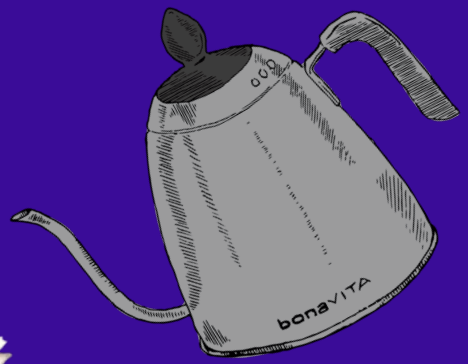
Diving Deep into LDAP

```
(
  |(Obfuscation, Deobfuscation &=De*te)(!c=tion)
)
```

Sabajete Elezaj (Sabi) & Daniel Bohannon (DBO)

PERMISO



aka
"DBO"

DANIEL BOHANNON

PRINCIPAL THREAT RESEARCHER

USA

MANDIANT (5 yrs)

Microsoft (2 yrs)

PERMISO (2 yrs)

@danielhbohannon

danielhbohannon

danielbohannon/Invoke-Obfuscation
/Invoke-CradleCrafter
/Invoke-DOSfuscation
/Revoke-Obfuscation
Permiso-io-tools/CloudConsoleCartographer

Solaris

aka
"SABI"

SABAJETE ELEZAJ

SENIOR CYBER SECURITY ENGINEER

Albania

Government (1 yr)

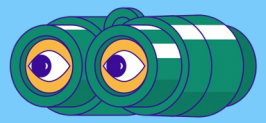
Consulting (3 yrs)

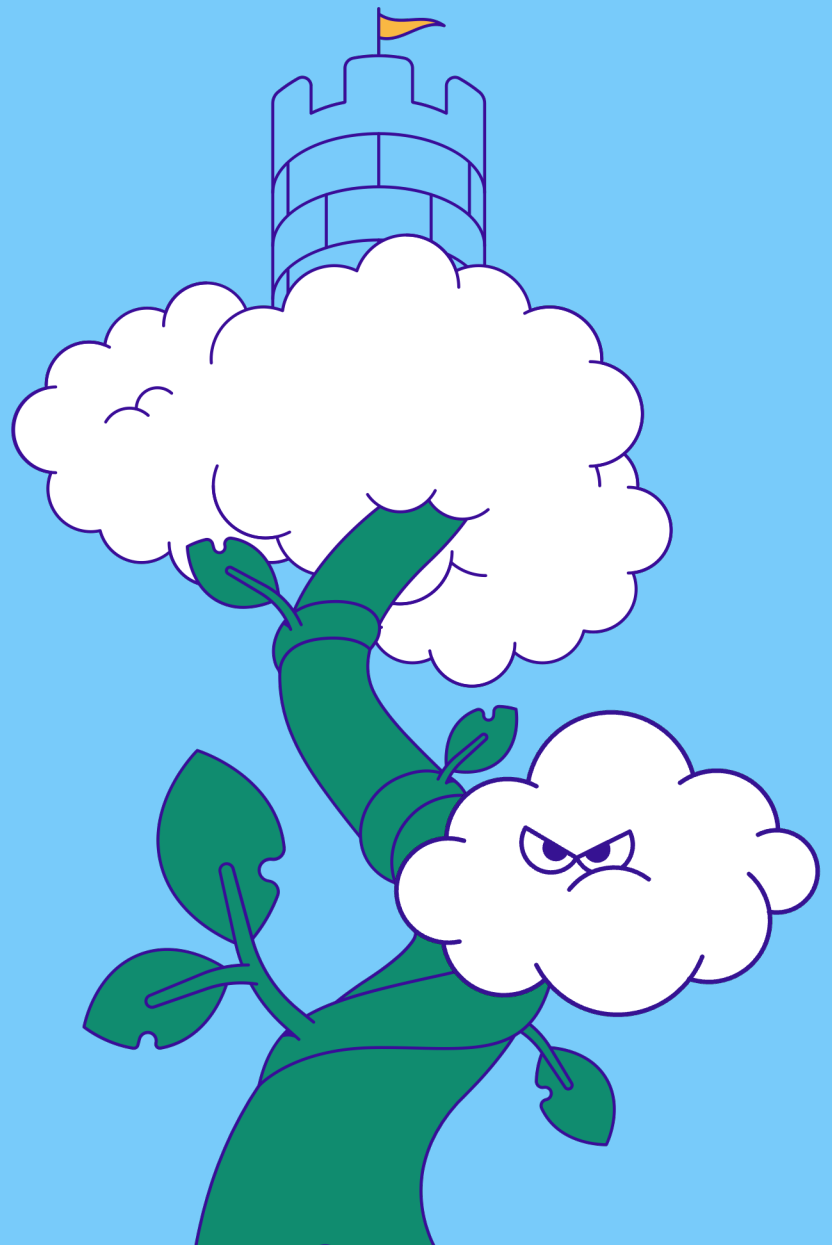
Engineering (3 yrs)

@sabi_elezi

sabajete-elezaj

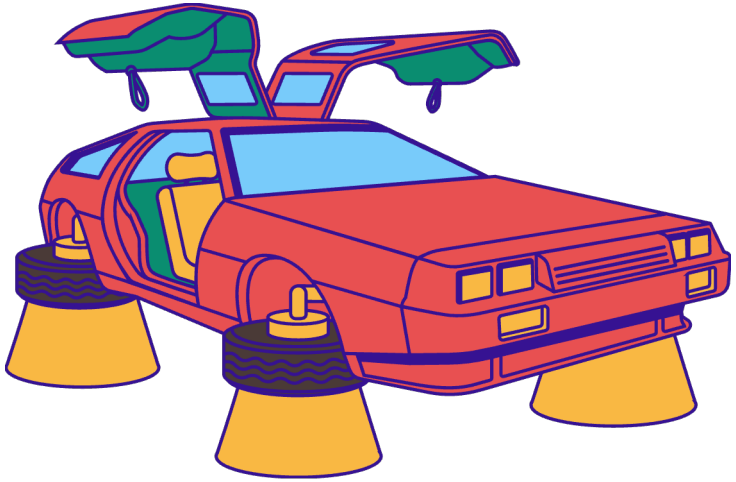
AGENDA

- Introduction 
- LDAP Overview
- PROBLEM: Obfuscating LDAP
- SOLUTION: Parse, Enrich, Detect
- MaLDAPtive Tool Demo + Release



Back to the History

- 1980s
  - X.500 directory services
  - X.500 Directory Access Protocol (DAP)
- 1993–1997
  - “Lightweight” Directory Access Protocol (LDAP) v1–3
  - Used the simpler TCP/IP protocol stack
- 1998
  - OpenLDAP developed by OpenLDAP Project
- 2000
  - Microsoft released Active Directory (AD)
  - **Ensured compliance of AD with LDAP!**



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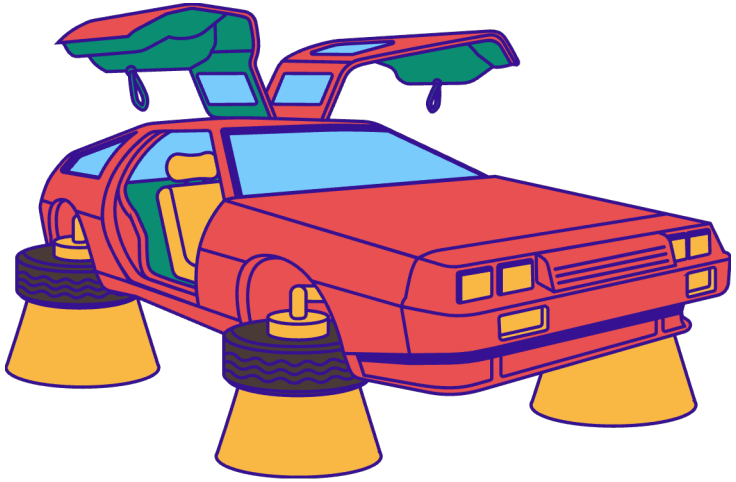
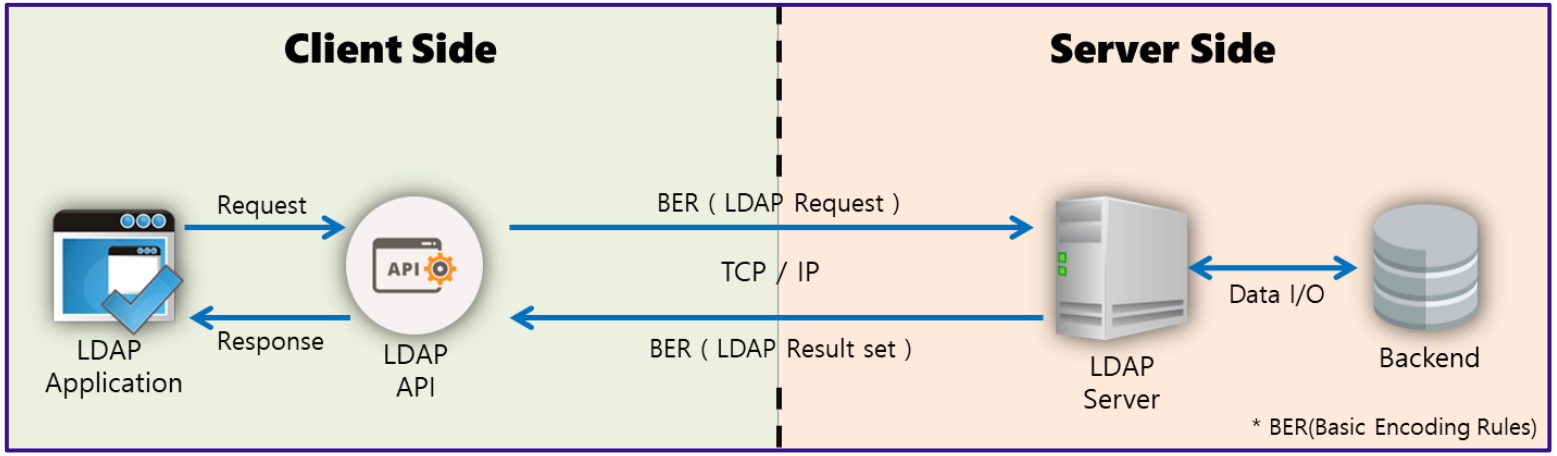




https://ldap.or.kr/wp-content/uploads/2017/07/%EA%B7%B8%EB%A6%BC3.png

Back to the Future

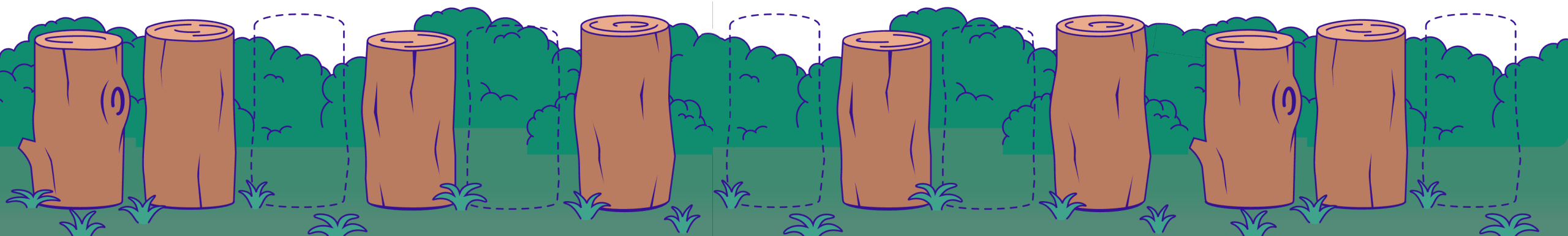
- Open-source tools for LDAP visibility (defensive & offensive usages)
  - 2015 – PowerView (@harmj0y)
  - 2016 – Bloodhound (SpecterOps)
  - 2017 – PingCastle (Vincent Le Toux)

BLOODHOUND

PING CASTLE

Back to the Logs?

- How to get LDAP logs **in a lab**?
  - SilkETW (Ruben Boonen, 2019)
  - LDAPMon (Johnny Johnson, 2023)
- How to get LDAP logs **in production**?
  - Defender for Endpoint (EDR agent)
  - Defender for Identity (sensor on DC)



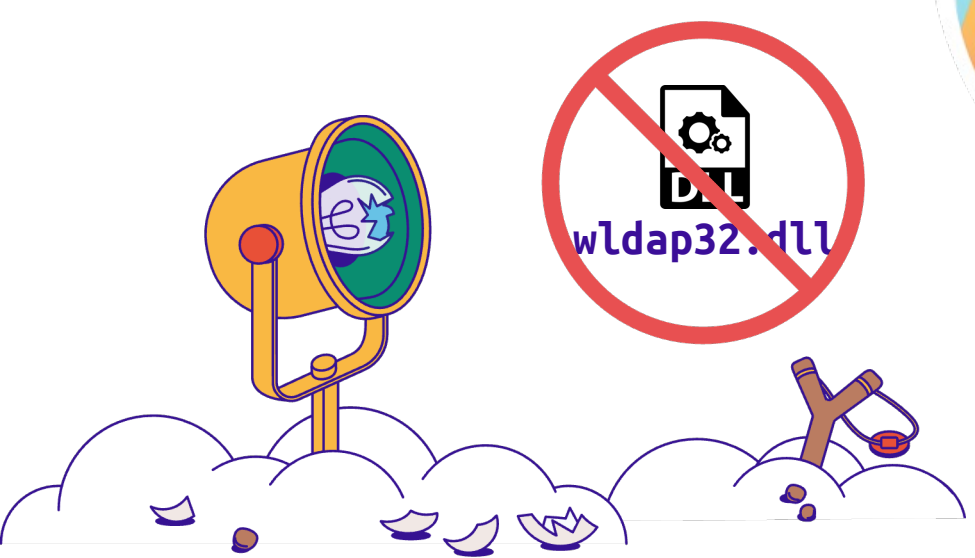
Client-side vs Server-side LDAP Logs

- Client-side logs
  - WYSIWYG
  - #YOLO
  - Obfuscation ripe

- Server-side logs
  - Significant normalization (but not 100%)
  - Undocumented expansions and substitutions of values

Client-side vs Server-side LDAP Logs

- Client-side logs
  - WYSIWYG
  - #YOLO
  - Obfuscation ripe
  - 100% log evasion opportunities

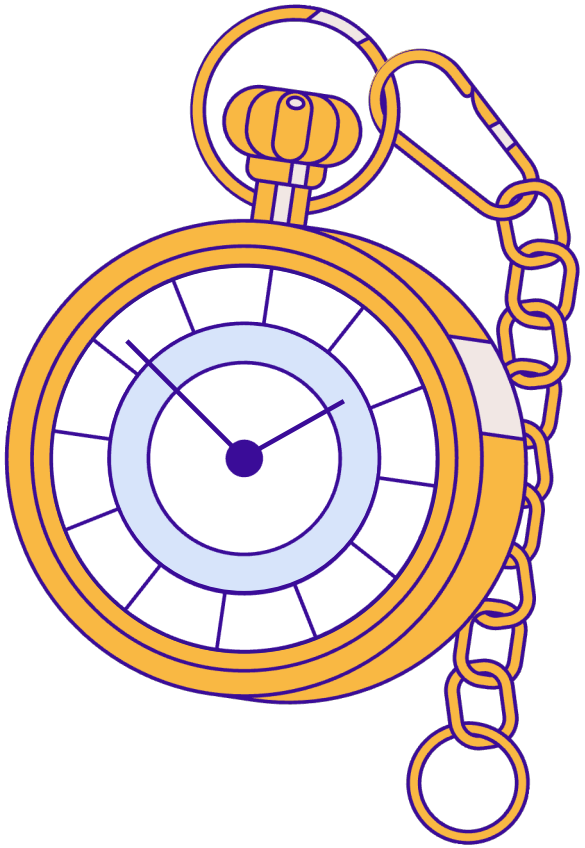


ADWS
(Active Directory Web Services)

- Server-side logs
  - Significant normalization (but not 100%)
  - Undocumented expansions and substitutions of values

What's Happening Over the Next 40 Minutes

1. Speed run of LDAP SearchRequest parsing, obfuscation, deobfuscation & detection
2. Completion of our **2,000-hour** R&D journey
3. Demo & release our brand new open-source framework: **MaLDAPtive**



Merriam-Webster

maladaptive adjective

mal·adap·tive ˌma-lə-ˈdap-tiv

1 : marked by poor or inadequate adaptation

2 : not conducive to adaptation

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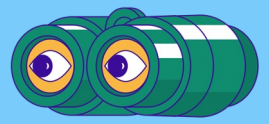
- LDAP Overview 
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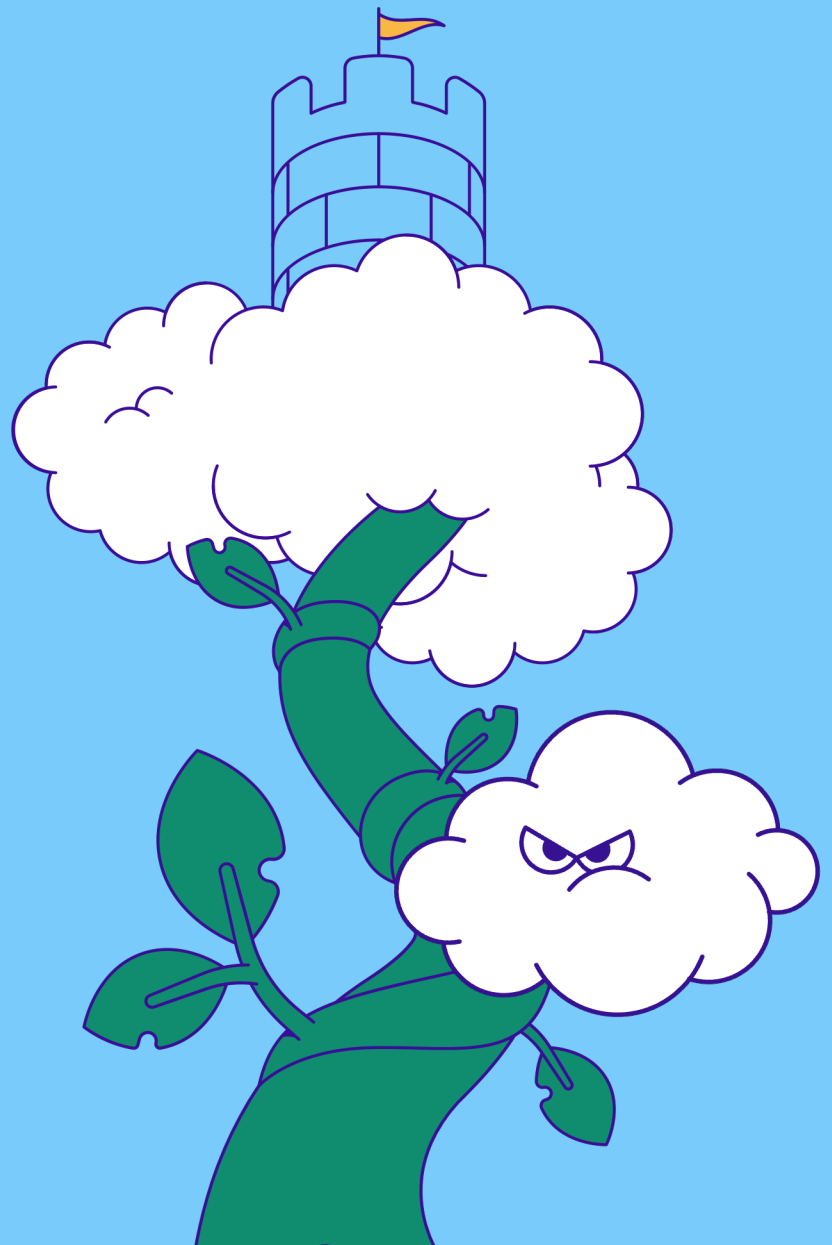
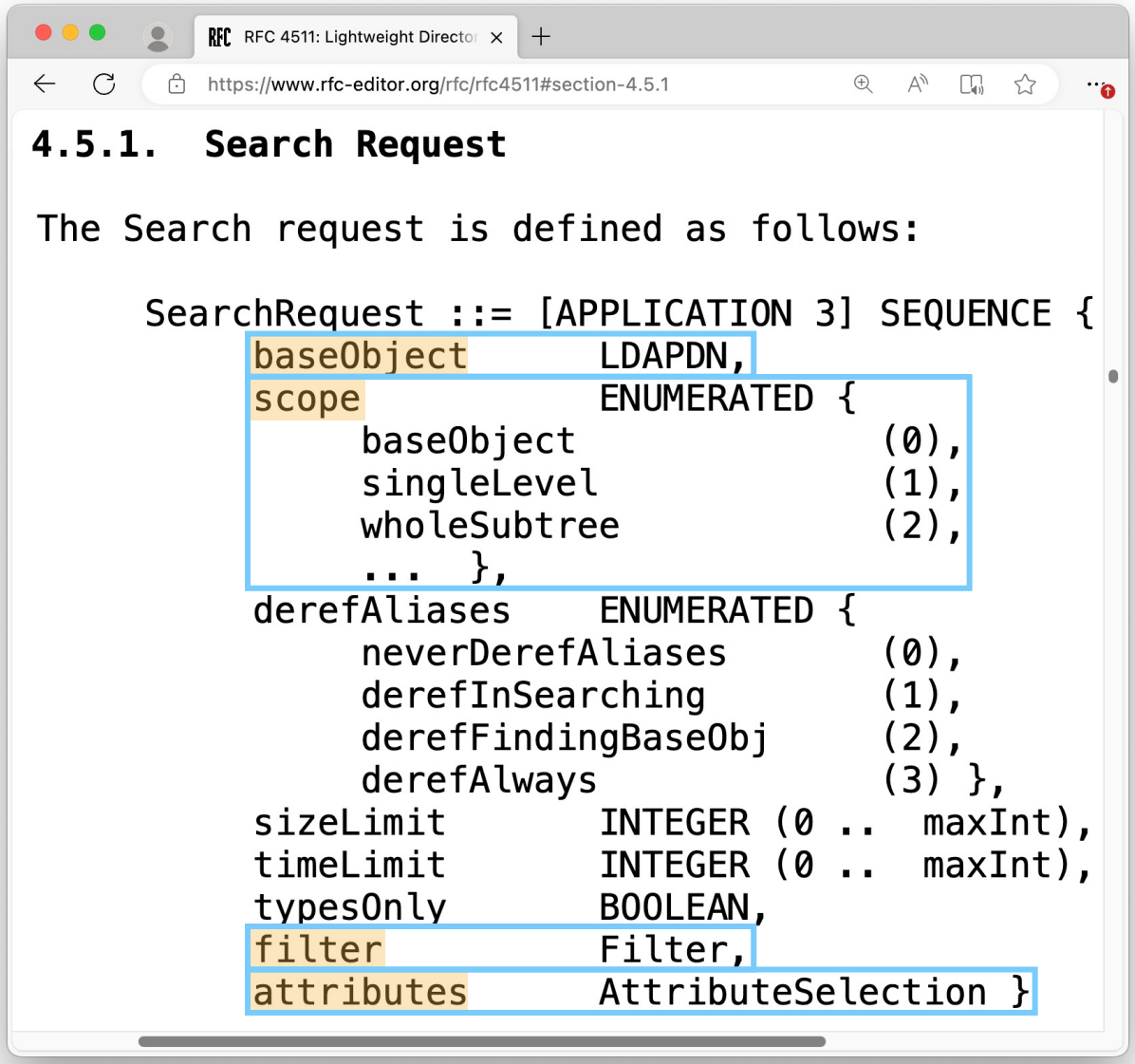


Anatomy of an LDAP SearchRequest (RFC 4511)

- RFC 4511 Section 4.5.1
  - BaseObject
    - LDAP://DC=contoso,DC=com
  - Scope
    - Subtree
  - Filter
    - (name=Sabi)
  - AttributeSelection
    - name,lastlogon,memberof



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  - Scope
    - `Subtree`
  - Filter
    - `(name=Sabi)`
  - AttributeSelection
    - `name,lastlogon,memberof`

Secondary obfuscation focus

Primary detection focus

Primary obfuscation focus

Tertiary obfuscation focus

Anatomy of an LDAP SearchFilter (RFC 1558)

- Required tokens
  - GroupStart, Attribute, ComparisonOperator, Value, GroupEnd

Anatomy of an LDAP SearchFilter (RFC 1558)

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- Optional tokens
  - BooleanOperator, ExtensibleMatchFilter

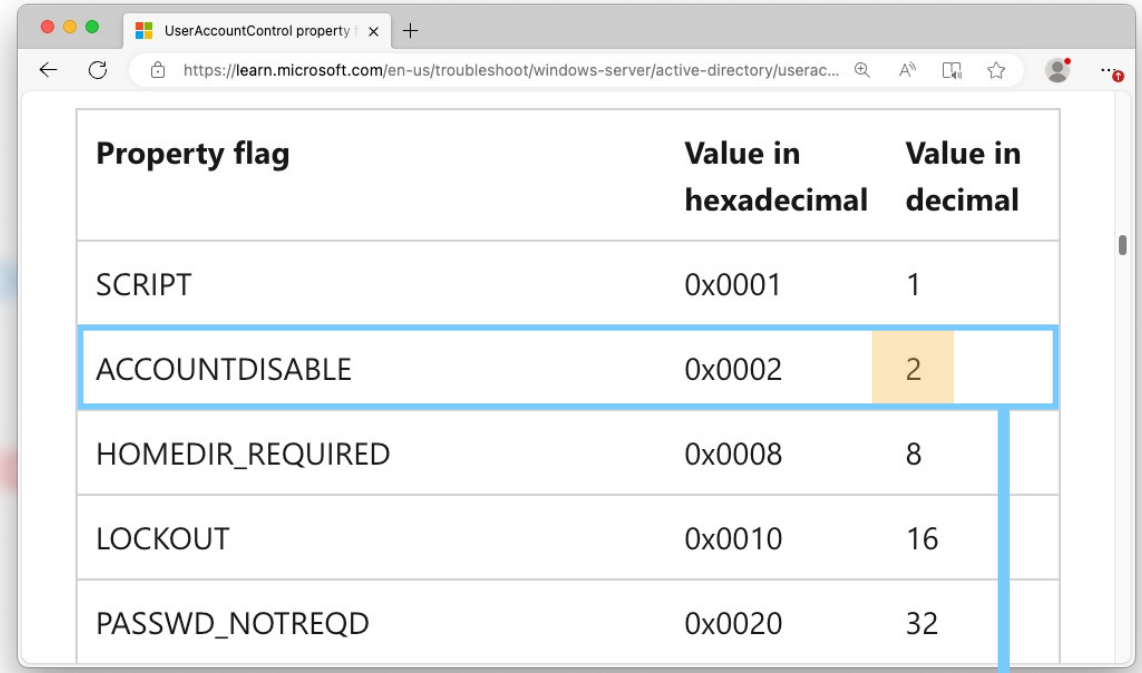
```
(name=Sabi)

(!(userAccountControl:1.2.840.113556.1.4.803:=2))
```

BooleanOperator

ExtensibleMatchFilter

Anatomy of an LDAP SearchFilter (RFC 1558)

- Required tokens
  - GroupStart, Attribute, Comparison
- Optional tokens
  - BooleanOperator, ExtensibleMatch




```
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(!(userAccountControl:1.2.840.113556.1.4.803:=2))
```

BooleanOperator

ExtensibleMatchFilter

"Object is NOT disabled."

