthain")   &&
  (TARGET.NumJobStarts <=
   MY.MaxTries)
HasMatlabLicense = true
MaxTries = 4
```

References when matching

Reference: lookup

e.g. SomeName -> "Foo"

```
IsGood = true
IsNotGood = false
RunTime = 123
Name = "Foo"
SomeName = Name
Price = 23.45
Foo = undefined
U = Missing
```

References when matching

Reference: lookup

e.g. SomeName -> "Foo"

```
IsGood = true
IsNotGood = false
RunTime = 123
Name = "Foo"
SomeName = Name
Price = 23.45
Foo = undefined
U = Missing
```

References when matching

```
IsGood = true
RunTime = 123
Name = "Foo"
SomeName = Name
Price = 23.45
Foo = undefined
U = Missing
```

```
IsGood = true
RunTime = 123
Name = "Bar"
Price = 23.45
Foo = undefined
U = Missing
```

What does SomeName return now?

References when matching

```
IsGood = true
RunTime = 123
Name = "Foo"
SomeName = Name
Price = 23.45
Foo = undefined
U = Missing
```

```
IsGood = true
RunTime = 123
Name = "Bar"
Price = 23.45
Foo = undefined
U = Missing
```

What does SomeName return now?

References when matching

- Ads are checked in order
- Lookup first in the local ad
- Then the other ad

References with My and Target

- Prefix reference with “My.” or “Target.”
- To force lookup in one side or the other
- Rarely used, but good idea

References when matching

```
IsGood = true
RunTime = 123
Name = "Foo"
SomeName = TARGET.Name
Price = 23.45
Foo = undefined
U = Missing
```

```
IsGood = true
RunTime = 123
Name = "Bar"
Price = 23.45
Foo = undefined
U = Missing
```

What does OldName return now?

References when matching

```
IsGood = true
RunTime = 123
Name = "Foo"
SomeName = TARGET.Name
Price = 23.45
Foo = undefined
U = Missing
```

```
IsGood = true
RunTime = 123
Name = "Bar"
Price = 23.45
Foo = undefined
U = Missing
```

What does OldName return now?

References when matching

```
IsGood = true
RunTime = 123
SomeName = Name
Price = 23.45
Foo = undefined
U = Missing
```

```
IsGood = true
RunTime = 123
Name = "Bar"
SomeName = Name
Price = 23.45
Foo = undefined
U = Missing
```

What does SomeName return now?

References when matching

```
IsGood = true
RunTime = 123
SomeName = Name
Price = 23.45
Foo = undefined
U = Missing
```

```
IsGood = true
RunTime = 123
Name = "Bar"
SomeName = Name
Price = 23.45
Foo = undefined
U = Missing
```

What does SomeName return now?

Questions?

Thank You!