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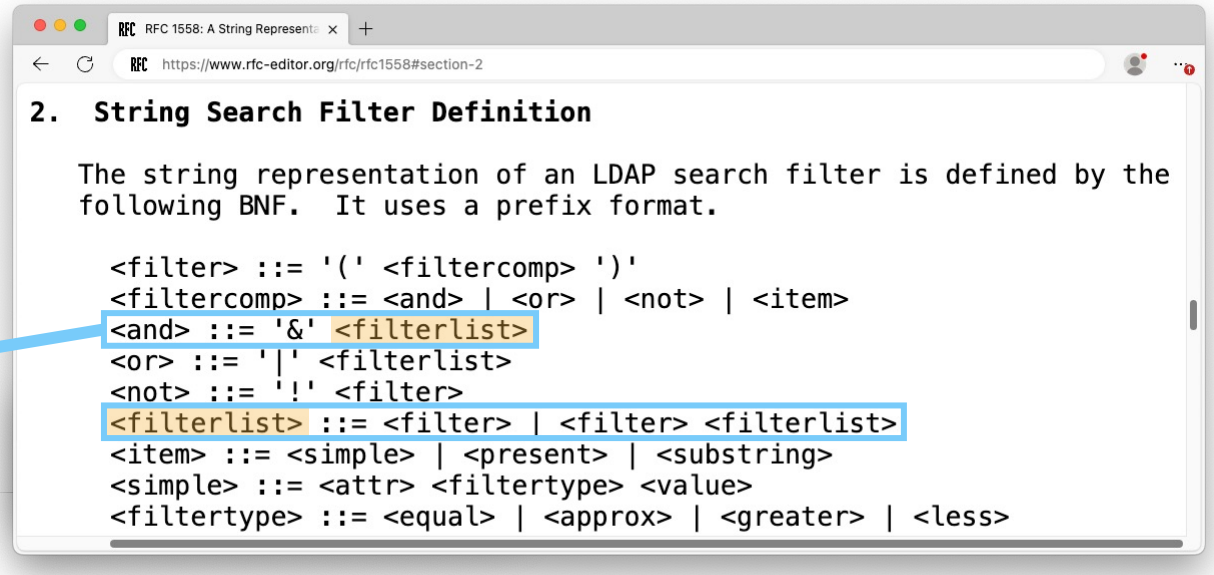


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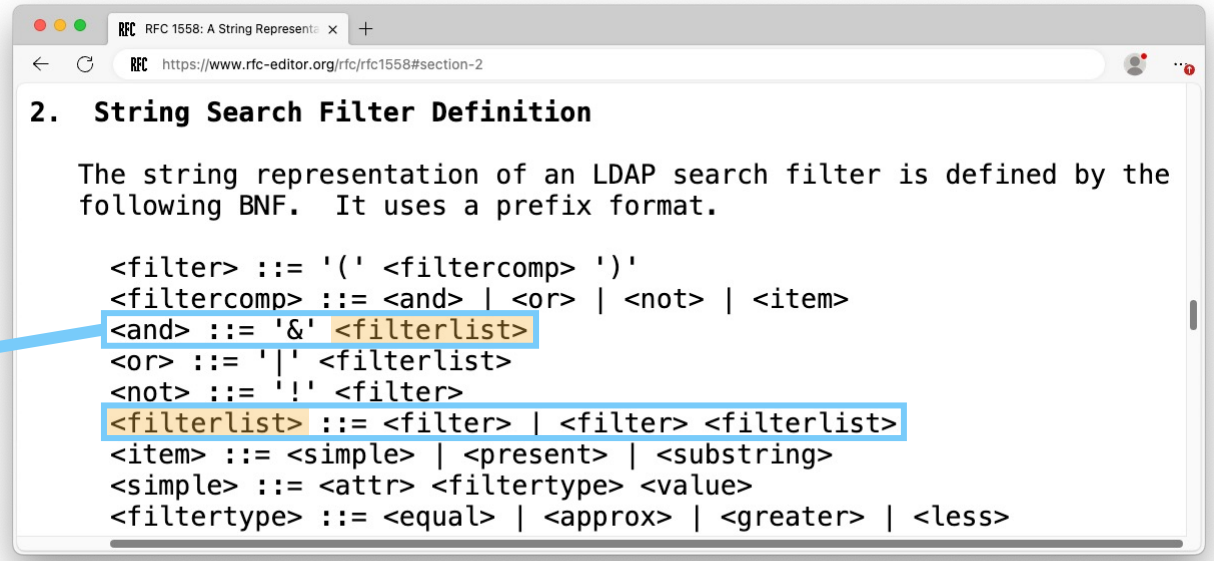
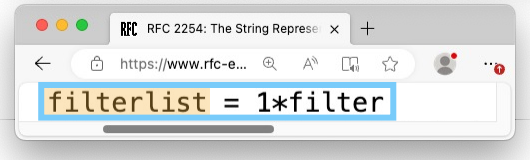
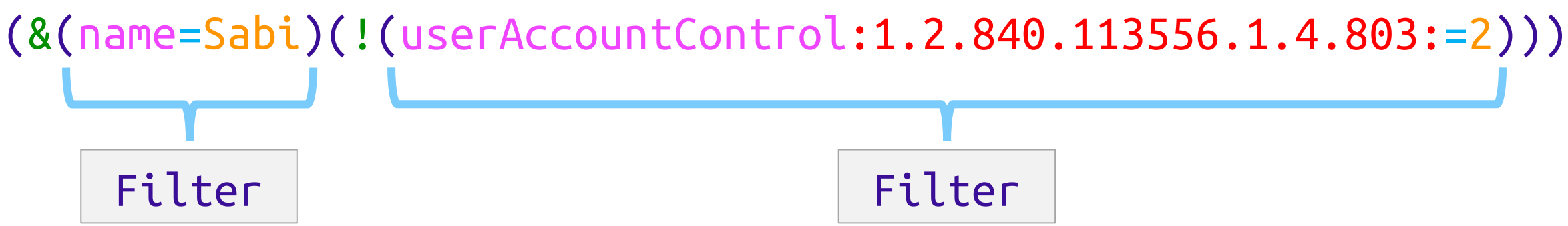




Anatomy of an LDAP SearchFilter (RFC 1558)

```
(&(name=Sabi)(!(userAccountControl:1.2.840.113556.1.4.803:=2)))
```

Anatomy of an LDAP SearchFilter (RFC 1558)



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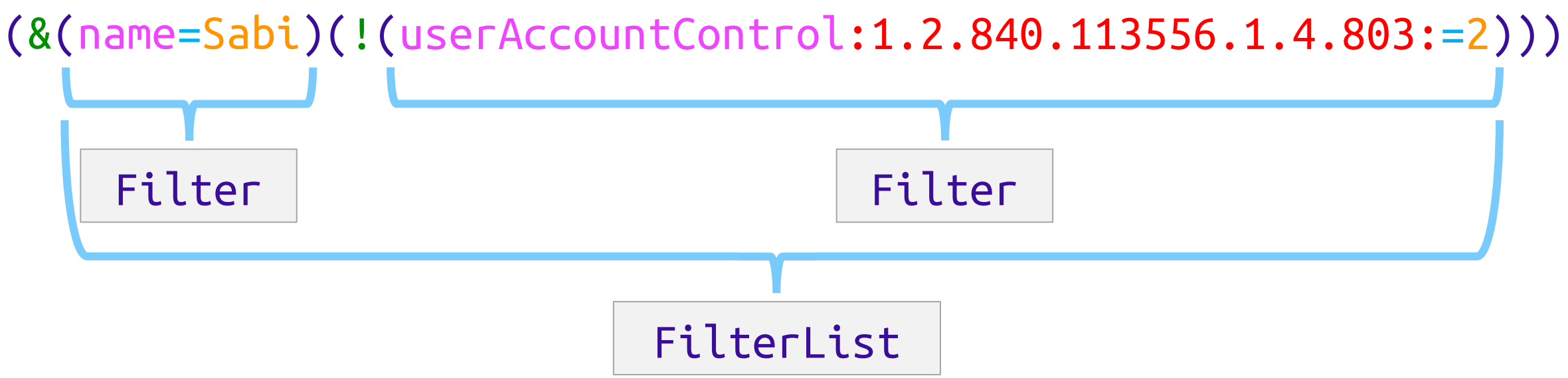

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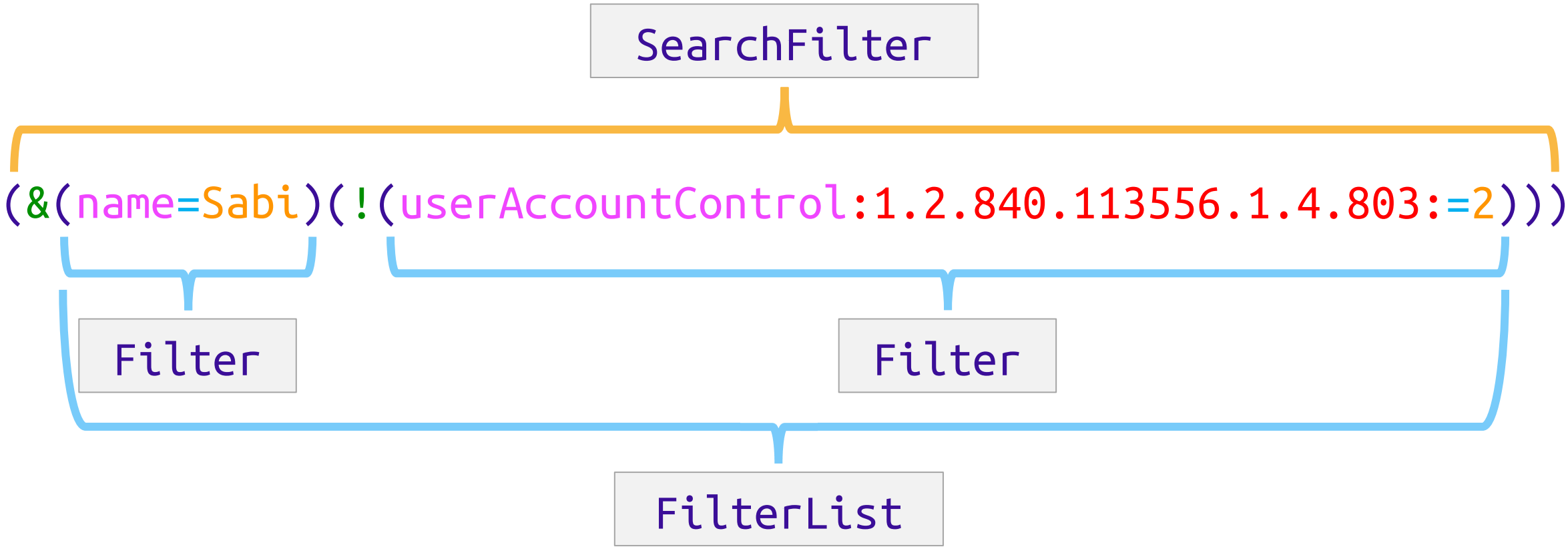

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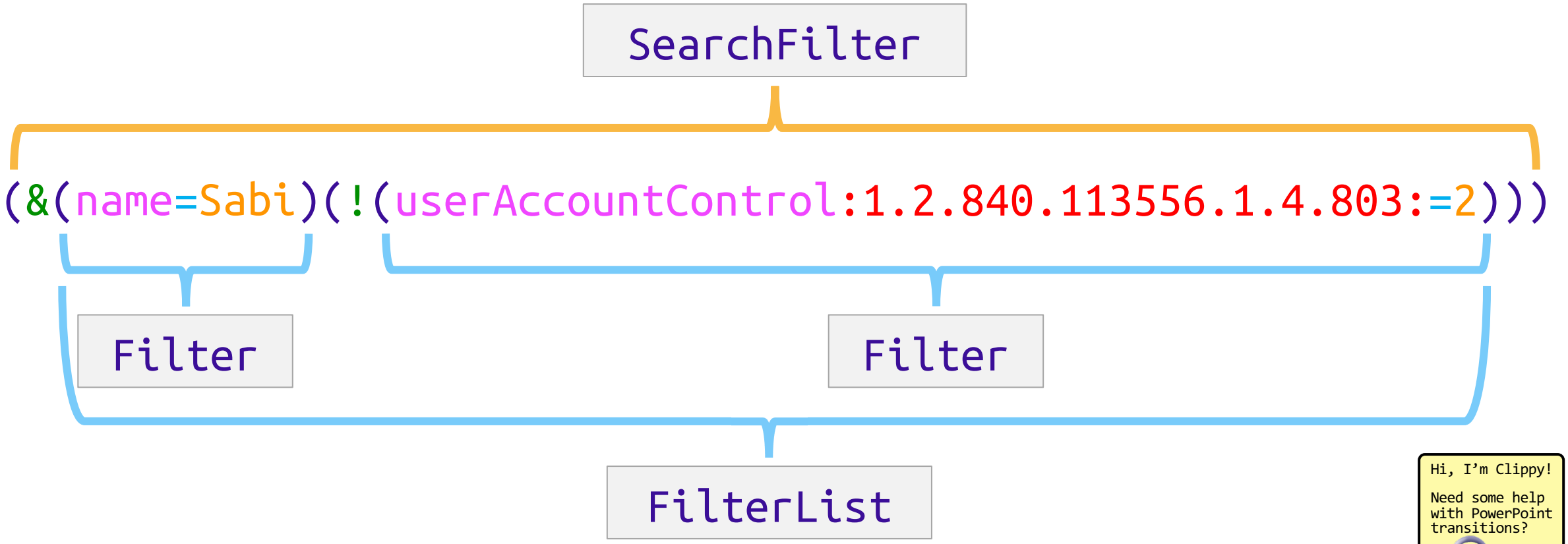

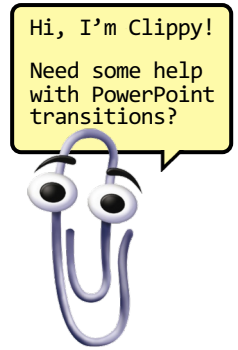

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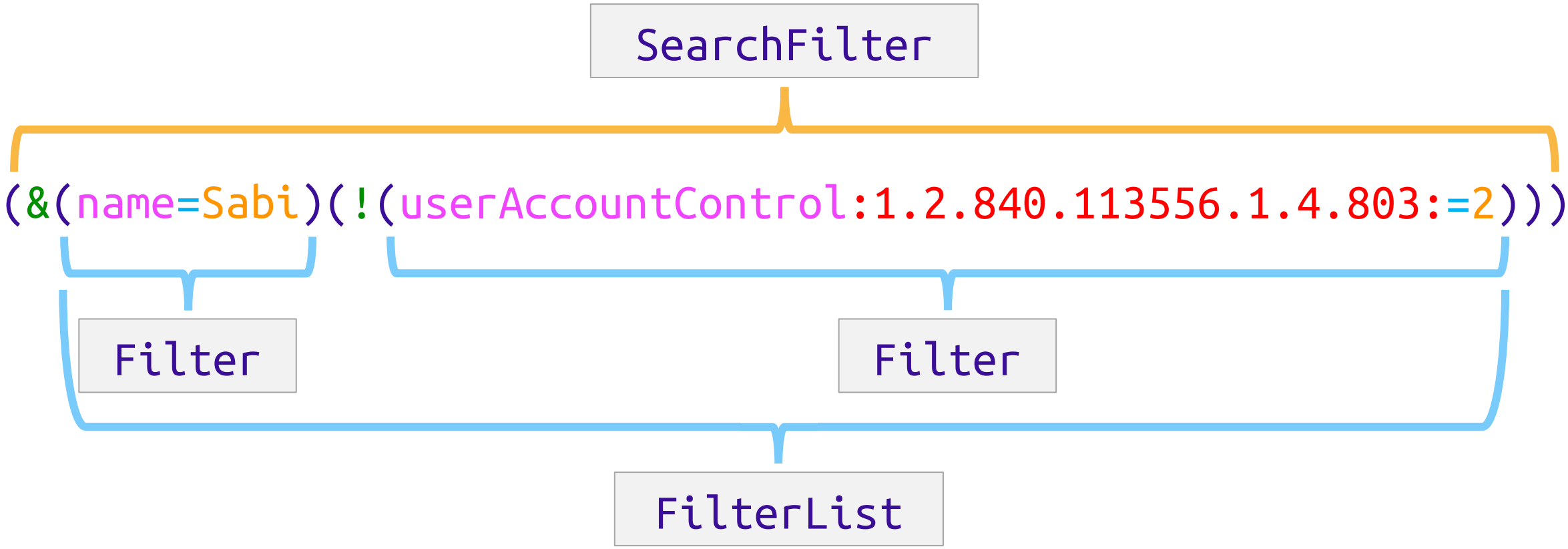

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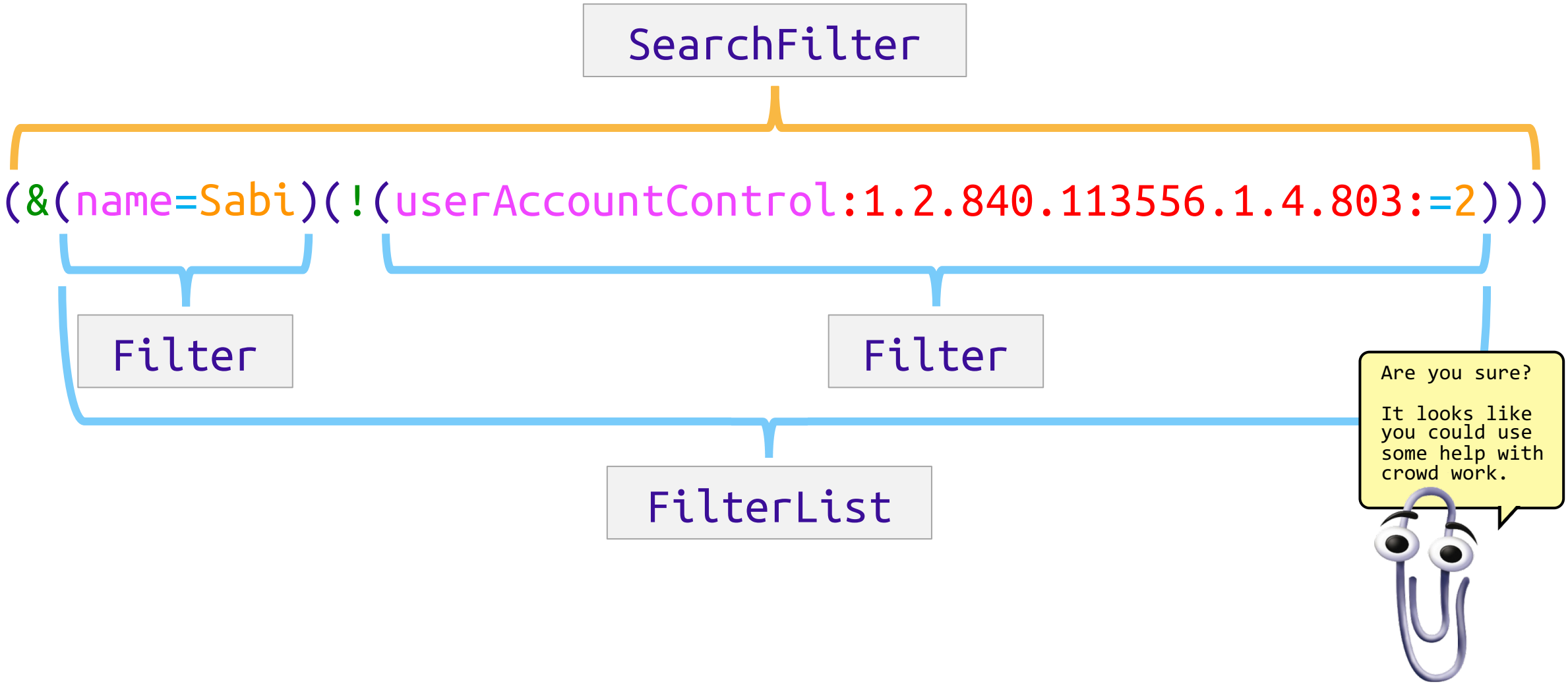

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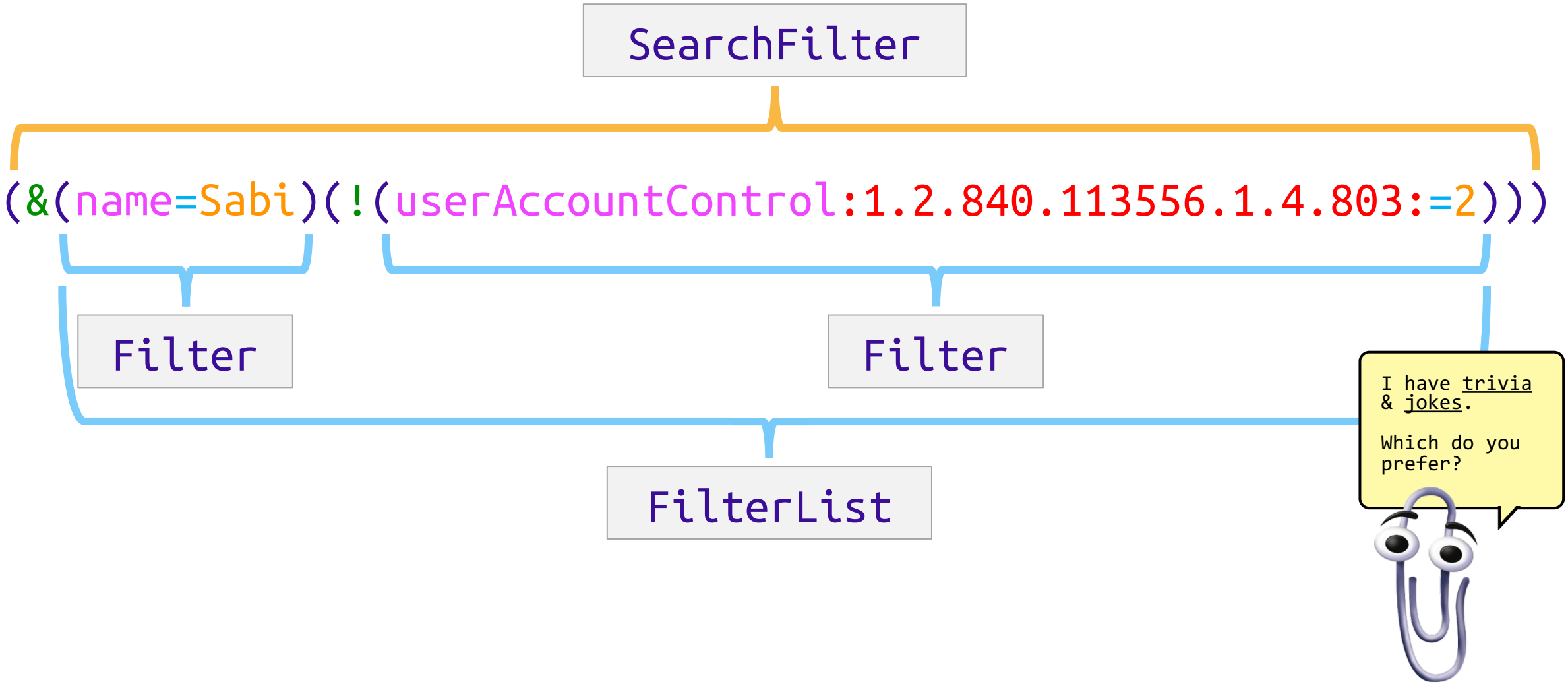

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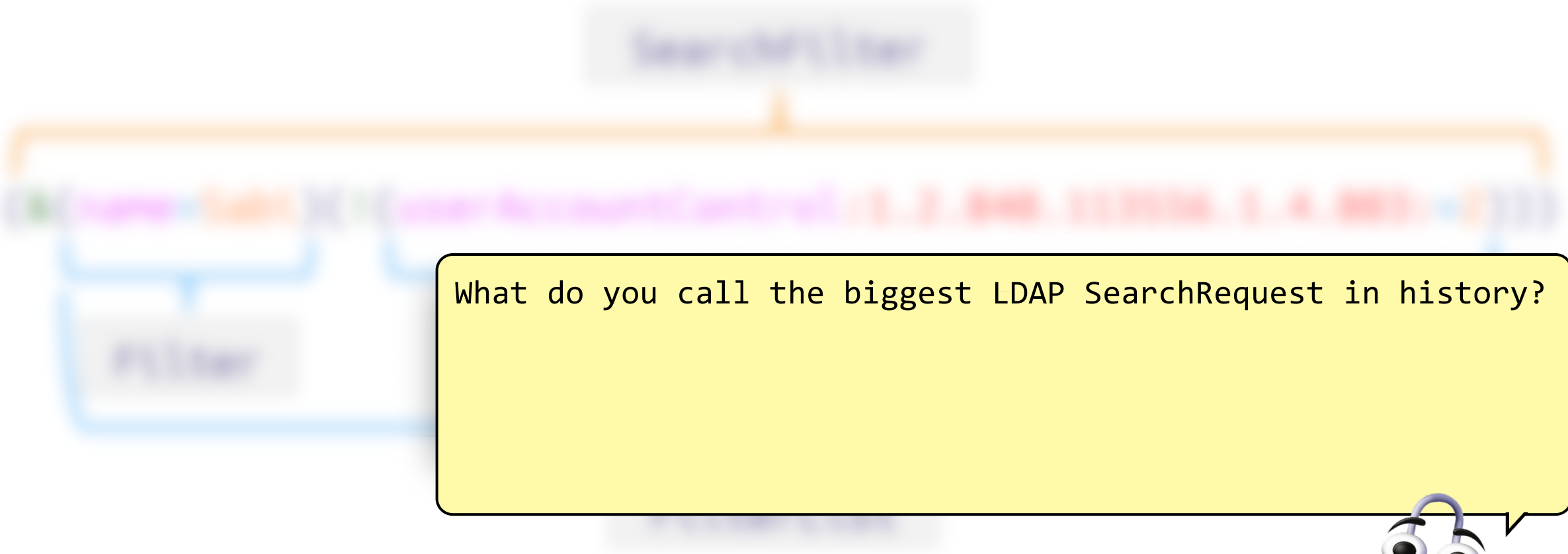
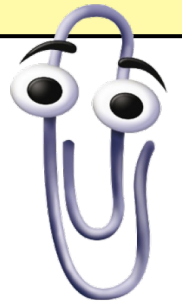


What do you call the biggest LDAP SearchRequest in history?



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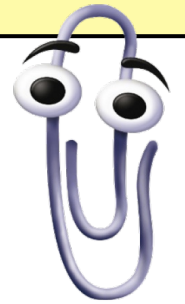
What do you call the biggest LDAP SearchRequest in history?

10,485,760 bytes (~10.5 MB)

That’s so funny it qualifies as trivia AND a joke!



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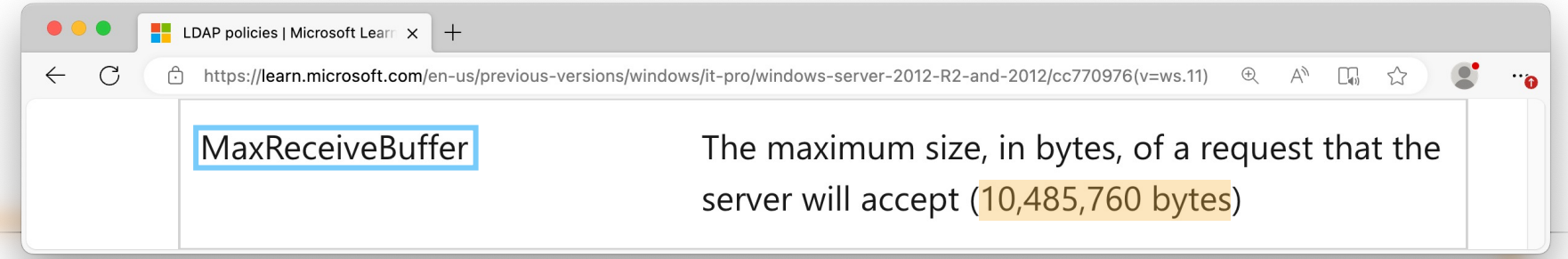

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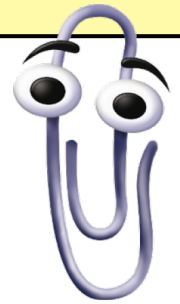

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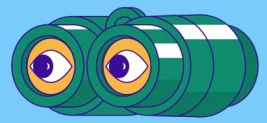
- PROBLEM: Obfuscating LDAP 
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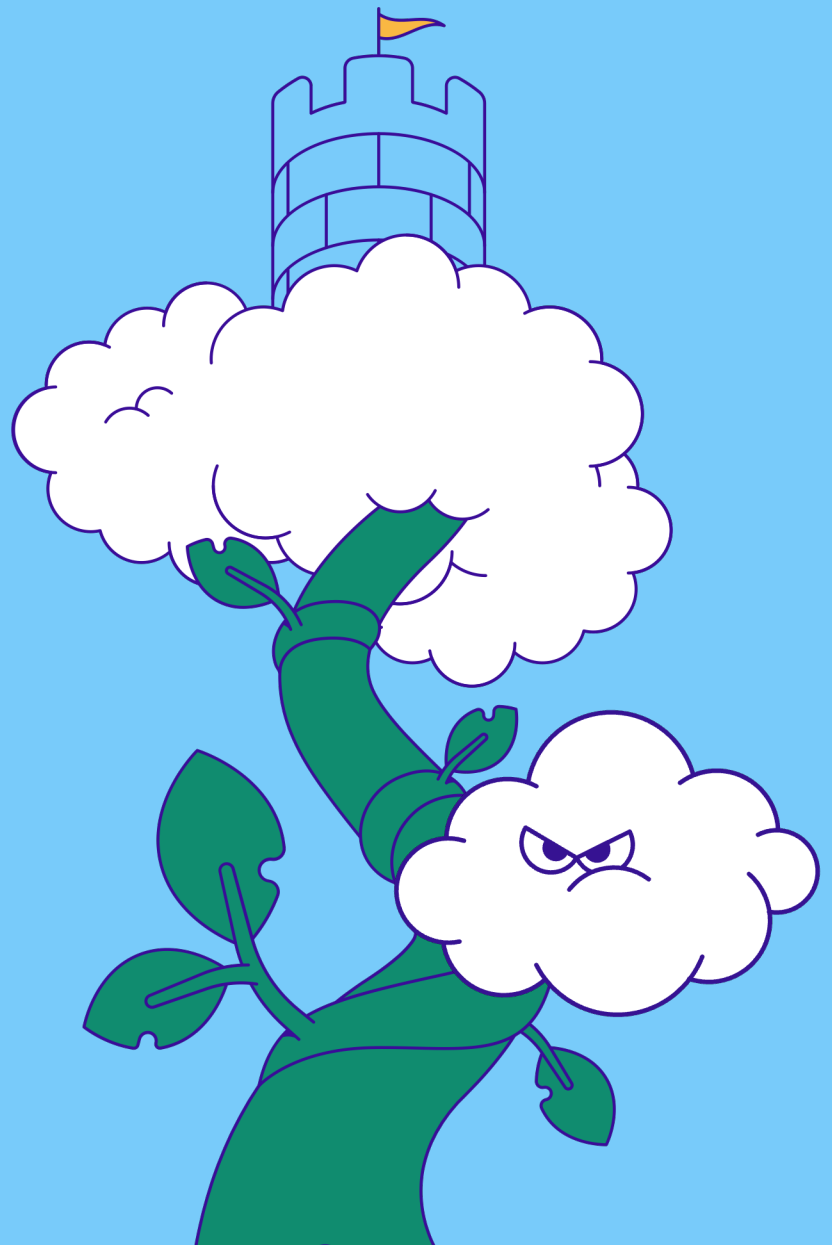
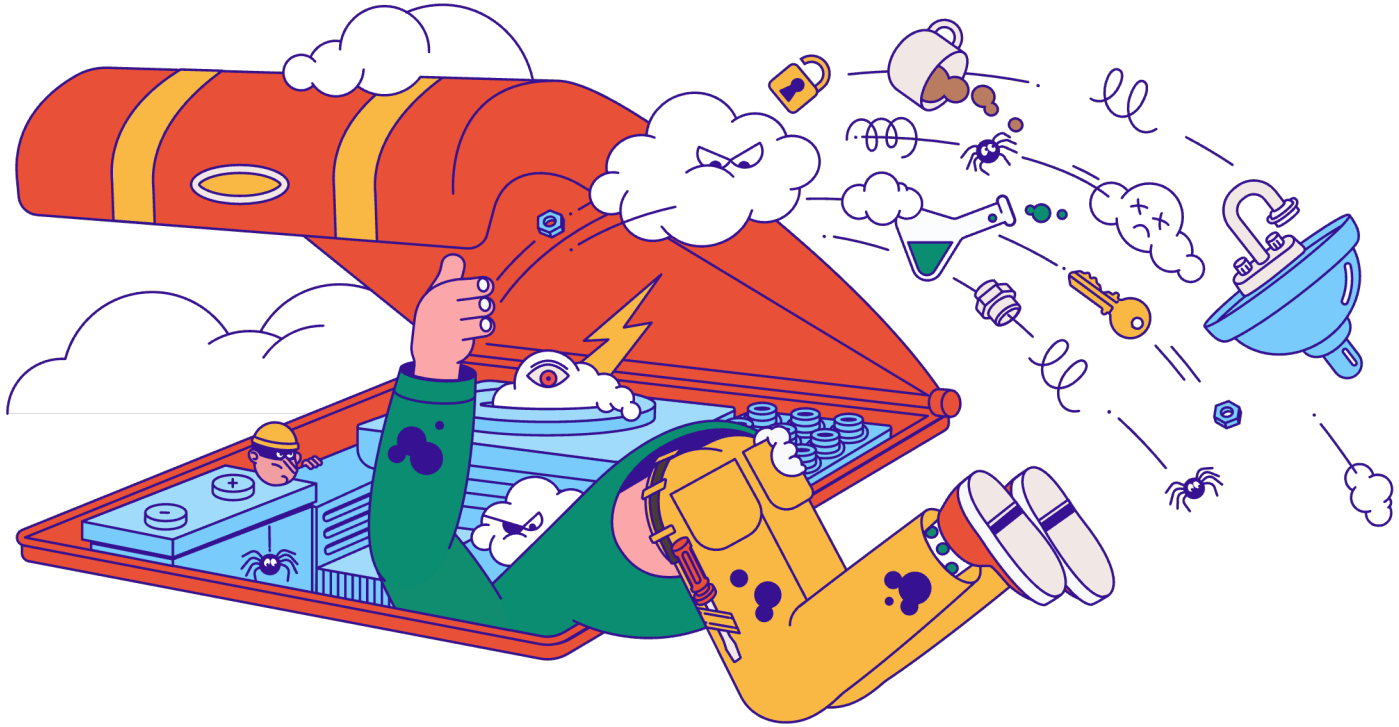


PROBLEM: Obfuscating LDAP 👀

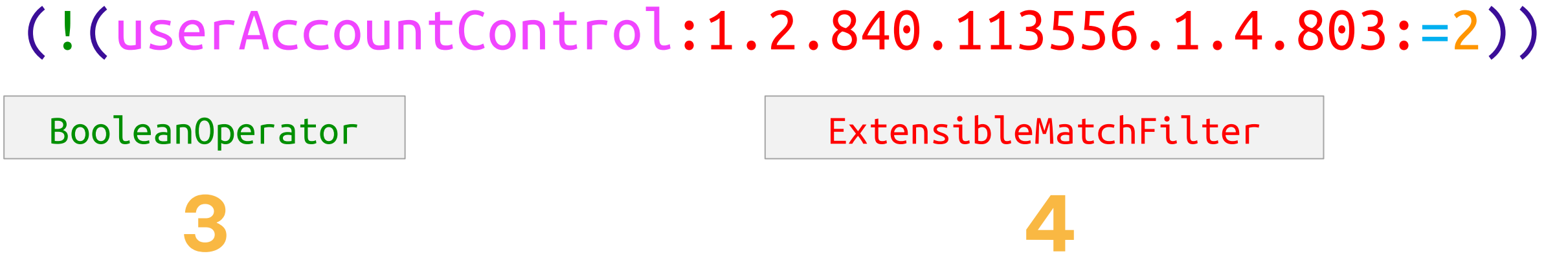
Obfuscating LDAP: 3 Deep Dives * 3 Genres

- Obfuscation Deep Dives:
  1. Filter → `(name=Sabi)`
  2. BaseObject → `LDAP://DC=contoso,DC=com`
  3. AttributeSelection → `name,lastlogon,memberof`
- Obfuscation Genres:
  - Substitution
  - Insertion
  - Transformation

WARNING! Undocumented Findings Ahead



LDAP SearchFilter Token Types



Obfuscation::Filter::Attribute

- Attribute obfuscation
  - Casing

```
(name=Domain Admins)
```

Obfuscation::Filter::Attribute

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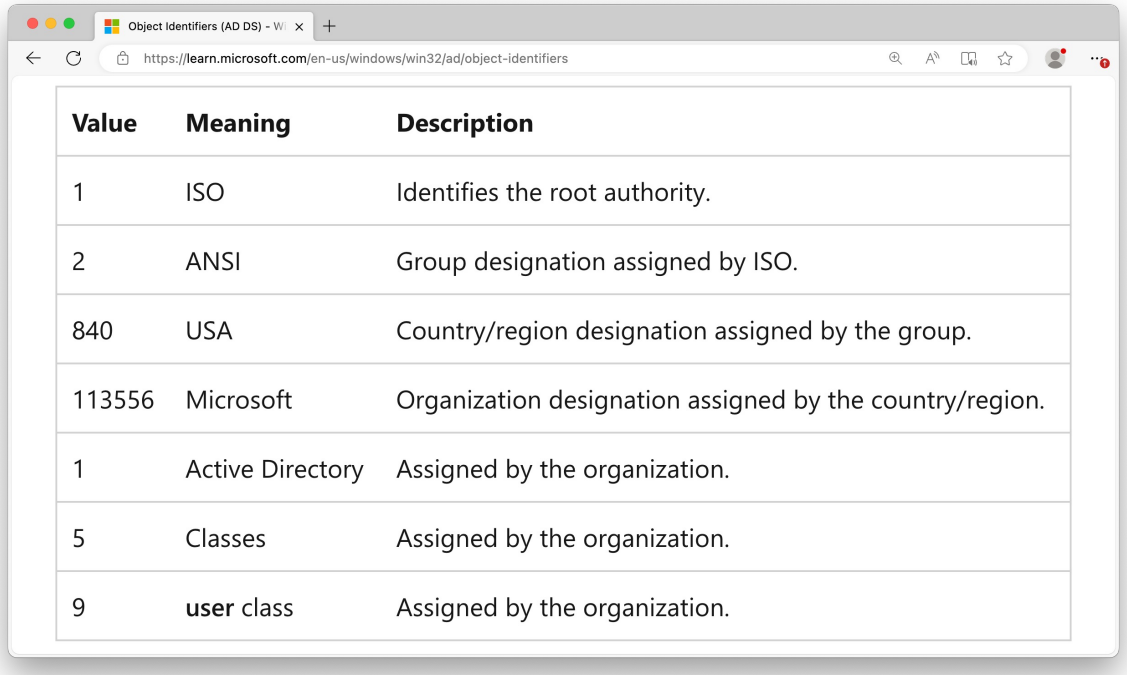
```
(nAmE=Domain Admins)
```

Obfuscation::Filter::Attribute

- Attribute obfuscation
  - Casing
  - OID (Object Identifiers) notation
    - Unique numeric values to identify object classes, **attributes** & syntaxes
    - Defined by directory service
    - *OID notation is a **dotted string of numbers** which is described in the following table*



Value	Meaning	Description
1	ISO	Identifies the root authority.
2	ANSI	Group designation assigned by ISO.
840	USA	Country/region designation assigned by the group.
113556	Microsoft	Organization designation assigned by the country/region.
1	Active Directory	Assigned by the organization.
5	Classes	Assigned by the organization.
9	**user** class	Assigned by the organization.

```
(1.2.840.113556.1.4.1=Domain Admins)
```

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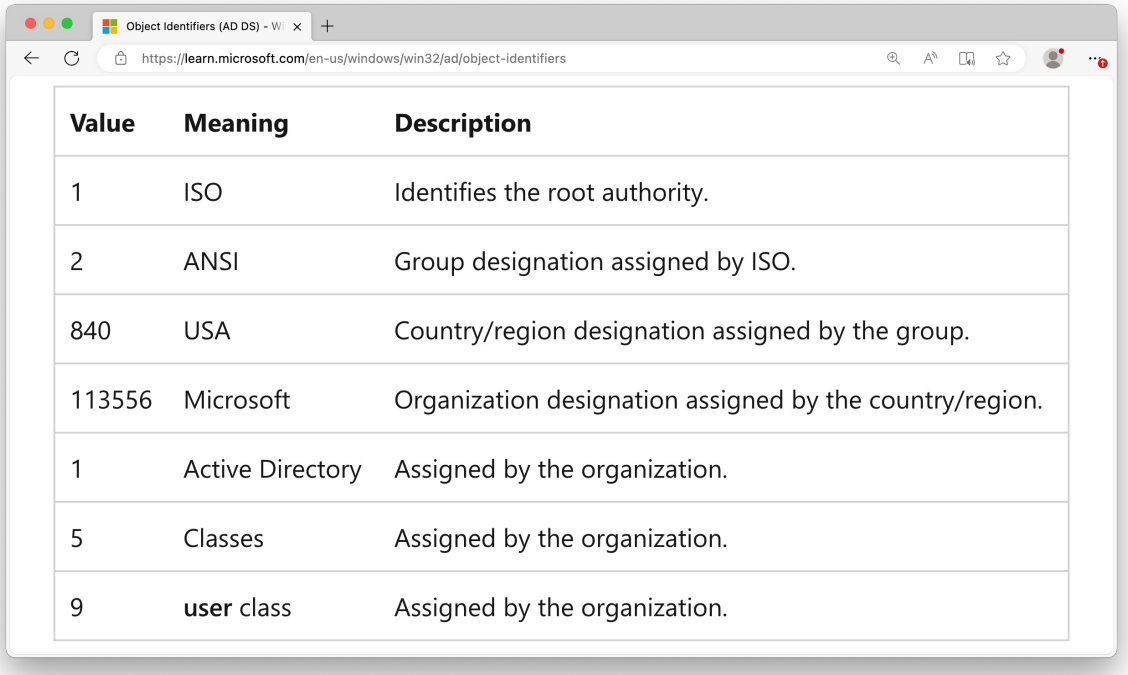

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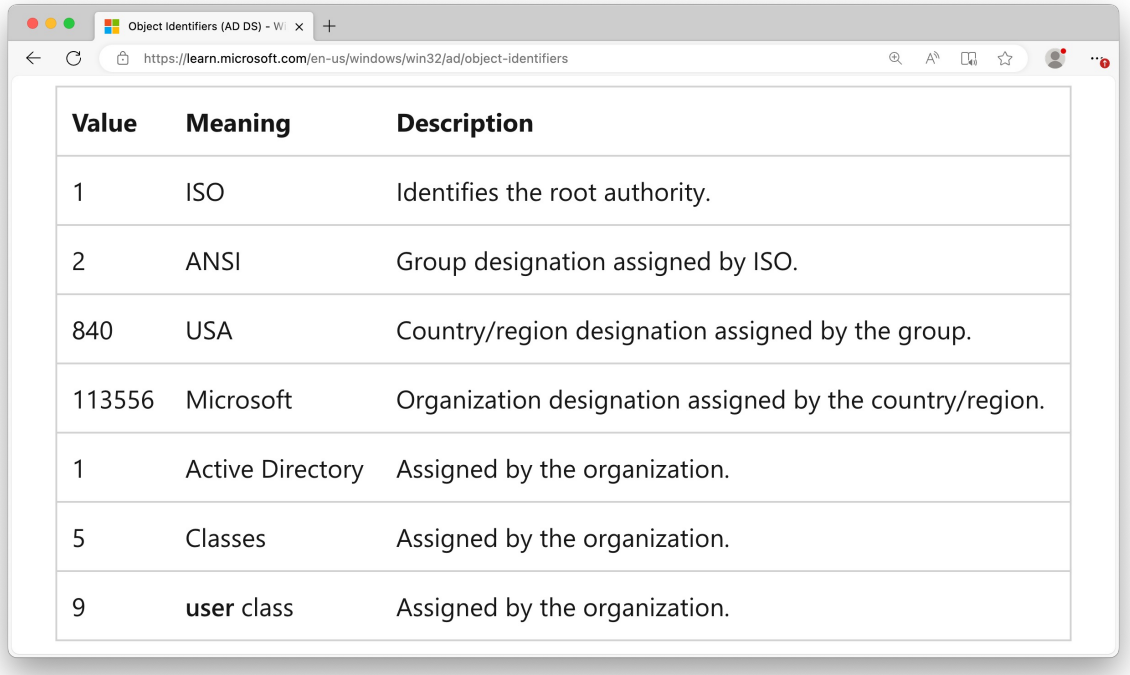

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```
(oId.1.2.840.113556.1.4.1=Domain Admins)
```

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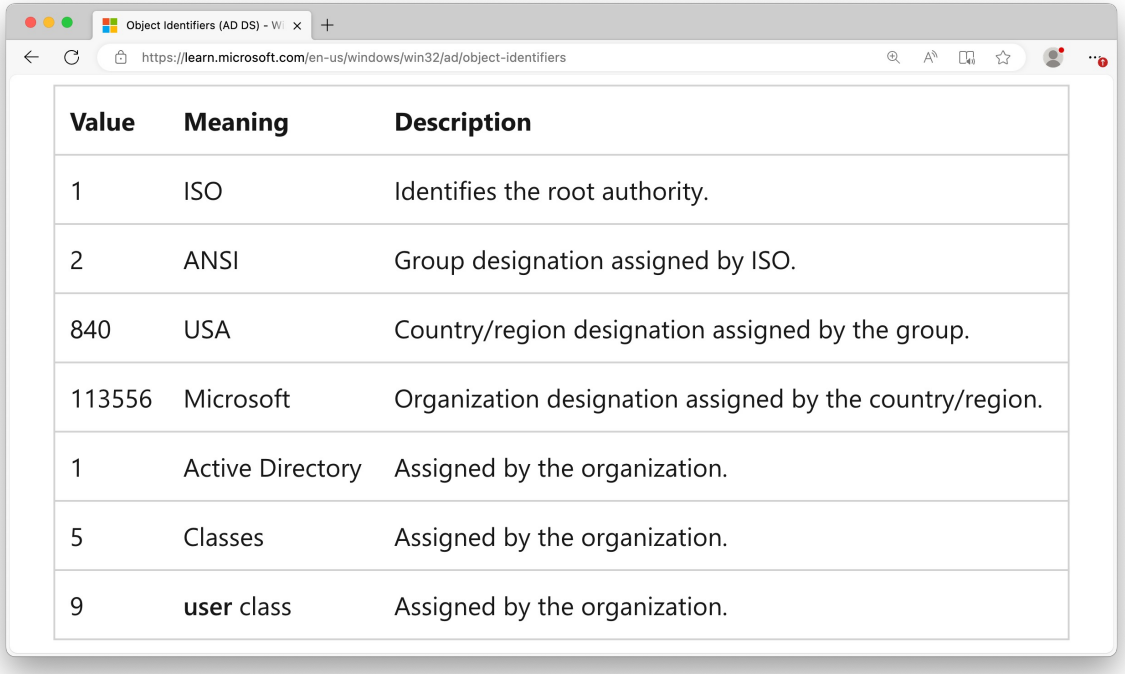

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(oId.001.02.000840.00113556.000001.04.001=Domain Admins)

Obfuscation::Filter::Attribute

- Attribute obfuscation
  - Casing
  - OID (Object Identifiers) notation
  - aNR (Ambiguous Name Resolution)

```
(name=Domain Admins)
```

Obfuscation::Filter::Attribute

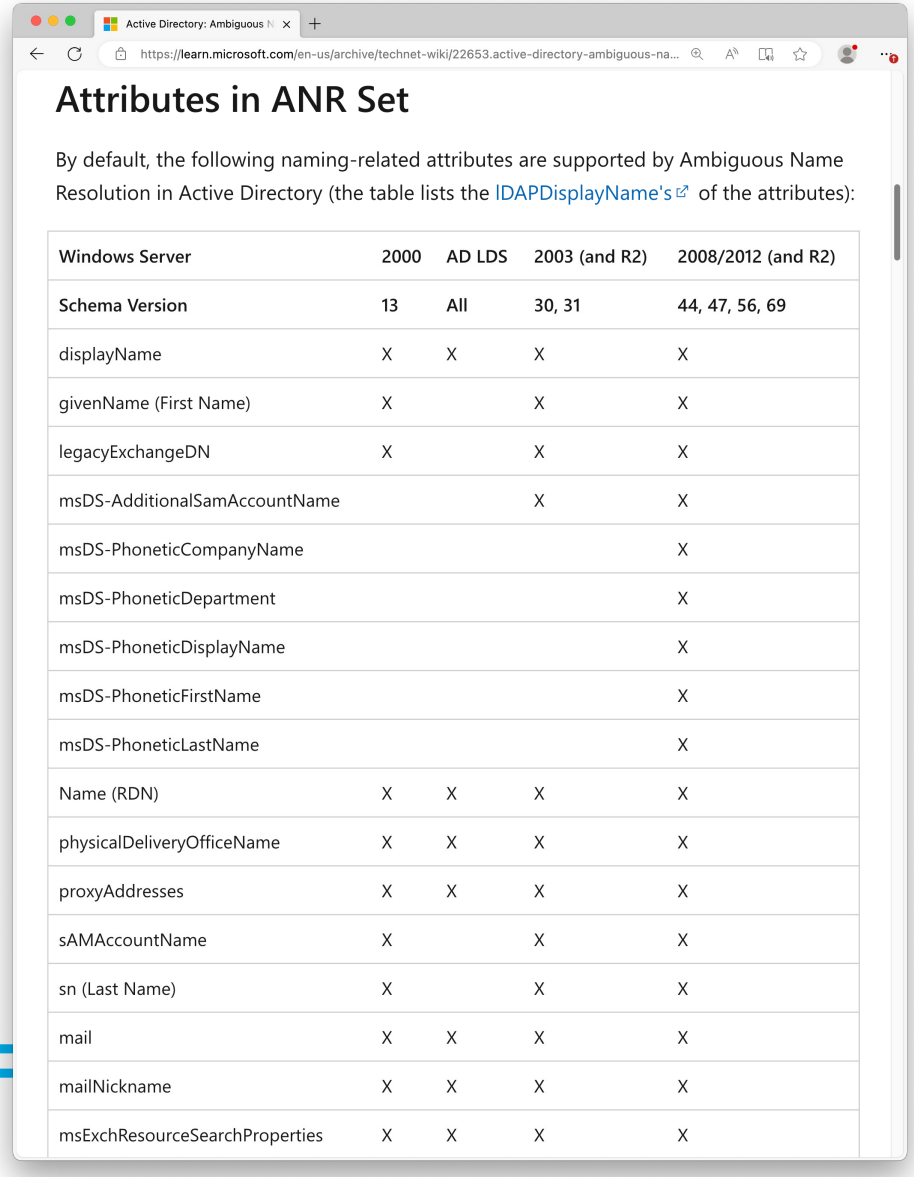
- Attribute obfuscation
  - Casing
  - OID (Object Identifiers) notation
  - aNR (Ambiguous Name Resolution)

```
(name=Domain Admins)
        ↓
(aNR=Domain Admins)
        ↓
(1.2.840.113556.1.4.1208=Domain Admins)
```

Obfuscation::Filter::Attribute

- Attribute obfuscation
  - Casing
  - OID (Object Identifiers) notation
  - aNR (Ambiguous Name Resolution)

```
(name=Domain Admins)
        ↓
(aNR=Domain Admins)
        ↓
(1.2.840.113556.1.4.1208=
```



Attributes in ANR Set

By default, the following naming-related attributes are supported by Ambiguous Name Resolution in Active Directory (the table lists the lDAPDisplayName's of the attributes):

Windows Server	2000	AD LDS	2003 (and R2)	2008/2012 (and R2)
Schema Version	**13**	**All**	**30, 31**	**44, 47, 56, 69**
displayName	X	X	X	X
givenName (First Name)	X		X	X
legacyExchangeDN	X		X	X
msDS-AdditionalSamAccountName			X	X
msDS-PhoneticCompanyName				X
msDS-PhoneticDepartment				X
msDS-PhoneticDisplayName				X
msDS-PhoneticFirstName				X
msDS-PhoneticLastName				X
Name (RDN)	X	X	X	X
physicalDeliveryOfficeName	X	X	X	X
proxyAddresses	X	X	X	X
sAMAccountName	X		X	X
sn (Last Name)	X		X	X
mail	X	X	X	X
mailNickname	X	X	X	X
msExchResourceSearchProperties	X	X	X	X

Obfuscation::Filter::Attribute

```
(
   |
   (displayName=domain admins*)
   (givenName=domain admins*)
   (legacyExchangeDN=domain admins)
   (physicalDeliveryOfficeName=domain admins*)
   (proxyAddresses=domain admins*)
   (Name=domain admins*)
   (sAMAccountName=domain admins*)
   (sn=domain admins*)
)
```

No “*”

Active Directory: Ambiguous

https://learn.microsoft.com/en-us/archive/technet-wiki/22653.active-directory-ambiguous-na...

Attributes in ANR Set

By default, the following naming-related attributes are supported by Ambiguous Name Resolution in Active Directory (the table lists the lDAPDisplayName's of the attributes):

Windows Server	2000	AD LDS	2003 (and R2)	2008/2012 (and R2)
Schema Version	**13**	**All**	**30, 31**	**44, 47, 56, 69**
displayName	X	X	X	X
givenName (First Name)	X		X	X
legacyExchangeDN	X		X	X
msDS-AdditionalSamAccountName			X	X
msDS-PhoneticCompanyName				X
msDS-PhoneticDepartment				X
msDS-PhoneticDisplayName				X
msDS-PhoneticFirstName				X
msDS-PhoneticLastName				X
Name (RDN)	X	X	X	X
physicalDeliveryOfficeName	X	X	X	X
proxyAddresses	X	X	X	X
sAMAccountName	X		X	X
sn (Last Name)	X		X	X
mail	X	X	X	X
mailNickname	X	X	X	X
msExchResourceSearchProperties	X	X	X	X

Obfuscation::Filter::Attribute

```
(
  |
  (displayName=domain admins*)
  (givenName=domain admins*)
  (legacyExchangeDN=domain admins)
  (physicalDeliveryOfficeName=domain admins*)
  (proxyAddresses=domain admins*)
  (Name=domain admins*)
  (sAMAccountName=domain admins*)
  (sn=domain admins*)
  (givenName=domain*)
  (sn=admins*)
  (givenName=admins*)
  (sn=domain*)
)
```

No “*”

First*Last*

Last*First*

Active Directory: Ambiguous

https://learn.microsoft.com/en-us/archive/technet-wiki/22653.active-directory-ambiguous-na...

Attributes in ANR Set

By default, the following naming-related attributes are supported by Ambiguous Name Resolution in Active Directory (the table lists the lDAPDisplayName's of the attributes):

Windows Server	2000	AD LDS	2003 (and R2)	2008/2012 (and R2)
Schema Version	**13**	**All**	**30, 31**	**44, 47, 56, 69**
displayName	X	X	X	X
givenName (First Name)	X		X	X
legacyExchangeDN	X		X	X
msDS-AdditionalSamAccountName			X	X
msDS-PhoneticCompanyName				X
msDS-PhoneticDepartment				X
msDS-PhoneticDisplayName				X
msDS-PhoneticFirstName				X
msDS-PhoneticLastName				X
Name (RDN)	X	X	X	X
physicalDeliveryOfficeName	X	X	X	X
proxyAddresses	X	X	X	X
sAMAccountName	X		X	X
sn (Last Name)	X		X	X
mail	X	X	X	X
mailNickname	X	X	X	X
msExchResourceSearchProperties	X	X	X	X

Obfuscation::Filter::Attribute

(aNR=krbtgt)

(aNR=krb)

(aNR=krb*Appeal/AnythingYouWant!!!)

Active Directory: Ambiguous

https://learn.microsoft.com/en-us/archive/technet-wiki/22653.active-directory-ambiguous-na...

Attributes in ANR Set

By default, the following naming-related attributes are supported by Ambiguous Name Resolution in Active Directory (the table lists the lDAPDisplayName's of the attributes):

Windows Server	2000	AD LDS	2003 (and R2)	2008/2012 (and R2)
Schema Version	13	All	30, 31	44, 47, 56, 69
displayName	X	X	X	X
givenName (First Name)	X		X	X
legacyExchangeDN	X		X	X
msDS-AdditionalSamAccountName				
			X	X
mail	X	X	X	X
mailNickname	X	X	X	X
msExchResourceSearchProperties	X	X	X	X

Obfuscation::Filter::Attribute

- Attribute obfuscation
  - Casing
  - OID (Object Identifiers) notation
  - aNR (Ambiguous Name Resolution)

```
(aNR=Domain Admins)
```

```
(aNR==Domain Admins)
```

You can force ANR to require an exact match on any of the attributes in the table by starting the value with the equal sign, "=" (so the filter has two equal signs).

Attributes in ANR Set

By default, the following naming-related attributes are supported by Ambiguous Name Resolution in Active Directory (the table lists the lDAPDisplayName's of the attributes):

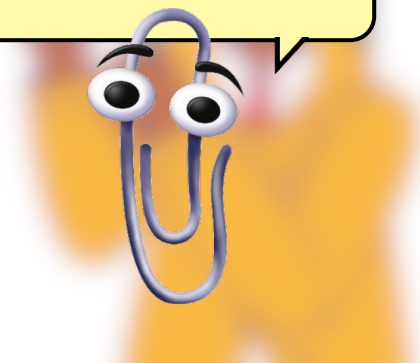
Windows Server	2000	AD LDS	2003 (and R2)	2008/2012 (and R2)
Schema Version	**13**	**All**	**30, 31**	**44, 47, 56, 69**
displayName	X	X	X	X
givenName (First Name)	X		X	X
legacyExchangeDN	X		X	X
msDS-AdditionalSamAccountName			X	X
msDS-PhoneticCompanyName				X
msDS-PhoneticDepartment				X
msDS-PhoneticDisplayName				X
msDS-PhoneticFirstName				X
msDS-PhoneticLastName				X
Name (RDN)	X	X	X	X
physicalDeliveryOfficeName	X	X	X	X
proxyAddresses	X	X	X	X
sAMAccountName	X		X	X
sn (Last Name)	X		X	X
mail	X	X	X	X
mailNickname	X	X	X	X
msExchResourceSearchProperties	X	X	X	X

Obfuscation::Filter::Attribute

- Attribute obfuscation
  - Casing
    - `(name=Domain Admins)`
    - `(nAmE=Domain Admins)`
  - OID (Object Identifiers) notation
    - `(1.2.840.113556.1.4.1=Domain Admins)`
    - `(OID.1.2.840.113556.1.4.1=Domain Admins)`
    - `(oId.001.02.000840.00113556.000001.04.001=Domain Admins)`
  - aNR (Ambiguous Name Resolution)
    - `(aNR=Domain Admins)`
    - `(aNR==Domain Admins)`

Obfuscation::Filter::Attribute

Do you know where else Ambiguous Name Resolution exists?

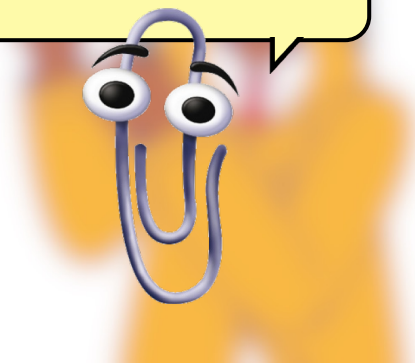


Obfuscation::Filter::Attribute

Do you know where else Ambiguous Name Resolution exists?

Microsoft!

What is more ambiguous than resolving to rename your products every 6 months, amirite?



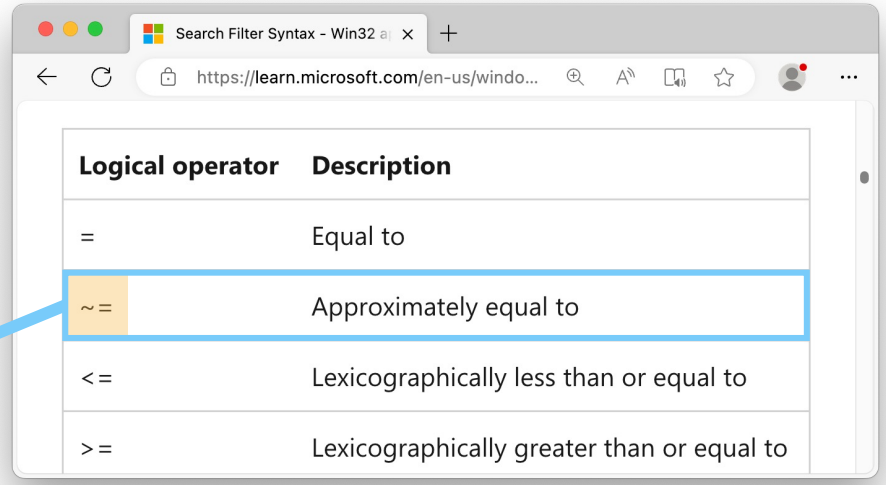
Obfuscation::Filter::ComparisonOperator

- ComparisonOperator obfuscation

```
(name=Domain Admins)
```

Obfuscation::Filter::ComparisonOperator

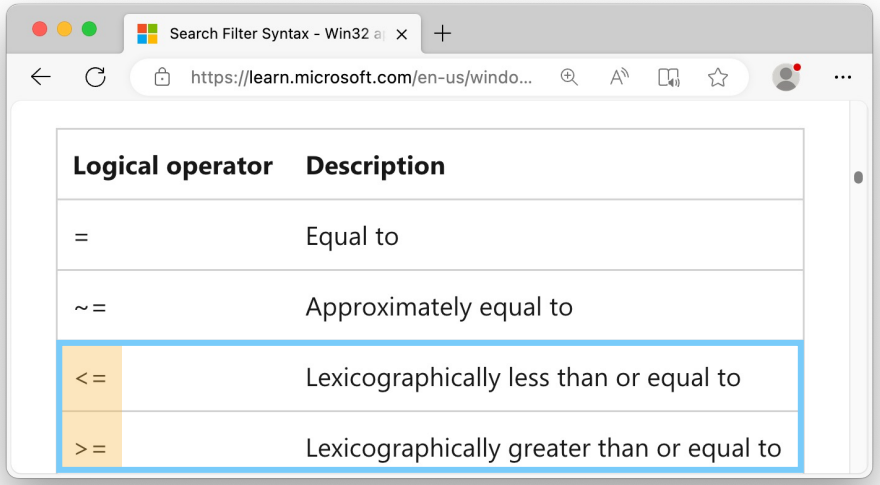
- ComparisonOperator obfuscation
  - Approximately equal to
    - Case still doesn't matter
    - Wildcards non-functional




```
(name~=Domain Admins)
```

Obfuscation::Filter::ComparisonOperator

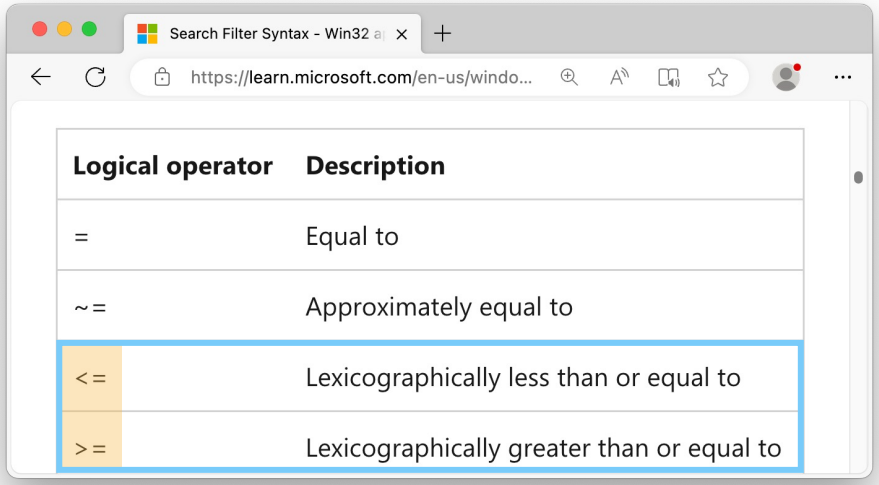
- ComparisonOperator obfuscation
  - Approximately equal to
  - Logically equivalent presence filter




```
(servicePrincipalName=*)
```

Obfuscation::Filter::ComparisonOperator

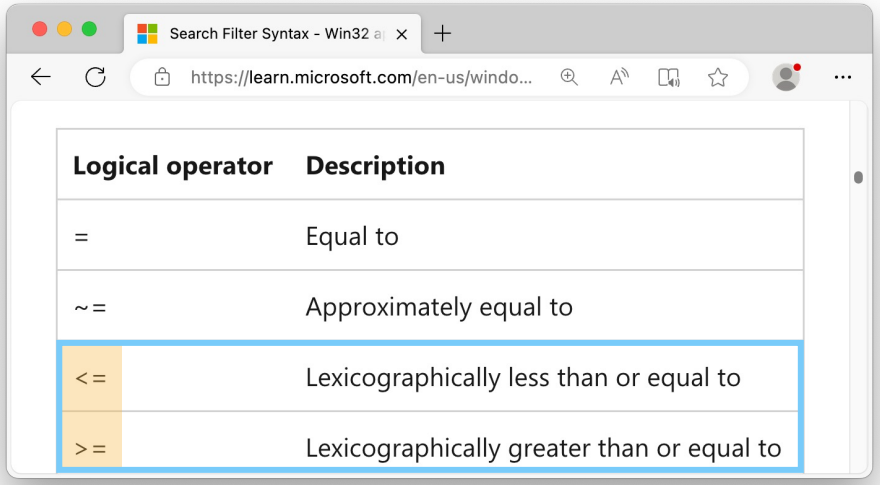
- ComparisonOperator obfuscation
  - Approximately equal to
  - Logically equivalent presence filter




```
(servicePrincipalName>==)
```

Obfuscation::Filter::ComparisonOperator

- ComparisonOperator obfuscation
  - Approximately equal to
  - Logically equivalent presence filter




```
(servicePrincipalName>==)
(servicePrincipalName>=!)
(servicePrincipalName<=zzz)
```

!"#$%&'()*+,-./ 0-9 :;<=>?@ A-Z [\]^_` a-z {|}~

(servicePrincipalName>==)

(servicePrincipalName>=!)

(servicePrincipalName<=zzz)

!"#$%&'()*+,-./ 0-9 :;<=>?@ A-Z [\]^_` a-z {|}~

0-9 a-z 

(servicePrincipalName>==)

(servicePrincipalName>=!)

(servicePrincipalName<=zzz)

!"#$%&'()*+,-./ 0-9 :;<=>?@ A-Z [\]^_` a-z {|}~

'-

+<=> 0-9 a-z

(servicePrincipalName>==)

(servicePrincipalName>=!)

(servicePrincipalName<=zzz)

!"#$%&'()*+,-./ 0-9 :;<=>?@ A-Z [\]^_` a-z {|}~

'- !"#$%&()*,./:;?@[\]^_`{|}~+<=> 0-9 a-z

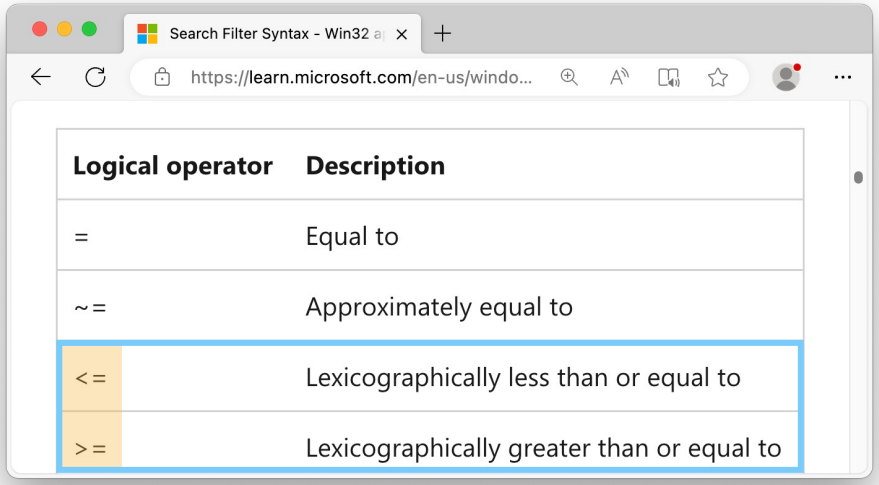
(servicePrincipalName>==)

(servicePrincipalName>=!)

(servicePrincipalName<=zzz)

Obfuscation::Filter::ComparisonOperator

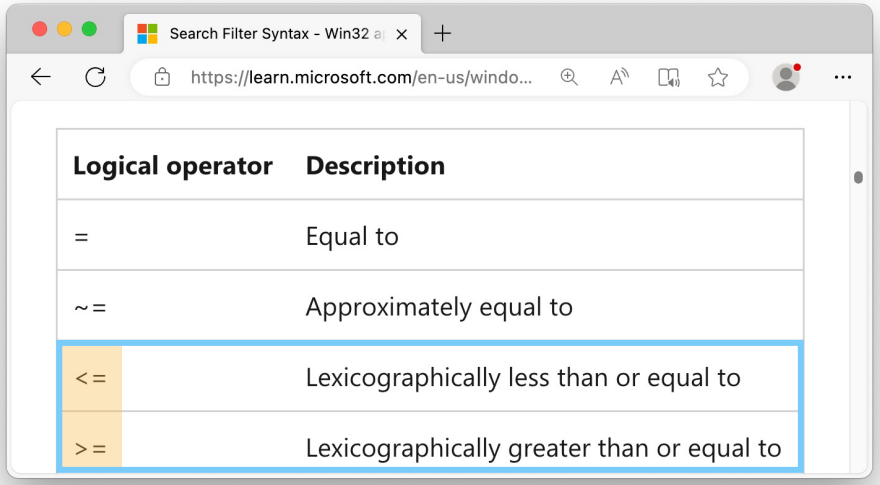
- ComparisonOperator obfuscation
  - Approximately equal to
  - Logically equivalent presence filter
  - Logically equivalent range filters




```
(samaccounttype=805306368)
```

Obfuscation::Filter::ComparisonOperator

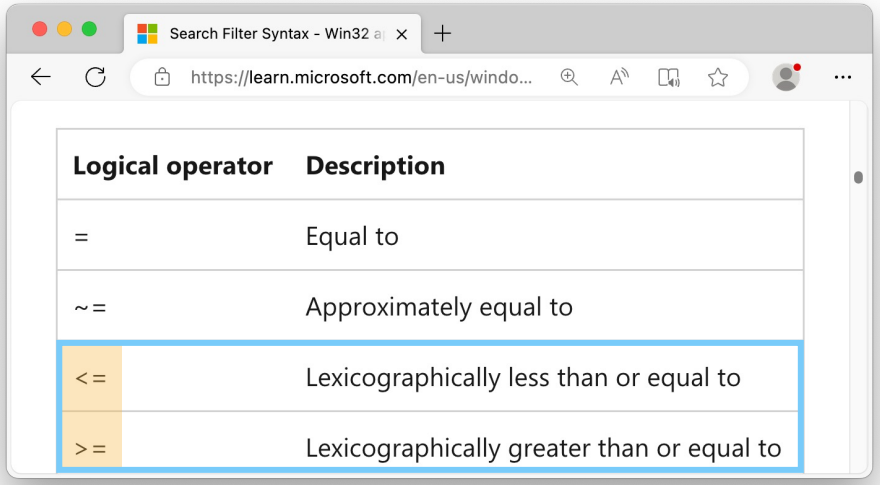
- ComparisonOperator obfuscation
  - Approximately equal to
  - Logically equivalent presence filter
  - Logically equivalent range filters




```
(
    &
    (samaccounttype>=805306367)
    (samaccounttype<=805306369)
)
```

Obfuscation::Filter::ComparisonOperator

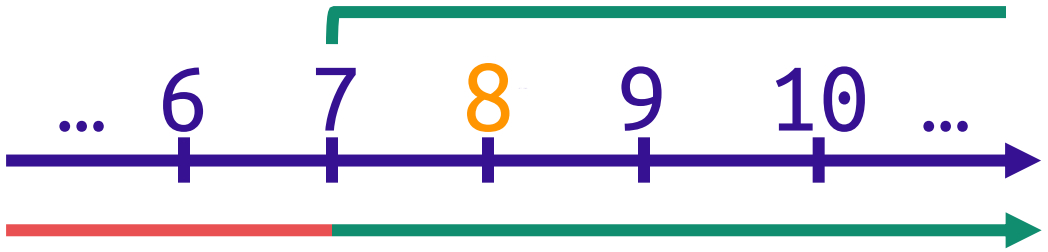
- ComparisonOperator obfuscation
  - Approximately equal to
  - Logically equivalent presence filter
  - Logically equivalent range filters




```
(
        &
        (samaccounttype>=805306367)
        (samaccounttype<=805306369)
        (!(samaccounttype=805306367))
        (!(samaccounttype=805306369))
)
```

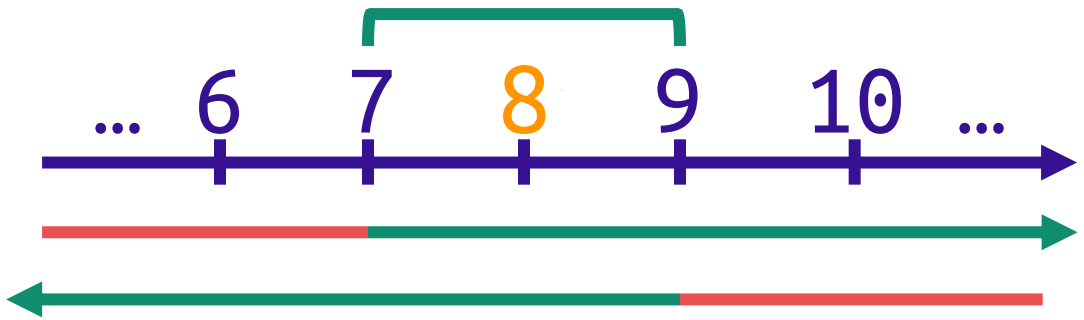
>=7
<=9
!=7
!=9

```
(
    &
    (samaccounttype>=805306367)
    (samaccounttype<=805306369)
    (!(samaccounttype=805306367))
    (!(samaccounttype=805306369))
)
```



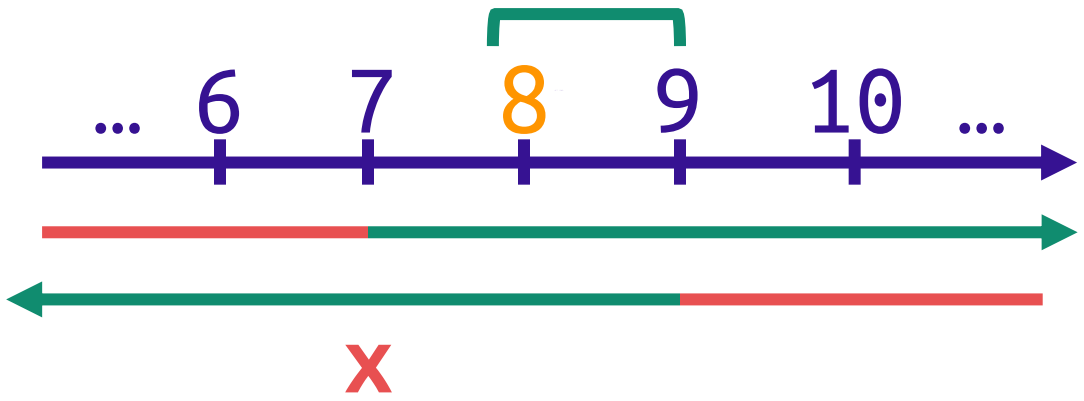
>=7
<=9
!=7
!=9

```
(
  &
  (samaccounttype>=805306367)
  (samaccounttype<=805306369)
  (!(samaccounttype=805306367))
  (!(samaccounttype=805306369))
)
```



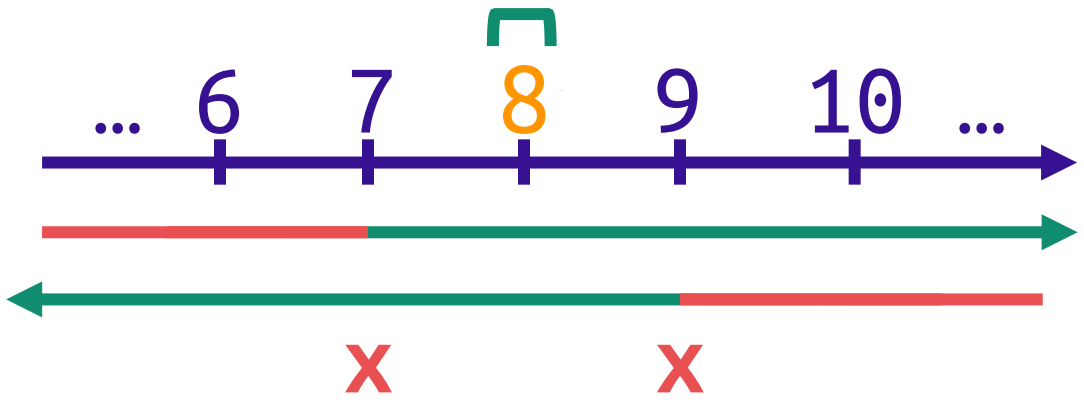
>=7
<=9
!=7
!=9

```
(
  &
  (samaccounttype>=805306367)
  (samaccounttype<=805306369)
  (!(samaccounttype=805306367))
  (!(samaccounttype=805306369))
)
```



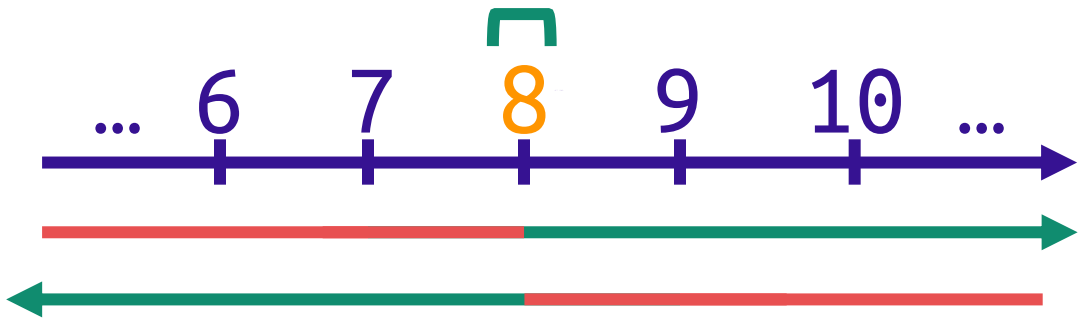
>=7
<=9
!=7
!=9

```
(
  &
  (samaccounttype>=805306367)
  (samaccounttype<=805306369)
  (!(samaccounttype=805306367))
  (!(samaccounttype=805306369))
)
```



>=7
<=9
!=7
!=9

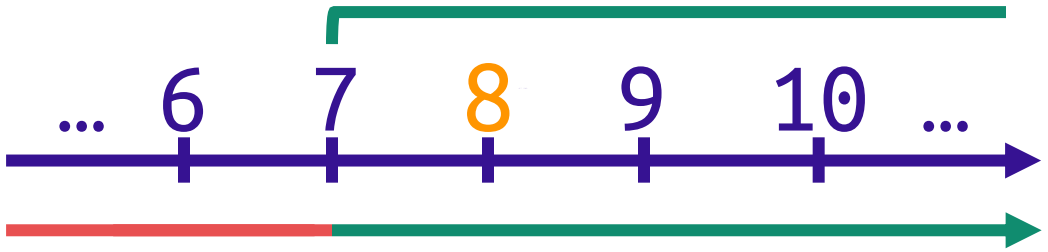
```
(
&
(samaccounttype>=805306367)
(samaccounttype<=805306369)
(!(samaccounttype=805306367))
(!(samaccounttype=805306369))
)
```



>=8	>=7
<=8	<=9
	!=7
	!=9

```
(
  &
  (samaccounttype>=805306367)
  (samaccounttype<=805306369)
  (!(samaccounttype=805306367))
  (!(samaccounttype=805306369))
)
```

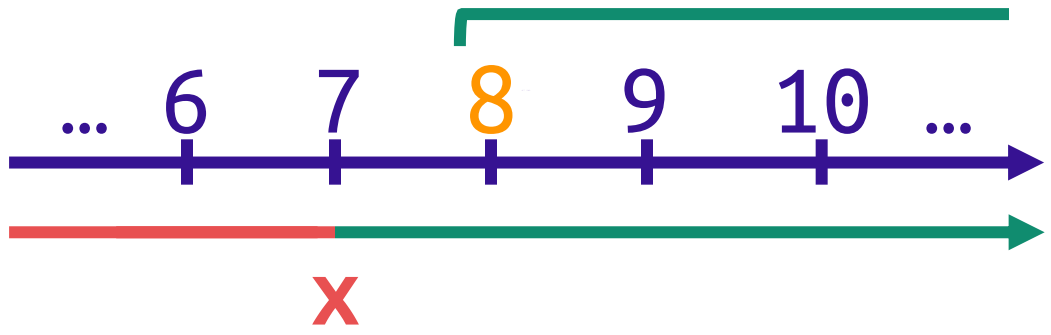
>=7
!=7
!>=9



>=8	>=7
<=8	<=9
	!=7
	!=9

```
(
  &
  (samaccounttype>=805306367)
  (samaccounttype<=805306369)
  (!(samaccounttype=805306367))
  (!(samaccounttype=805306369))
)
```

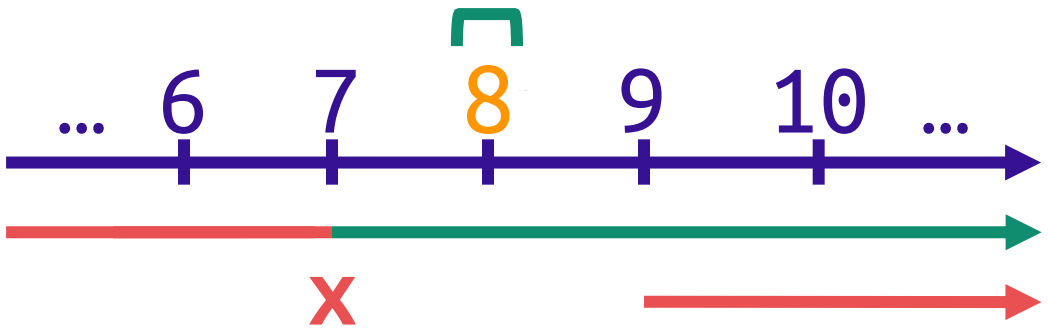
>=7
!=7
!>=9



>=8	>=7
<=8	<=9
	!=7
	!=9

```
(
  &
  (samaccounttype>=805306367)
  (samaccounttype<=805306369)
  (!(samaccounttype=805306367))
  (!(samaccounttype=805306369))
)
```

>=7
!=7
!>=9



>=8	>=7
<=8	<=9
	!=7
	!=9

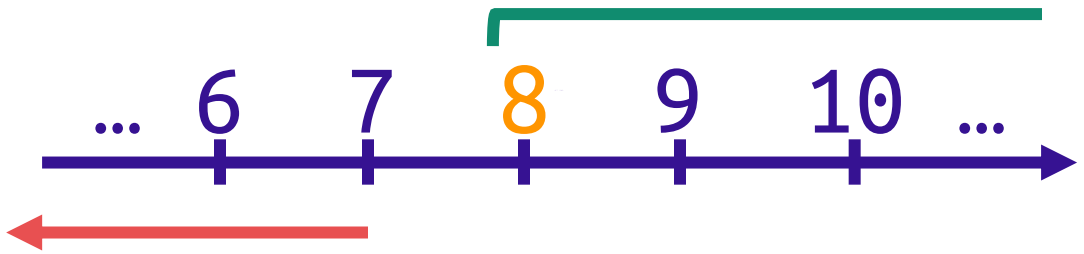
```
(
  &
  (samaccounttype>=805306367)
  (samaccounttype<=805306369)
  (!(samaccounttype=805306367))
  (!(samaccounttype=805306369))
)
```

>=7	=*
!=7	!<=7
!>=9	!>=9

>=8	>=7
<=8	<=9
	!=7
	!=9

```
(
    &
    (samaccounttype>=805306367)
    (samaccounttype<=805306369)
    (!(samaccounttype=805306367))
    (!(samaccounttype=805306369))
)
```

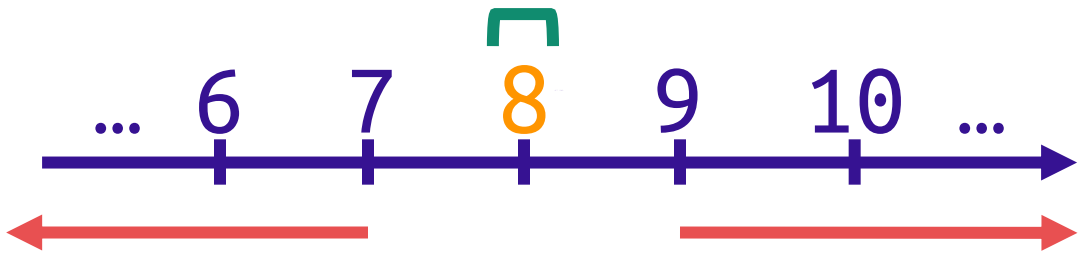
>=7	=*
!=7	!<=7
!>=9	!>=9



>=8	>=7
<=8	<=9
	!=7
	!=9

```
(
    &
    (samaccounttype>=805306367)
    (samaccounttype<=805306369)
    (!(samaccounttype=805306367))
    (!(samaccounttype=805306369))
)
```

>=7	=*
!=7	!<=7
!>=9	!>=9

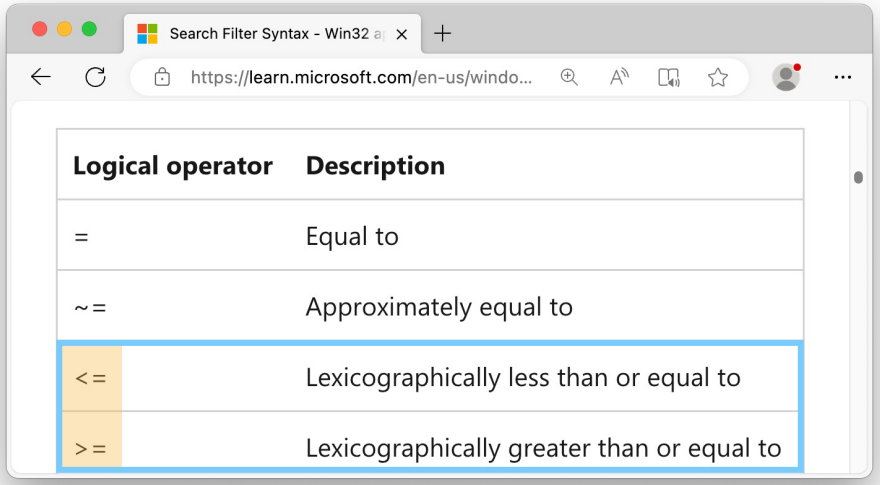


>=8	>=7
<=8	<=9
	!=7
	!=9

```
(
    &
    (samaccounttype>=805306367)
    (samaccounttype<=805306369)
    (!(samaccounttype=805306367))
    (!(samaccounttype=805306369))
)
```

Obfuscation::Filter::ComparisonOperator

- ComparisonOperator obfuscation
  - Approximately equal to
  - Logically equivalent presence filter
  - Logically equivalent range filters




```
(
    &
    (samaccounttype>=805306367)
    (samaccounttype<=805306369)
    (!(samaccounttype=805306367))
    (!(samaccounttype=805306369))
)
```

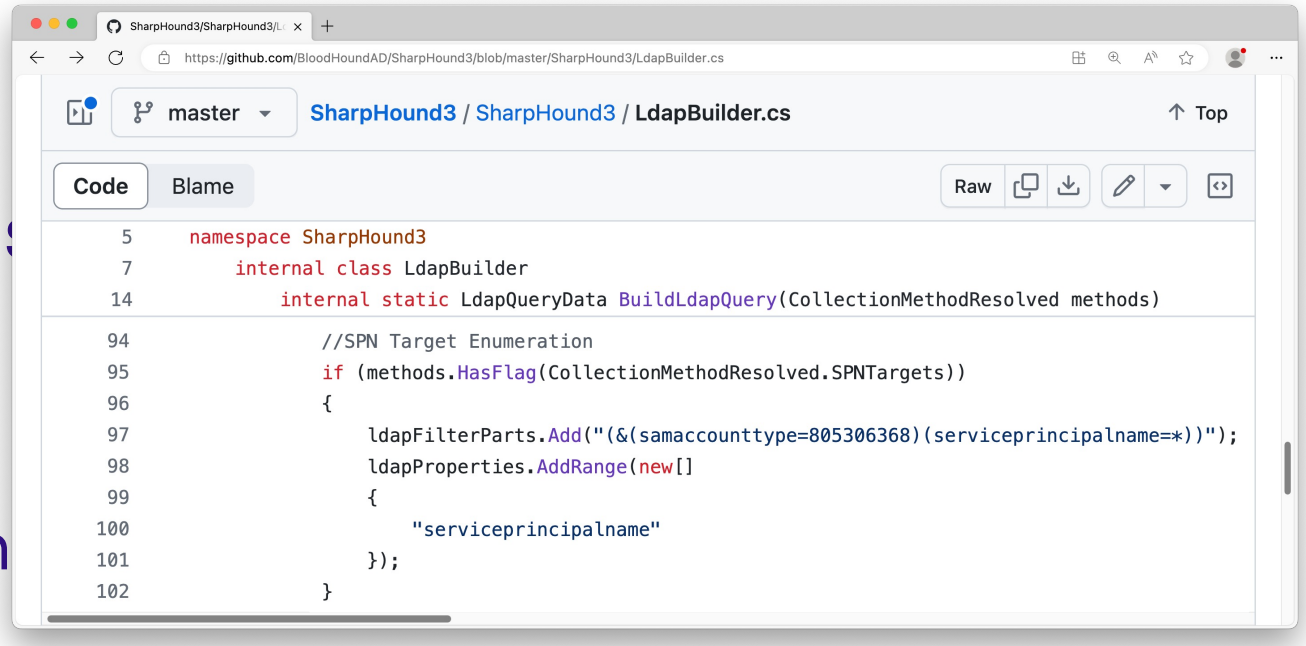
```
(
    &
    (name>=Domain Ad)
    (name<=Domain Ae)
    (name=*mins)
)
```

Obfuscation::Filter::ComparisonOperator

- ComparisonOperator obfuscation
  - Approximately equal to
    - `(name=Domain Admins)`
    - `(name~=Domain Admins)`
  - Logically equivalent presence filter
    - `(servicePrincipalName=*)`
    - `(servicePrincipalName>==)`
    - `(servicePrincipalName>=!)`
    - `(servicePrincipalName<=zzz)`
  - Logically equivalent range filters
    - `(samaccounttype=805306368)`
    - `(&(samaccounttype>=805306367)(samaccounttype<=805306369))`
    - `(&(name>=Domain Ad)(name<=Domain Ae))`

Obfuscation::Filter::ComparisonOperator

- ComparisonOperator obfu
  - Approximately equal to
    - (name=Domain Admins)
    - (name~=Domain Admins)
  - Logically equivalent presen
    - (servicePrincipalName=*)
    - (servicePrincipalName>==)
    - (servicePrincipalName>=!)
    - (servicePrincipalName<=zzz)
  - Logically equivalent range filters
    - (samaccounttype=805306368)
    - (&(samaccounttype>=805306367)(samaccounttype<=805306369))
    - (&(name>=Domain Ad)(name<=Domain Ae))



BLOODHOUND

Obfuscation::Filter::ComparisonOperator

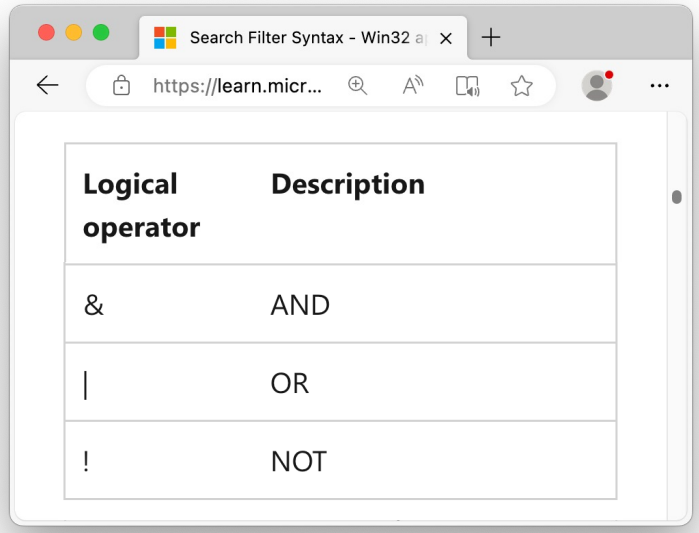
```
//SPN Target Enumeration
if (methods.HasFlag(CollectionMethodResolved.SPNTargets))
{                                (samaccounttype=805306368)(servicePrincipalName=*)
    ldapFilterParts.Add("(&(samaccounttype=805306368)(serviceprincipalname=*))");
    ldapProperties.AddRange(new[]
    {
        "serviceprincipalname"
    });
}
```

- Logically equivalent range filters

Obfuscation::Filter::BooleanOperator

AND → &

OR → |

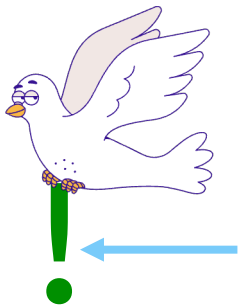


Logical operator	Description
&	AND
|	OR
!	NOT

Obfuscation::Filter::BooleanOperator

AND → &

OR → |



! ← NOT

Search Filter Syntax - Win32 a

https://learn.micr...

Logical operator	Description
&	AND
|	OR
!	NOT

Obfuscation::Filter::BooleanOperator

- BooleanOperator obfuscation
  - Additive

```
(co=Albania)
```

Obfuscation::Filter::BooleanOperator

- BooleanOperator obfuscation
  - Additive

```
(|(|(&(((((((|(|(co=Albania))))))))))))
```

Obfuscation::Filter::BooleanOperator

- BooleanOperator obfuscation
  - Additive
  - Double negation

```
(|(&(!(!(|(|(co=Albania))))))))))
```

Obfuscation::Filter::BooleanOperator

- BooleanOperator obfuscation
  - Additive
  - Double negation


```
(|(&(!(!(|(|(co=Albania))))))))))
```

```
(!(!(l=Kukës)))
```

```
(!(!l=Kukës))
```

Active Directory: LDAP Syntax

https://learn.microsoft.com/en-us/archive/technet-wiki/5392....

20. According to RFC 2254, the NOT operator, "!", should operate on a clause in parentheses (similar to the operators | and &). Although a clause similar to (!cn=*Smith) works in almost all cases, it would be more correct to use (!(cn=*Smith)).

Obfuscation::Filter::BooleanOperator

- BooleanOperator obfuscation
  - Additive
  - Double negation

```
(
   &
   (co=Albania)
   (
      |
      (l=Kukës)
      (l=Tiranë)
   )
)
```

Obfuscation::Filter::BooleanOperator

- BooleanOperator obfuscation
  - Additive
  - Double negation

```
(
  &1
  (co=Albania)
  (  2
     |
     (l=Kukës)
     (l=Tiranë)
  )
)
```

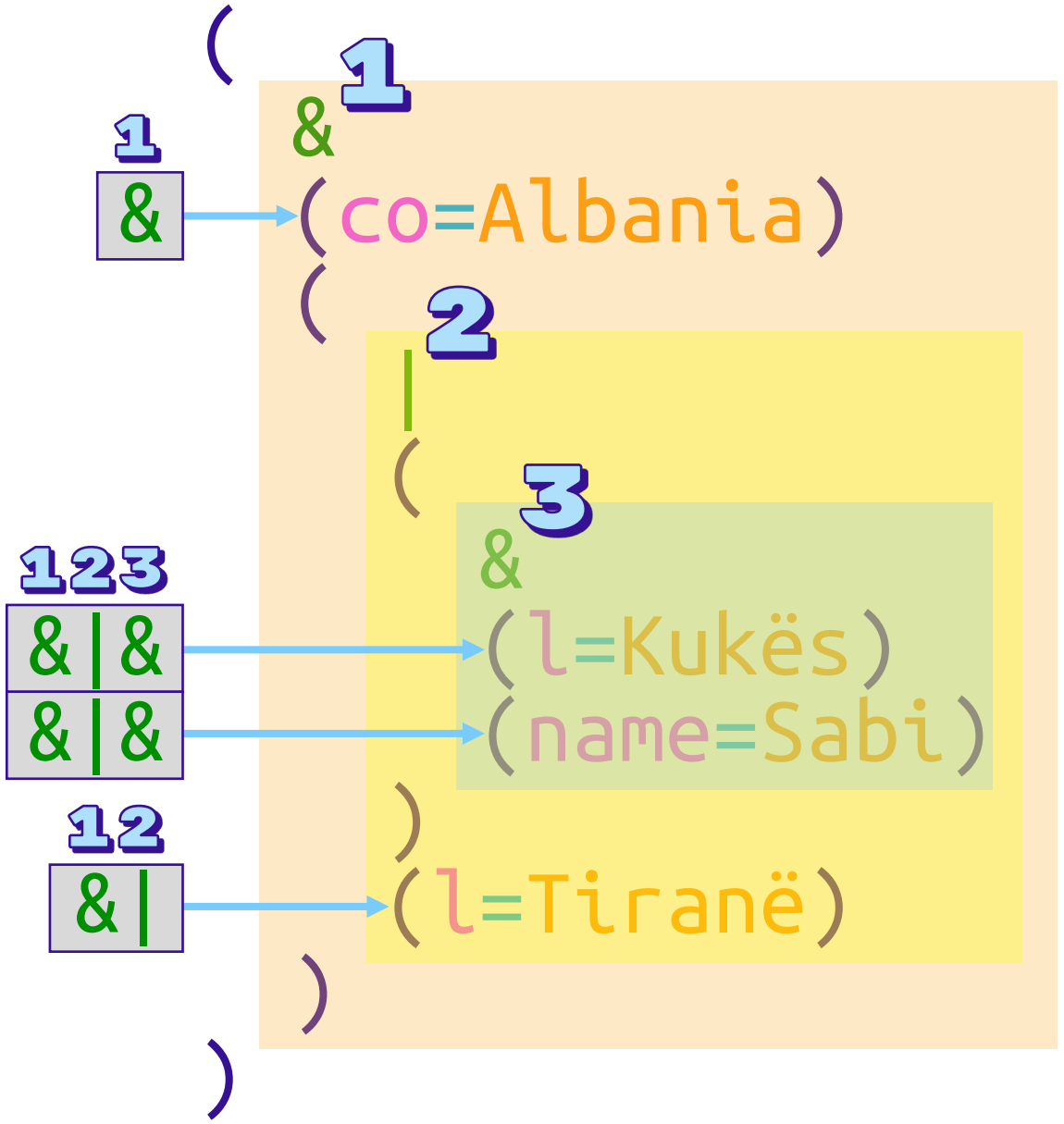
Obfuscation::Filter::BooleanOperator

- BooleanOperator obfuscation
  - Additive
  - Double negation

```
(
  &1
  (co=Albania)
  (
    2
    |
    (
      3
      &
      (l=Kukës)
      (name=Sabi)
    )
    (l=Tiranë)
  )
)
```

Obfuscation::Filter::BooleanOperator

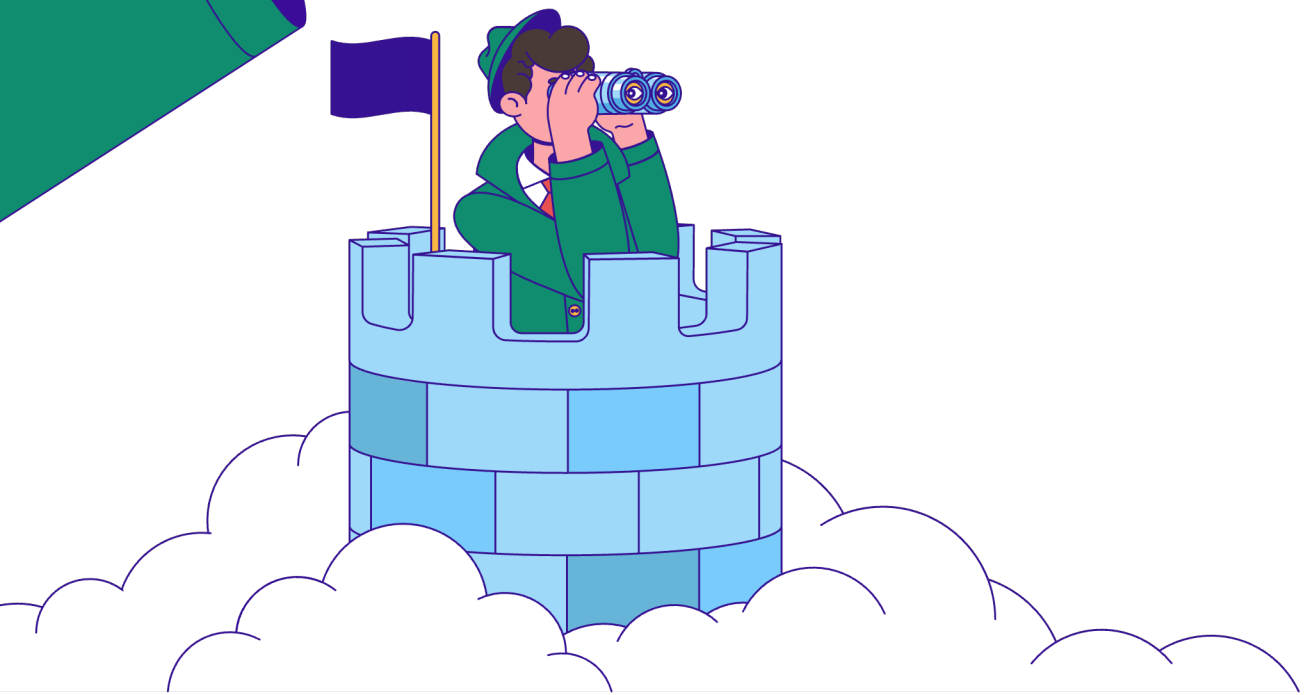
- BooleanOperator obfuscation
  - Additive
  - Double negation



Obfuscation::Filter::BooleanOperator

- Bool

! ONLY affects 1st BooleanOperator OR Filter (not FilterList).



```
(
  1 &
  (co=Albania)
  (
    2 !
    (
      (l=Kukës)
      (name=Sabi)
    )
  )
)
```

1 &

1 2 &!

&

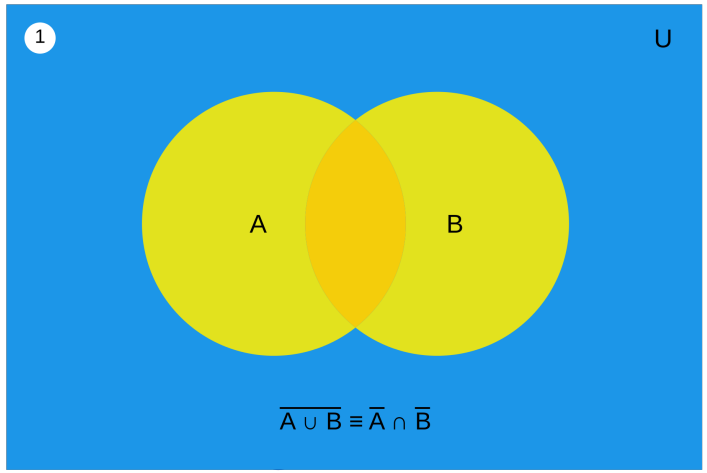
1 &

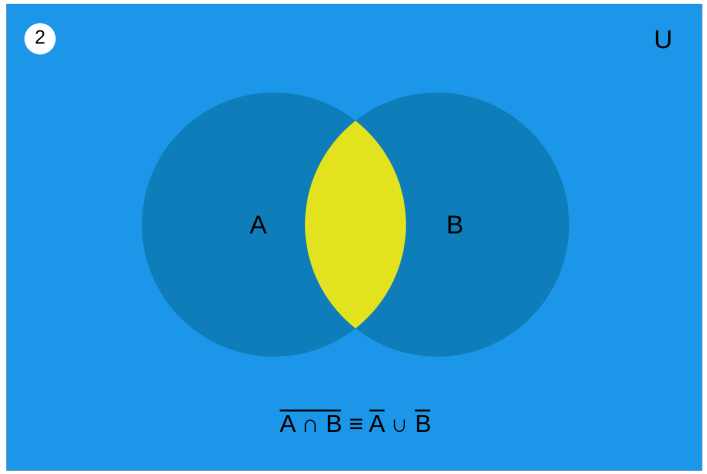
Obfuscation::Filter::BooleanOperator

- BooleanOperator obfuscation
  - Additive
  - Double negation
  - Logical inversion

```
(
   &
   (co=Albania)
   (
      |
      (l=Kukës)
      (l=Tiranë)
   )
)
```

Obfuscation::Filter::BooleanOperator





obfuscation

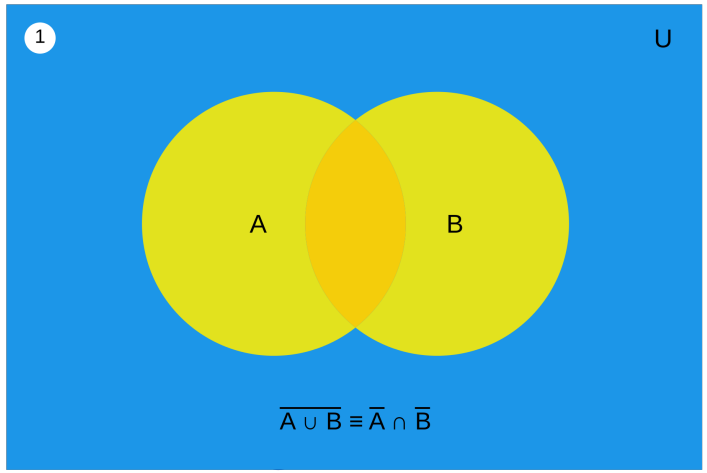
(De Morgan's laws)

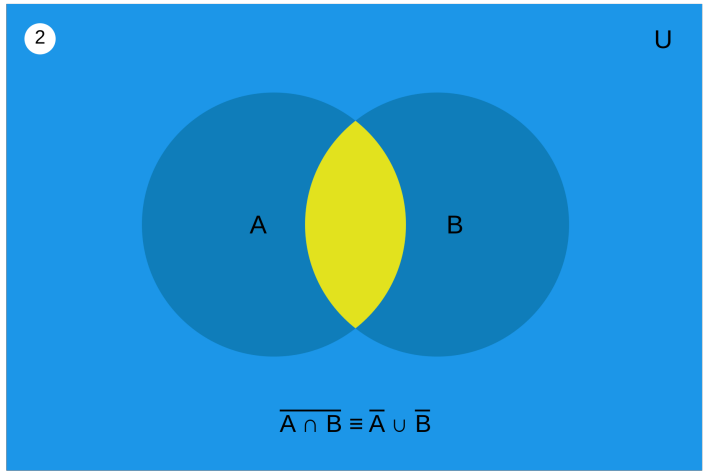
```
(
    &
    (co=Albania)
    (
        |
        (l=Kukës)
        (l=Tiranë)
    )
)
```

not (A or B) = (not A) and (not B)

not (A and B) = (not A) or (not B)

Obfuscation::Filter::BooleanOperator





obfuscation

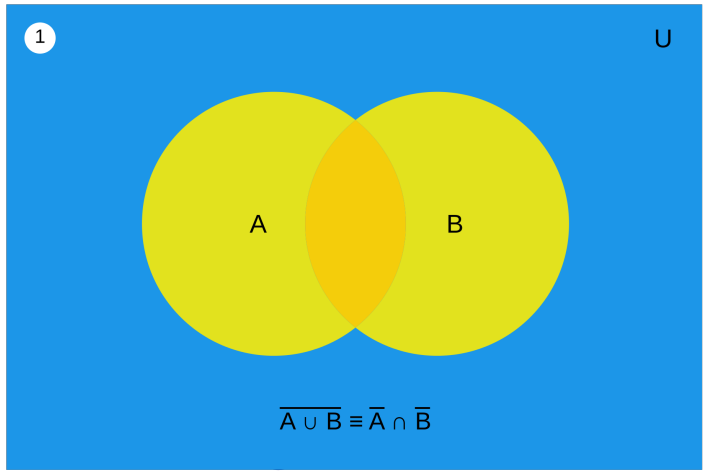
(De Morgan's laws)

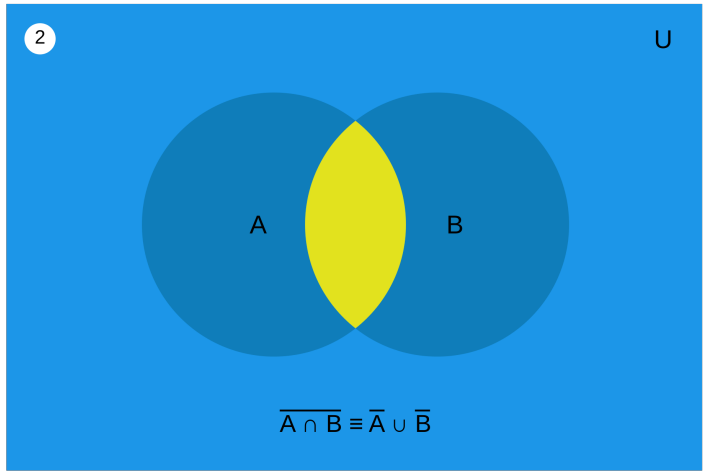
```
(
  !
1 (
        &
        (co=Albania)
2       (
          |
          (l=Kukës)
3         (l=Tiranë)
        )
      )
    )
```

not (A or B) = (not A) and (not B)

not (A and B) = (not A) or (not B)

Obfuscation::Filter::BooleanOperator





obfuscation

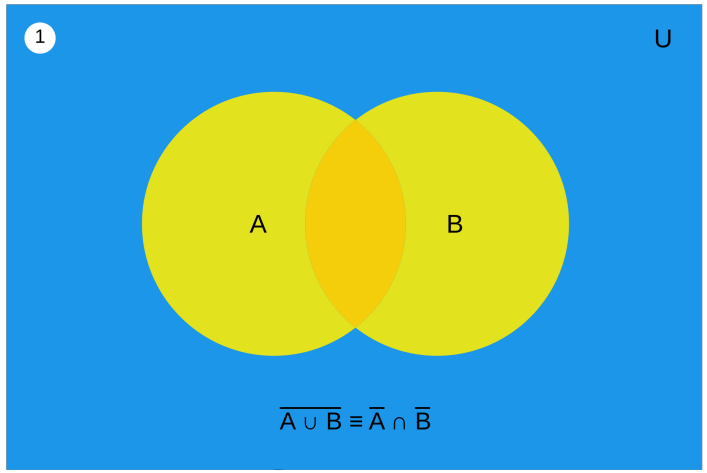
(De Morgan's laws)

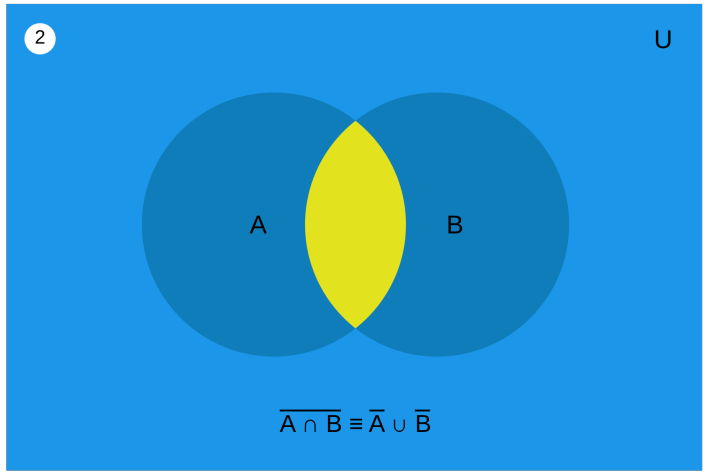
```
(
    !
1   (
        &
        (co=Albania)
2       (
            |
            (l=Kukës)
3           (l=Tiranë)
        )
    )
)
```

not (A or B) = (not A) and (not B)

not (A and B) = (not A) or (not B)

Obfuscation::Filter::BooleanOperator





obfuscation

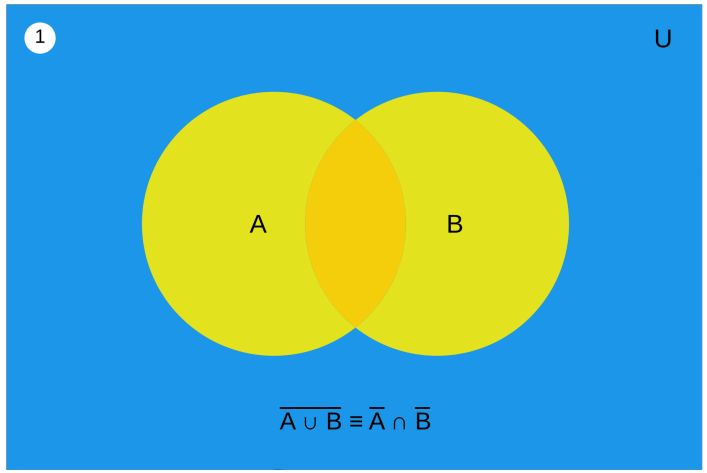
(De Morgan's laws)

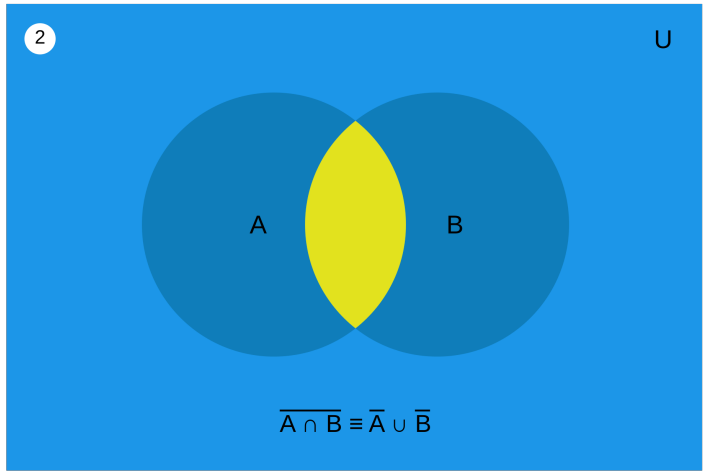
```
(
  !
1 (
    |
    (co=Albania)
2   (
      &
      (l=Kukës)
3     (l=Tiranë)
    )
  )
)
```

not (A or B) = (not A) and (not B)

not (A and B) = (not A) or (not B)

Obfuscation::Filter::BooleanOperator





obfuscation

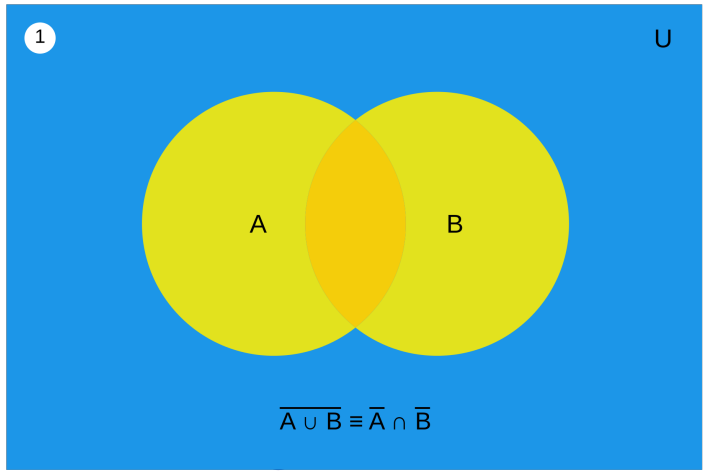
(De Morgan's laws)

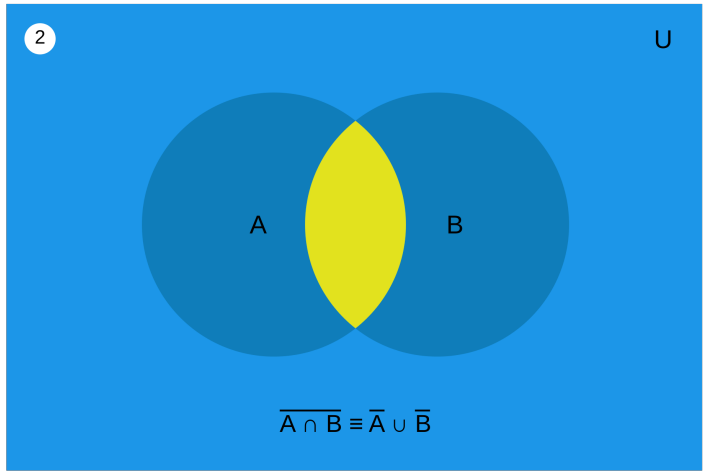
```
(
    !
1   (
        |
        (co=Albania)
2       (
            &
            (l=Kukës)
3           (l=Tiranë)
        )
    )
)
```

not (A or B) = (not A) and (not B)

not (A and B) = (not A) or (not B)

Obfuscation::Filter::BooleanOperator





obfuscation

(De Morgan's laws)

```
(
    !
1   (
        |
        (!co=Albania)
2       (
            &
            (!l=Kukës)
3           (!l=Tiranë)
        )
    )
)
```

not (A or B) = (not A) and (not B)

not (A and B) = (not A) or (not B)

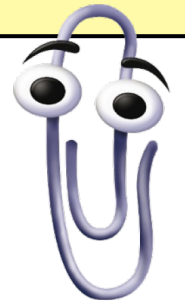
Obfuscation::Filter::BooleanOperator

- BooleanOperator obfuscation
  - Additive
    - `(co=Albania)`
    - `(|(&(((((|(|(co=Albania))))))))))`
  - Double negation
    - `(|(&((!((!(|(|(co=Albania))))))))))`
    - `(!(!l=Kukës))`
  - Logical inversion (De Morgan's laws)
    - `(&(co=Albania)(|(l=Kukës)(l=Tiranë)))`
    - `(!(|(!co=Albania)(&(!l=Kukës)(!l=Tiranë))))`

Obfuscation::Filter::BooleanOperator

- BooleanOperator obfuscation
  - Additive
    - (cn=Albanla)
    - (&(&(&(&(&(&(&(&(&(cn=Albanla))))))))))
  - Double Negation
    - (!(!(&(!(!(!(!(cn=Albanla)))))))))
    - (&(l=Kubds))
  - Logical Inversion (De Morg
    - (&(cn=Albanla)(!(l=Kubds)(!
    - (&(&(cn=Albanla)(&(l=Kubds)(&(

What is my LEAST favorite LDAP token type?

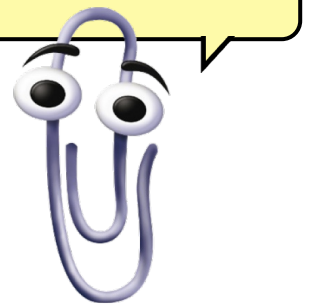


Obfuscation::Filter::BooleanOperator

- BooleanOperator obfuscation
  - Additive
    - (cn=Albania)
    - (!(!(&(!(!(cn=Albania))))))
  - Double Negation
    - (!(!(&(!(!(!(!(cn=Albania))))))))
    - (&(l=Kubds))
  - Logical Inversion (De Morg
    - (&(cn=Albania)(!(l=Kubds)(!
    - (&(|(cn=Albania)(&(l=Kubds)(&

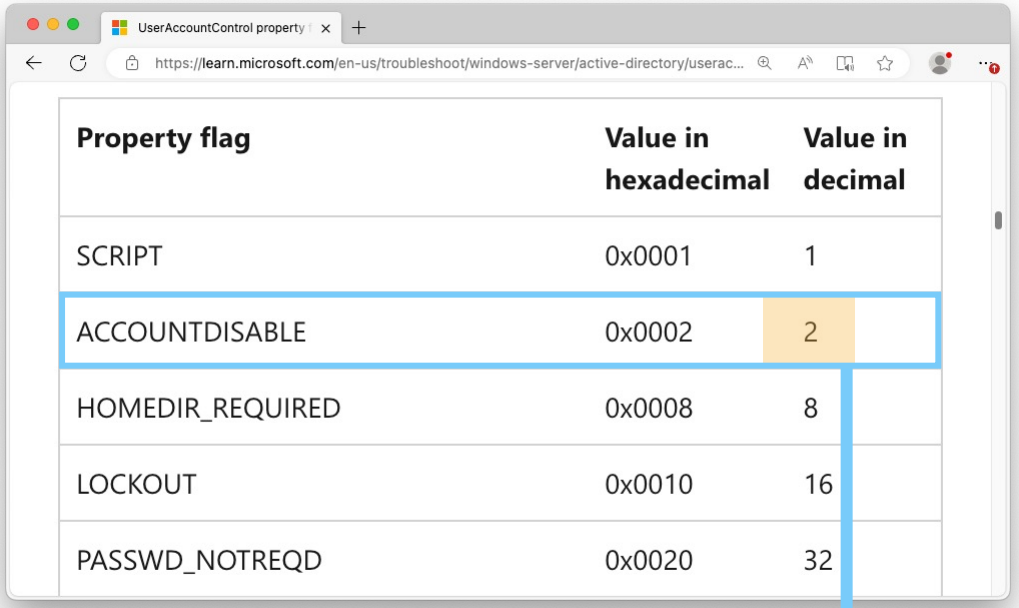
What is my LEAST favorite LDAP token type?

The BooleanOperator – because I'm afraid of getting tied up in NOTs (!)



Obfuscation::Filter::ExtensibleMatchFilter

- ExtensibleMatchFilter obfuscation



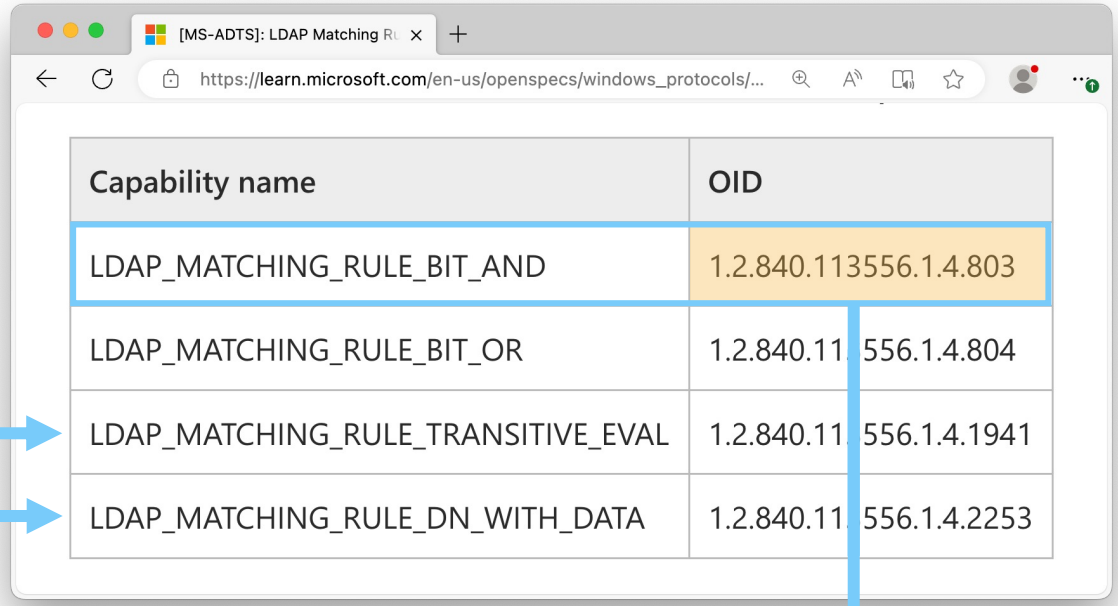
Property flag	Value in hexadecimal	Value in decimal
SCRIPT	0x0001	1
ACCOUNTDISABLE	0x0002	2
HOMEDIR_REQUIRED	0x0008	8
LOCKOUT	0x0010	16
PASSWD_NOTREQD	0x0020	32

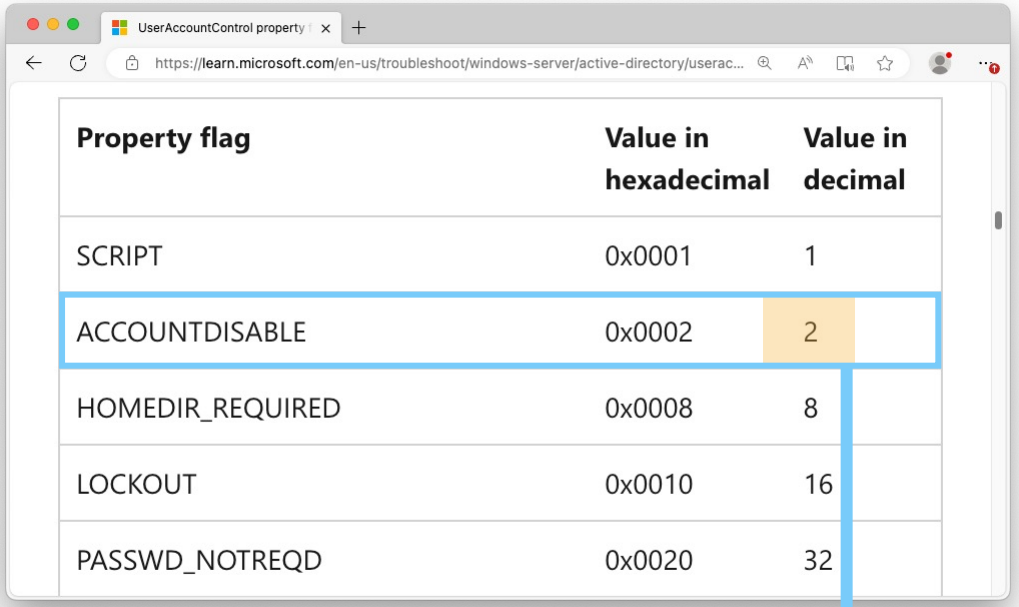
"Object is NOT disabled."

```
(!(userAccountControl:1.2.840.113556.1.4.803:=2))
```

Obfuscation::Filter::ExtensibleMatchFilter

- ExtensibleMatchFilter obfuscation



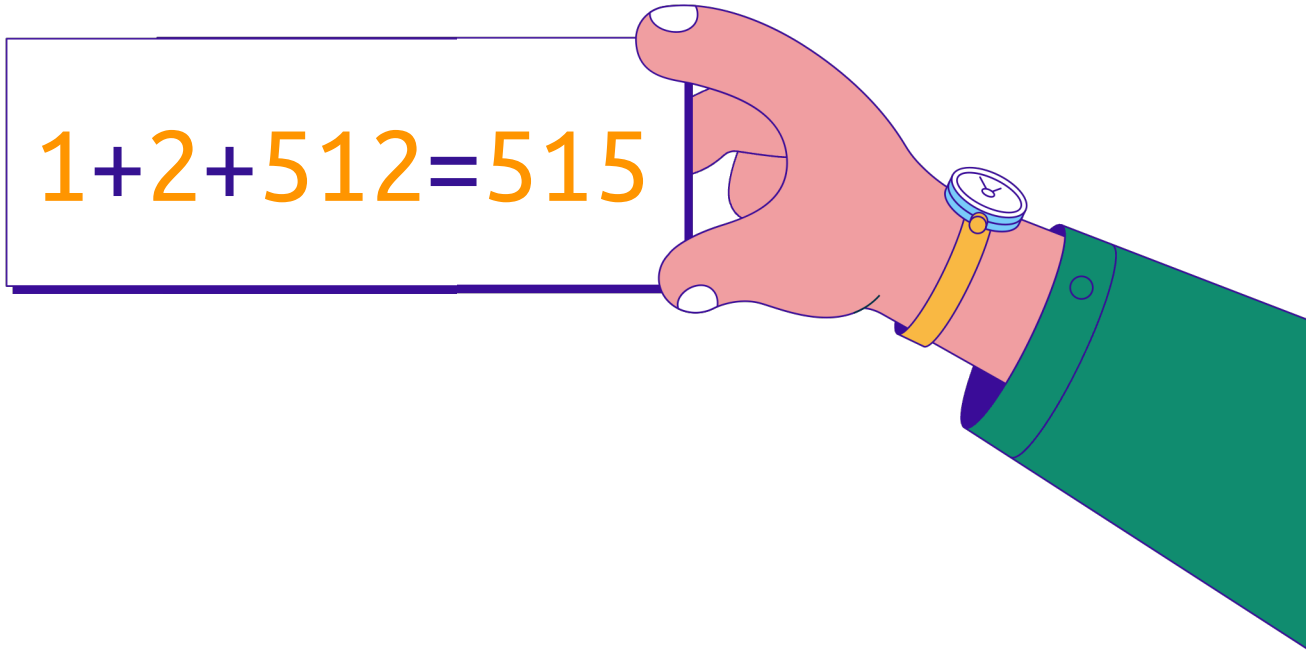


"Object is NOT disabled."

```
(!(userAccountControl:1.2.840.113556.1.4.803:=2))
```

Obfuscation::Filter::ExtensibleMatchFilter

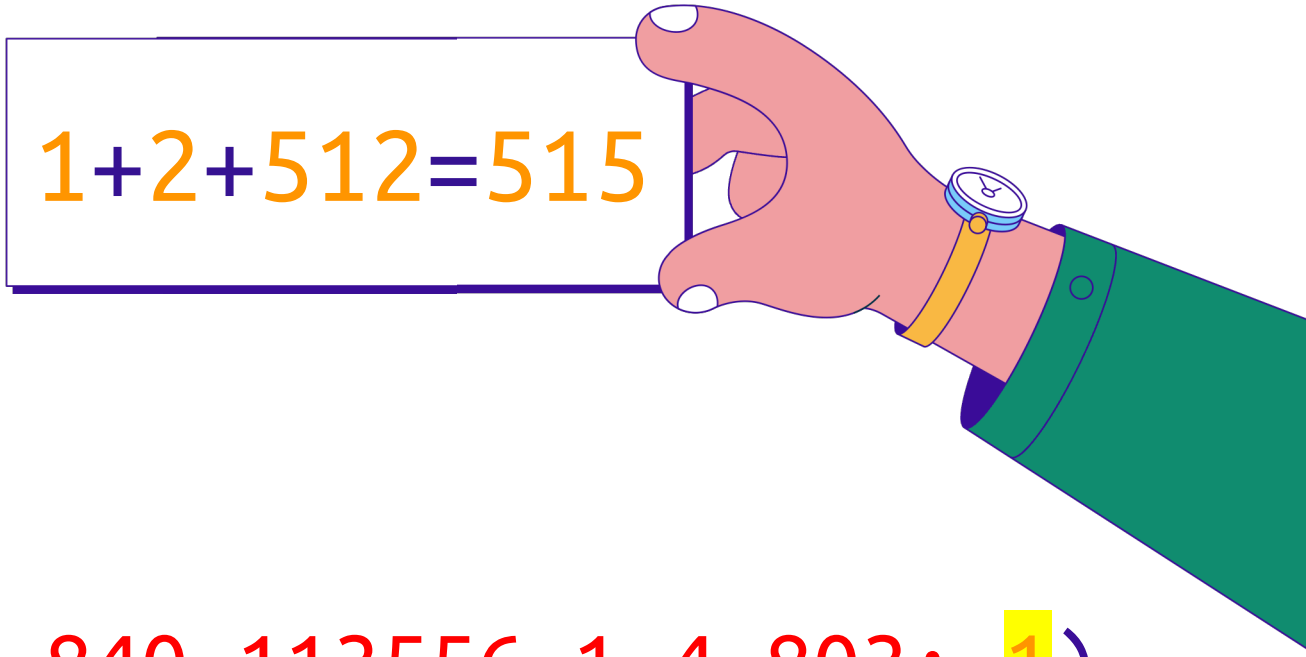
- ExtensibleMatchFilter obfuscation
  - Bitwise breakout (AND/OR)




```
(userAccountControl:1.2.840.113556.1.4.803:=515)
```

Obfuscation::Filter::ExtensibleMatchFilter

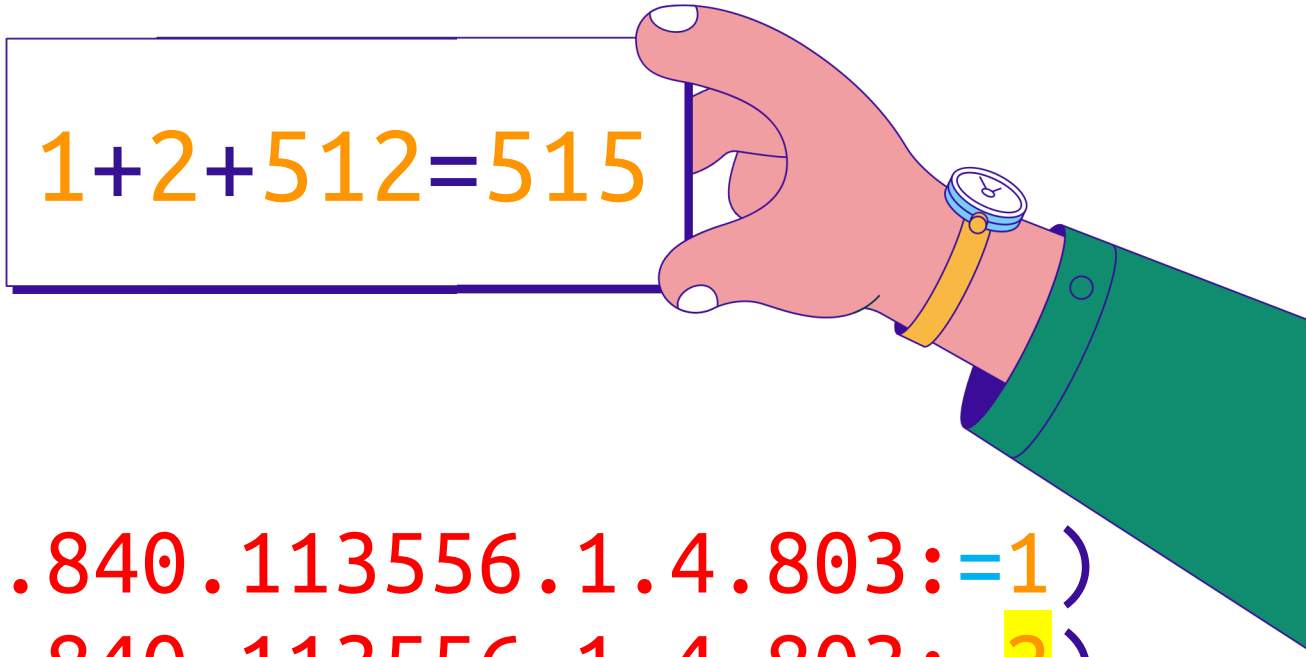
- ExtensibleMatchFilter obfuscation
  - Bitwise breakout (AND/OR)




```
(
   &
   (userAccountControl:1.2.840.113556.1.4.803:=1)
   (userAccountControl:1.2.840.113556.1.4.803:=514)
)
```

Obfuscation::Filter::ExtensibleMatchFilter

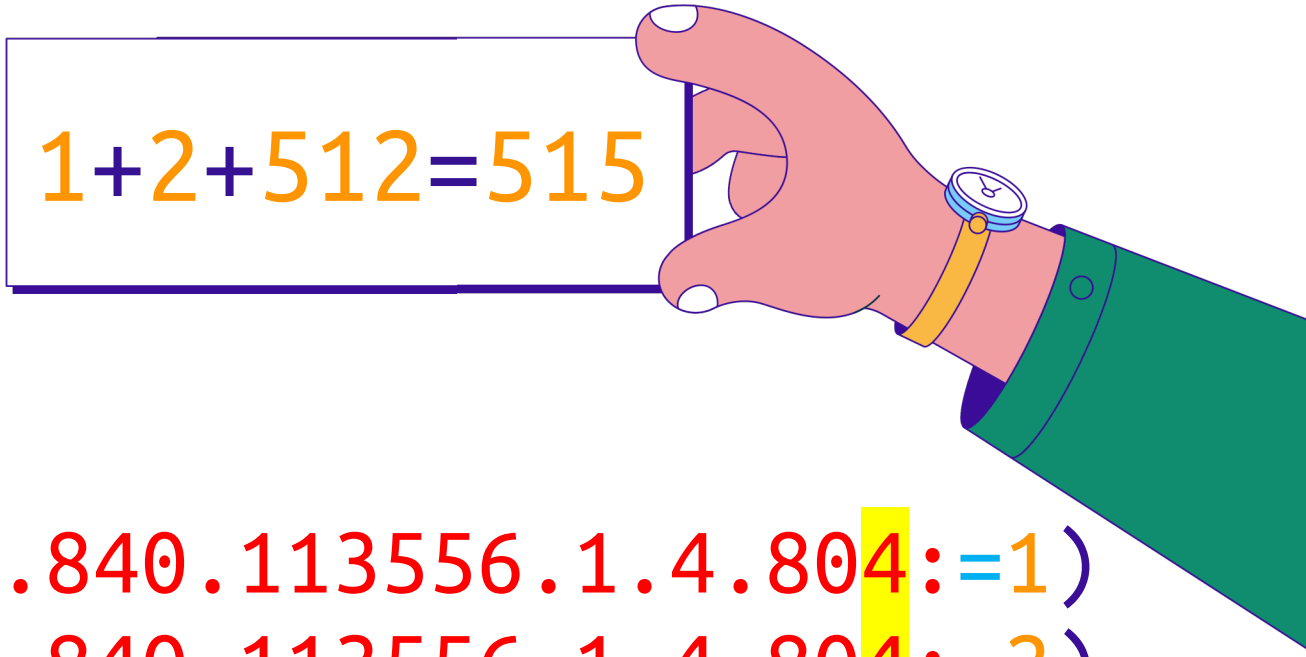
- ExtensibleMatchFilter obfuscation
  - Bitwise breakout (AND/OR)




```
(
   &
   (userAccountControl:1.2.840.113556.1.4.803:=1)
   (userAccountControl:1.2.840.113556.1.4.803:=2)
   (userAccountControl:1.2.840.113556.1.4.803:=512)
)
```

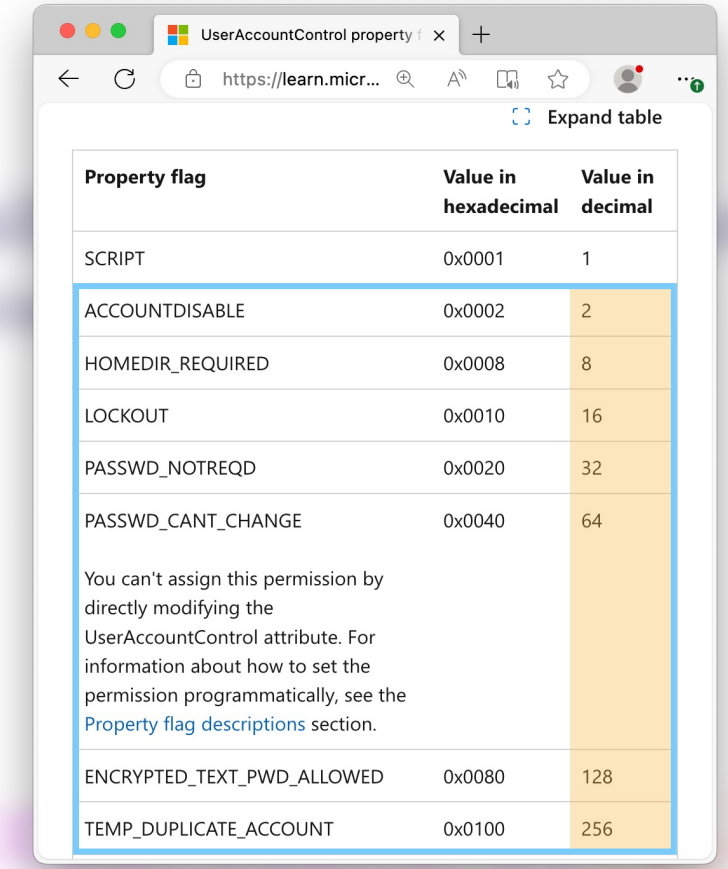
Obfuscation::Filter::ExtensibleMatchFilter

- ExtensibleMatchFilter obfuscation
  - Bitwise breakout (AND/OR)

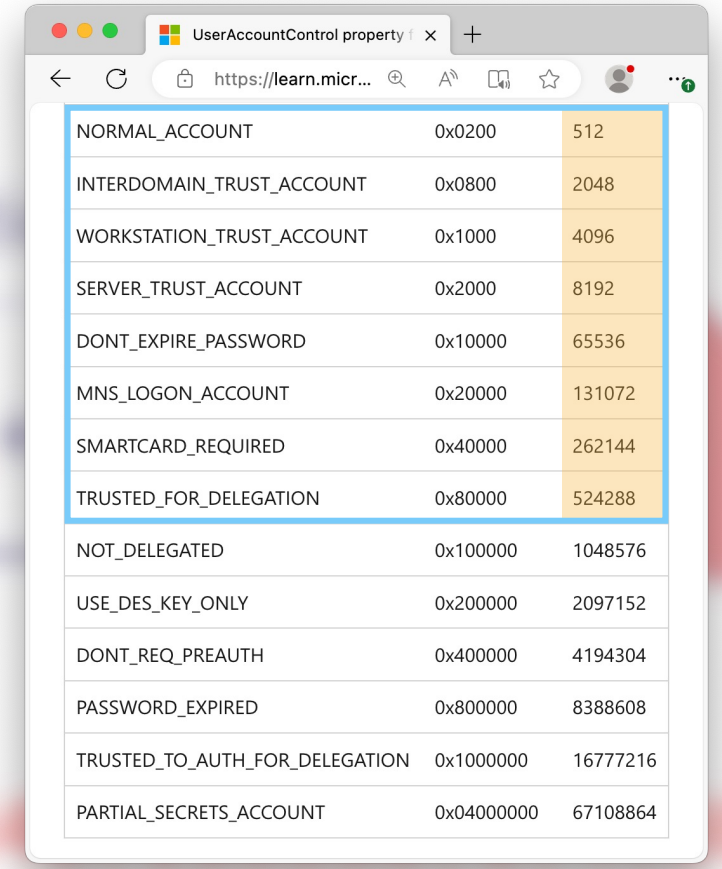



```
(
   |
   (userAccountControl:1.2.840.113556.1.4.804:=1)
   (userAccountControl:1.2.840.113556.1.4.804:=2)
   (userAccountControl:1.2.840.113556.1.4.804:=512)
)
```

Obfuscation::Filter::ExtensibleMatchFilter



Property flag	Value in hexadecimal	Value in decimal
SCRIPT	0x0001	1
ACCOUNTDISABLE	0x0002	2
HOMEDIR_REQUIRED	0x0008	8
LOCKOUT	0x0010	16
PASSWD_NOTREQD	0x0020	32
PASSWD_CANT_CHANGE You can't assign this permission by directly modifying the UserAccountControl attribute. For information about how to set the permission programmatically, see the Property flag descriptions section.	0x0040	64
ENCRYPTED_TEXT_PWD_ALLOWED	0x0080	128
TEMP_DUPLICATE_ACCOUNT	0x0100	256



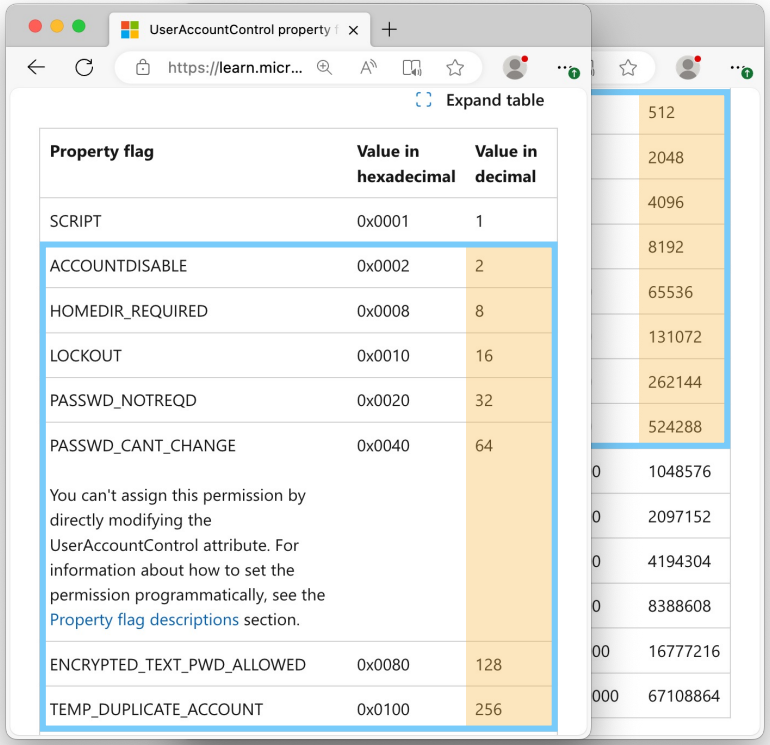
NORMAL_ACCOUNT	0x0200	512
INTERDOMAIN_TRUST_ACCOUNT	0x0800	2048
WORKSTATION_TRUST_ACCOUNT	0x1000	4096
SERVER_TRUST_ACCOUNT	0x2000	8192
DONT_EXPIRE_PASSWORD	0x10000	65536
MNS_LOGON_ACCOUNT	0x20000	131072
SMARTCARD_REQUIRED	0x40000	262144
TRUSTED_FOR_DELEGATION	0x80000	524288
NOT_DELEGATED	0x100000	1048576
USE_DES_KEY_ONLY	0x200000	2097152
DONT_REQ_PREAUTH	0x400000	4194304
PASSWORD_EXPIRED	0x800000	8388608
TRUSTED_TO_AUTH_FOR_DELEGATION	0x1000000	16777216
PARTIAL_SECRETS_ACCOUNT	0x04000000	67108864

```
Write-Verbose '[Get-DomainUser] Searching for users who can be delegated'
# negation of "Accounts that are sensitive and not trusted for delegation"
$Filter += '(!(userAccountControl:1.2.840.113556.1.4.803:=1048574))'
```

(!(userAccountControl:1.2.840.113556.1.4.803:=1048574))

Obfuscation::Filter::ExtensibleMatchFilter

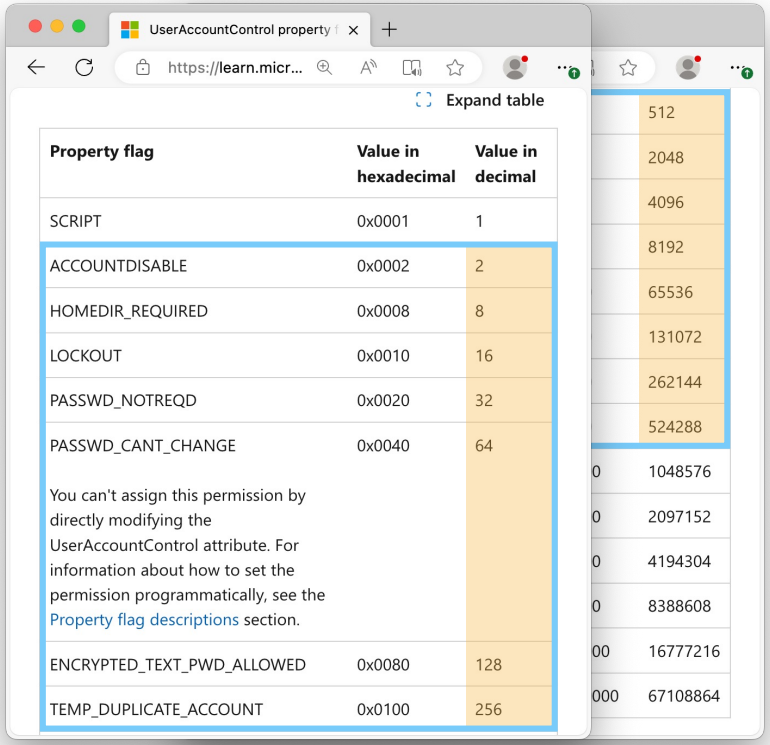
- ExtensibleMatchFilter obfuscation
  - Bitwise breakout (AND/OR)
  - Bitwise breakout (exact)
    - **AND**
      - **AND'd 1 bits**
      - **NOT OR'd 0 bits**




```
(userAccountControl=1048574)
```

Obfuscation::Filter::ExtensibleMatchFilter

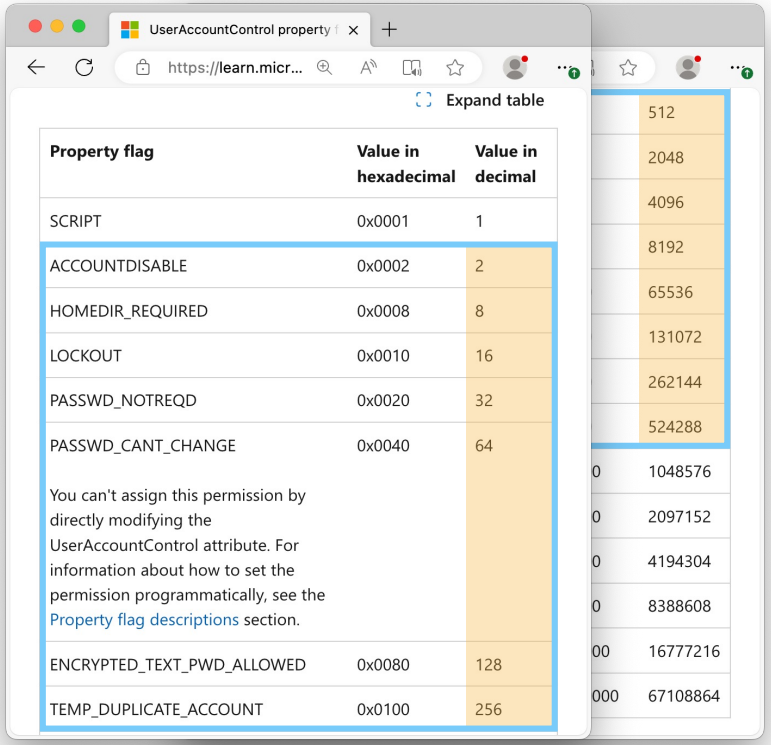
- ExtensibleMatchFilter obfuscation
  - Bitwise breakout (AND/OR)
  - Bitwise breakout (exact)
    - **AND**
      - **AND'd 1 bits**
      - **NOT OR'd 0 bits**




```
(
   &
   (userAccountControl:1.2.840.113556.1.4.803:=1048574)
   (!(userAccountControl:1.2.840.113556.1.4.804:=4293918721))
)
```

Obfuscation::Filter::ExtensibleMatchFilter

- ExtensibleMatchFilter obfuscation
  - Bitwise breakout (AND/OR)
  - Bitwise breakout (exact)
    - **AND**
      - **AND'd 1 bits**
      - **NOT OR'd 0 bits**




```
(
   &
   (userAccountControl:1.2.840.113556.1.4.803:=342294)
   (userAccountControl:1.2.840.113556.1.4.803:=706280)
   (!(userAccountControl:1.2.840.113556.1.4.804:=328204289))
   (!(userAccountControl:1.2.840.113556.1.4.804:=3965714432))
)
```

Obfuscation::Filter::ExtensibleMatchFilter

- ExtensibleMatchFilter obfuscation
  - Bitwise breakout (AND/OR)
    - `(userAccountControl:1.2.840.113556.1.4.803:=515)`
    - `(&(userAccountControl:1.2.840.113556.1.4.803:=1)`
      `(userAccountControl:1.2.840.113556.1.4.803:=514))`
  - Bitwise breakout (exact)
    - `(userAccountControl=1048574)`
    - `(&(userAccountControl:1.2.840.113556.1.4.803:=342294)`
      `(userAccountControl:1.2.840.113556.1.4.803:=706280)`
      `(!(userAccountControl:1.2.840.113556.1.4.804:=328204289))`
      `(!(userAccountControl:1.2.840.113556.1.4.804:=3965714432)))`

Obfuscation::Filter::Value

- Value obfuscation
  - Casing
    - Excluding Attributes with Value formats **Boolean**, **SID**, **HexObjectReplicaLink**, etc.

```
(name=krbtgt)
```

Obfuscation::Filter::Value

- Value obfuscation
  - Casing
    - Excluding Attributes with Value formats **Boolean**, **SID**, **HexObjectReplicaLink**, etc.

```
(name=kRBtgT)
```

Obfuscation::Filter::Value

- Value obfuscation
  - Casing
  - Prepended 0's

```
(sAMAccountName=805306368)
  (logonCount>=-1)
```

Obfuscation::Filter::Value

- Value obfuscation
  - Casing
  - Prepended 0's

```
(sAMAccountName=0000805306368)
  (logonCount>=-0000001)
```

Obfuscation::Filter::Value

- Value obfuscation
  - Casing
  - Prepended 0's
  - Timestamps

```
(whenCreated=20080217112855.000Z)
```

Obfuscation::Filter::Value

- Value obfuscation
  - Casing
  - Prepended 0's
  - Timestamps

(whenCreated=20080217112855.1337KaZanPlehrash)

Obfuscation::Filter::Value

- Value obfuscation
  - Casing
  - Prepended 0's
  - Timestamps

(whenCreated=20080217112855.1337KaZanPlehrash)

\5A
\5a

Obfuscation::Filter::Value

- Value obfuscation
  - Casing
  - Prepended 0's
  - Timestamps
  - Hex encoding

Character	Hex Representation
*	\2A
(	\28
)	\29
\	\5C
Nul	\00

Character	Hex Representation
á	\E1
é	\E9
í	\ED
ó	\F3
ú	\FA
ñ	\F1

```
(name=krbtgt)
```

Obfuscation::Filter::Value

- Value obfuscation
  - Casing
  - Prepended 0's
  - Timestamps
  - Hex encoding

Character	Hex Representation
*	\2A
(	\28
)	\29
\	\5C
Nul	\00

Character	Hex Representation
á	\E1
é	\E9
í	\ED
ó	\F3
ú	\FA
ñ	\F1

```
(name=krb\74g\74)
```

Obfuscation::Filter::Value

- Value obfuscation
  - Casing
  - Prepended 0's
  - Timestamps
  - Hex encoding

Character	Hex Representation
*	\2A
(	\28
)	\29
\	\5C
Nul	\00

Character	Hex Representation
á	\E1
é	\E9
í	\ED
ó	\F3
ú	\FA
ñ	\F1

(name=krb\74g\74)

In LDAP filters these characters should be escaped with the backslash escape character, followed by the **two character** ASCII hexadecimal representation of the character.

\00 → \0

\0A → \A

Obfuscation::Filter::Value

- Value obfuscation
  - Casing
  - Prepended 0's
  - Timestamps
  - Hex encoding
  - Wildcards

```
(name=krbtgt)
```

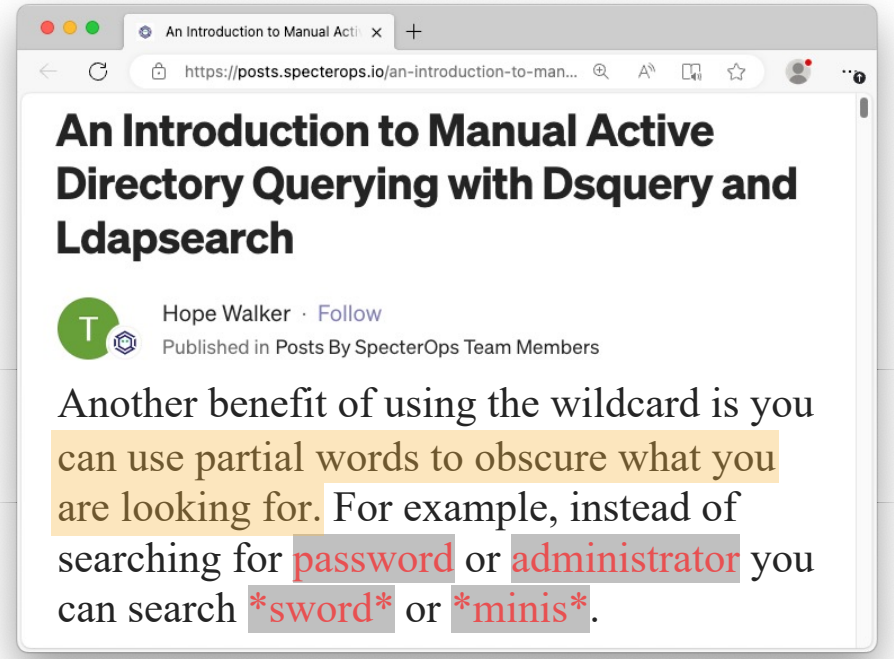
Obfuscation::Filter::Value

- Value obfuscation
  - Casing
  - Prepended 0's
  - Timestamps
  - Hex encoding
  - Wildcards

```
(name=*rb*g*)
```

Obfuscation::Filter::Value

- Value obfuscation
  - Casing
  - Prepended 0's
  - Timestamps
  - Hex encoding
  - Wildcards



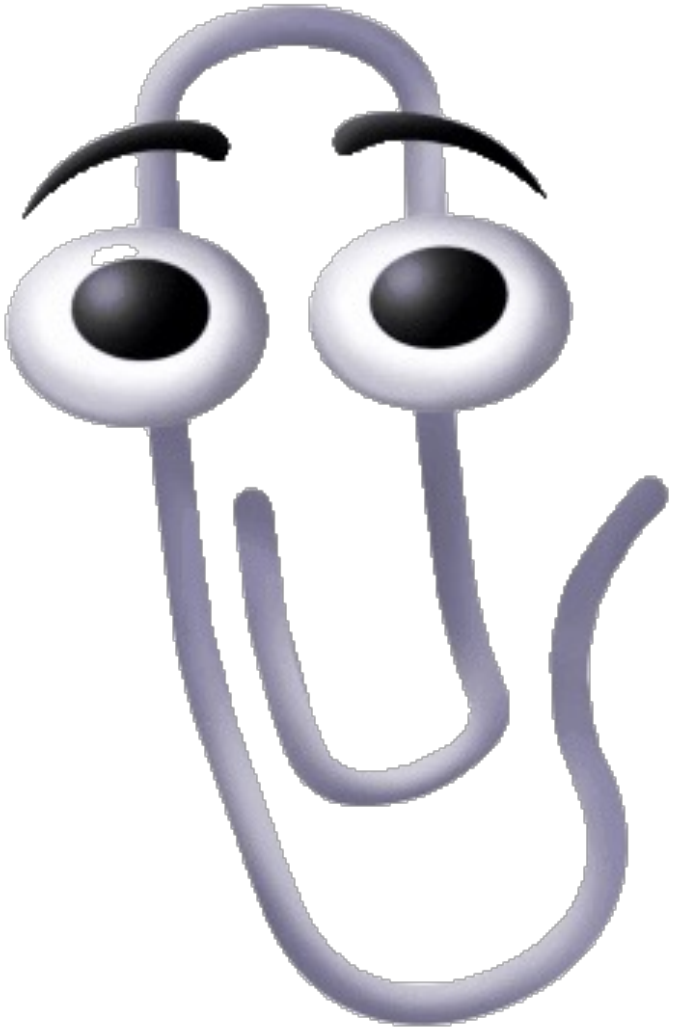

```
(name=*rb*g*)
```

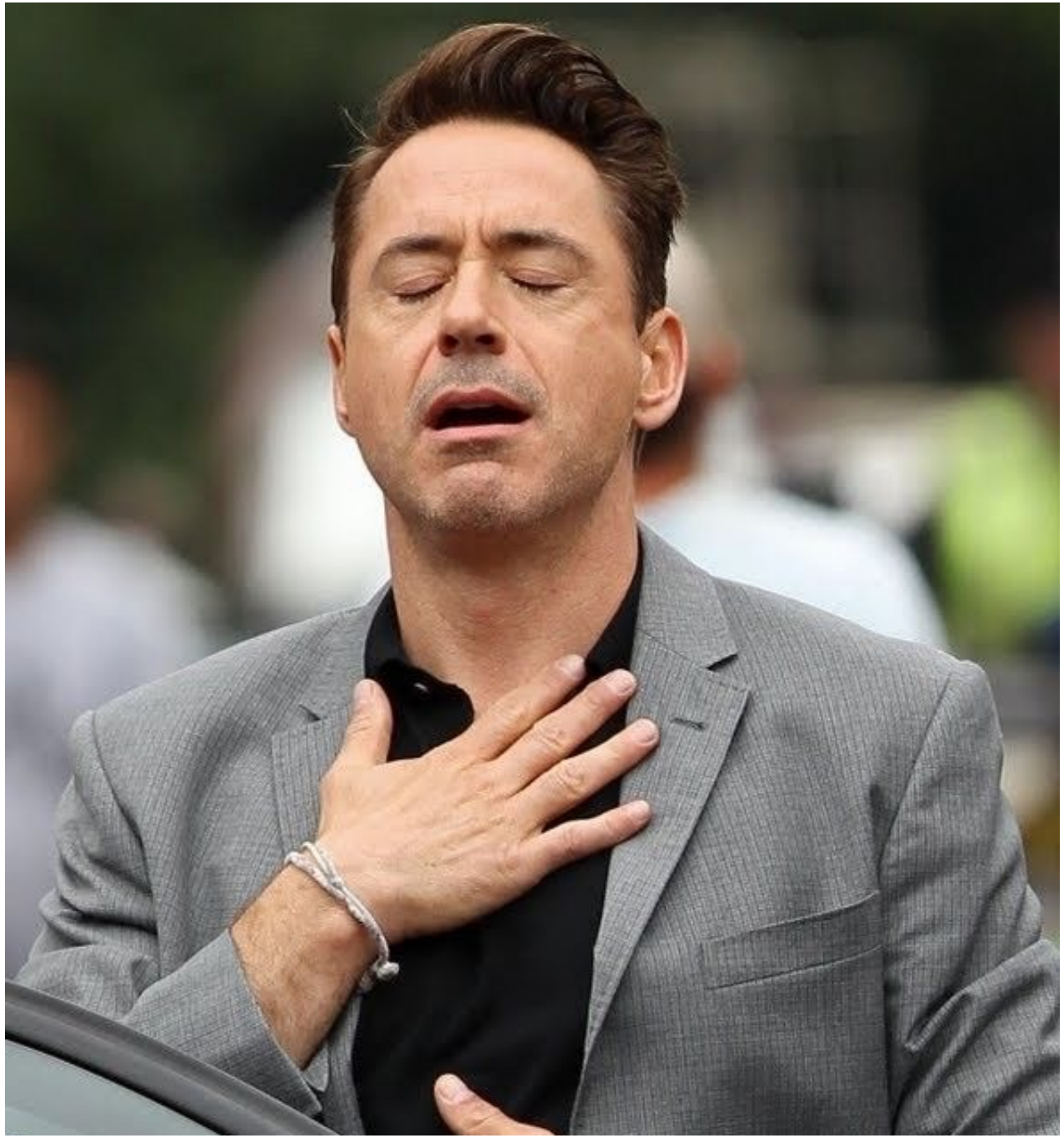
- **Hope Walker** (@Icemoonhsv) - SpecterOps
  - https://posts.specterops.io/an-introduction-to-manual-active-directory-querying-with-dsquery-and-ldapsearch-84943c13d7eb
  - https://posts.specterops.io/manual-ldap-querying-part-2-8a65099e12e3

Obfuscation::Filter::Value

- Value obfuscation
  - Casing
    - (name=kRBtgT)
  - Prepended 0's
    - (sAMAccountName=0000805306368)
    - (logonCount>=-0000001)
  - Timestamps
    - (whenCreated=20080217112855.1337KaZanPlehrash)
  - Hex encoding
    - (name=krb\74g\74)
  - Wildcards
    - (name=*rb*g*)

Obfuscation::Filter::That'sAll!





Obfuscation::Filter::Additional


```
(!(userAccountControl:1.2.840.113556.1.4.803:=2))
```

BooleanOperator

ExtensibleMatchFilter

3

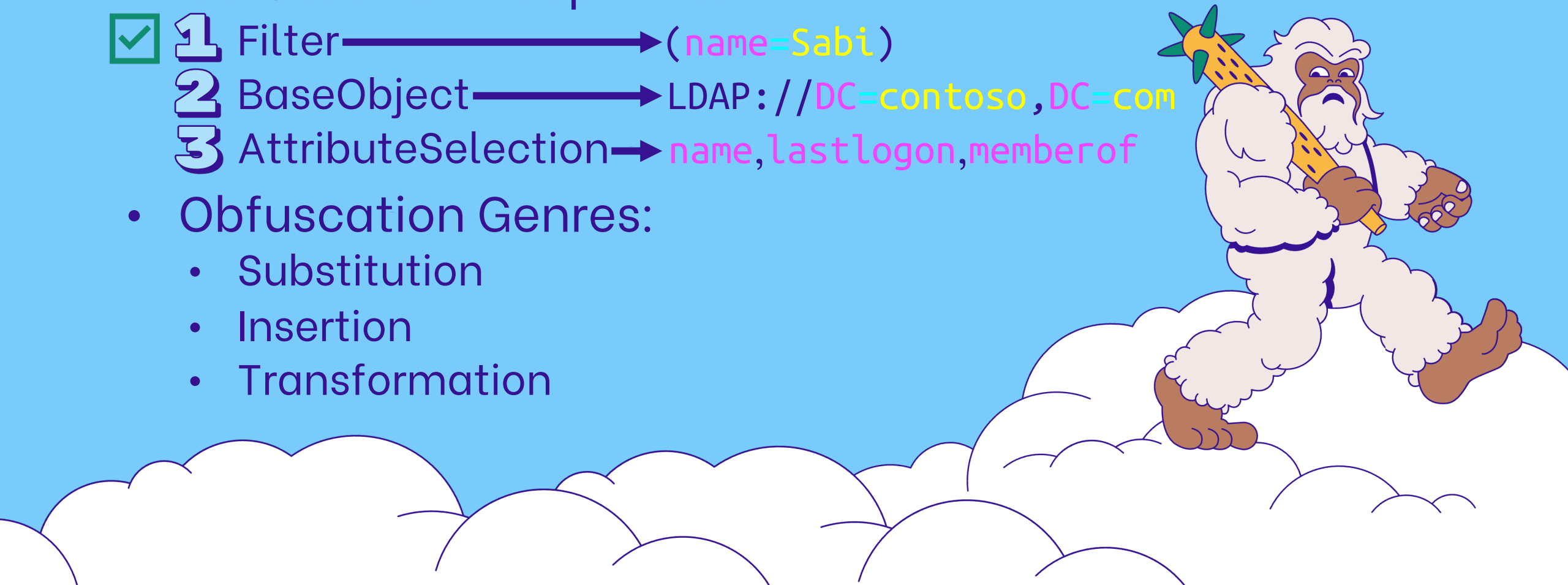
4

Obfuscation::Filter::Additional

- Filter-wide obfuscation
  - GroupStart/GroupEnd
    - `(((((name=krbtgt)))))`
  - Whitespace (newline, tab, whitespace, etc.)
    - `   (    (    (  (  (    name=  krbtgt)  )  )    )  )  `
  - Garbage filters
    - `(&(name=KushJamUne?)(name=krbtgt)(name=NukEDi!))`
    - `(|(un(e:J((am:=)s)a(b))i)(name=krbtgt)($}_=+;/@-))`
  - Filter/FilterList reordering

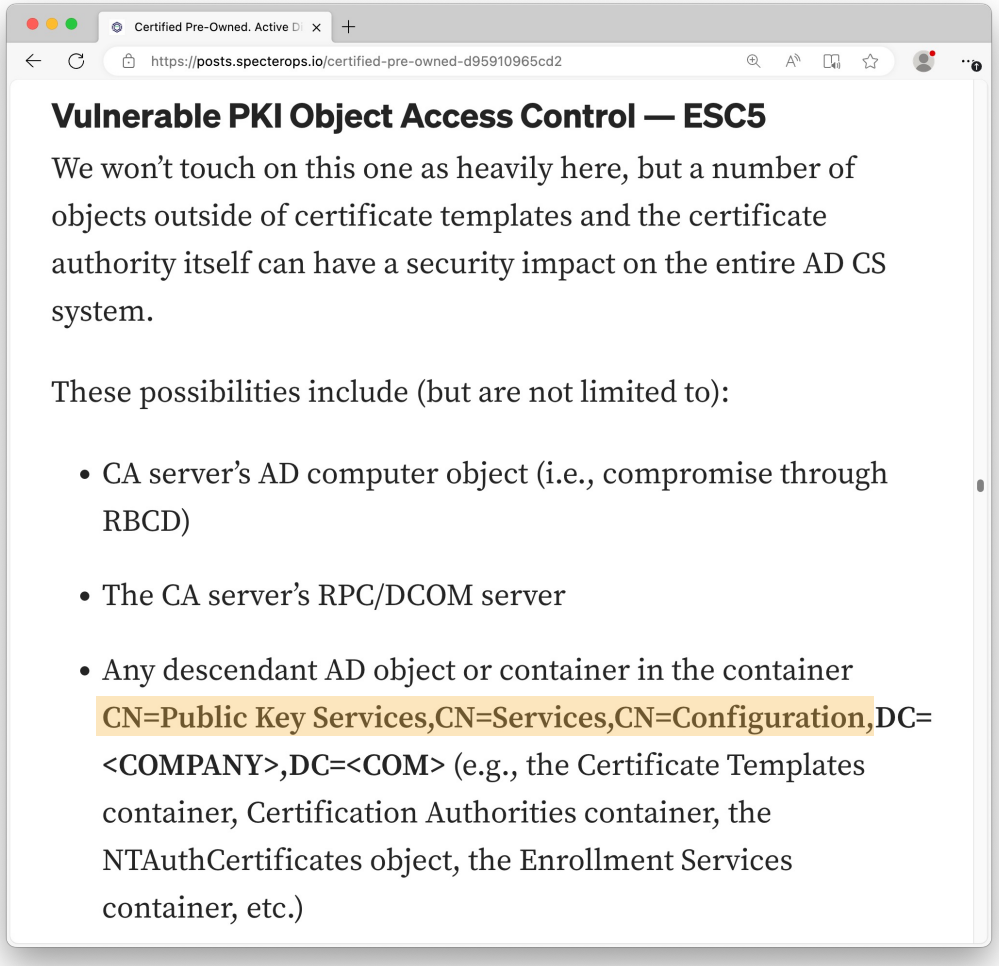
Obfuscating LDAP: 3 Deep Dives * 3 Genres

- Obfuscation Deep Dives:
  - ☑ 1 Filter → `(name=Sabi)`
  - 2 BaseObject → `LDAP://DC=contoso,DC=com`
  - 3 AttributeSelection → `name,lastlogon,memberof`
- Obfuscation Genres:
  - Substitution
  - Insertion
  - Transformation



Obfuscation::BaseObject

- BaseObject
  - LDAP://DC=contoso,DC=com
  - LDAP://CN=Public Key Services,CN=Services,CN=Configuration,DC=contoso,DC=com




```
// Container location per MS-WCCE 2.2.2.11.2 Enrollment Services Container
// - https://docs.microsoft.com/en-us/openspecs/windows_protocols/ms-wcce/3ec073ec-9b91-4bee-964e-56f22a93a28c
var root = new DirectoryEntry($"LDAP://{LdapServer}CN=Public Key Services,CN=Services,{ConfigurationPath}");
```

Obfuscation::BaseObject

- BaseObject

```
LDAP://DC=contoso,DC=com
```

Obfuscation::BaseObject

- BaseObject
  - Casing

LDAP://dC=coNToSo,dc=cOM

Obfuscation::BaseObject

- BaseObject
  - Casing
  - Hex encoding

LDAP://dC=co\4eToS\6F,dc=\63\4fM

Obfuscation::BaseObject

- BaseObject
  - Casing
  - Hex encoding
  - OID (Object Identifiers) notation

```
LDAP://0.9.2342.19200300.100.1.25=co\4eToS\6F,0.9.2342.19200300.100.1.25=\63\4fM
```

Obfuscation::BaseObject

- BaseObject
  - Casing
  - Hex encoding
  - OID (Object Identifiers) notation
  - Prepended 0's

```
LDAP://0.9.0002342.19200300.100.1.25=co\4eToS\6F,OId.000.9.2342.19200300.100.0001.25=\63\4fM
```

Obfuscation::BaseObject

- BaseObject
  - Casing
  - Hex encoding
  - OID (Object Identifiers) notation
  - Prepended 0's
  - Whitespace

```
LDAP: / / 0.9.0002342.19200300.100.1.25 = co\4eToS\6F ,OId.000.9.2342.19200300.100.0001.25 = \63\4fM
```

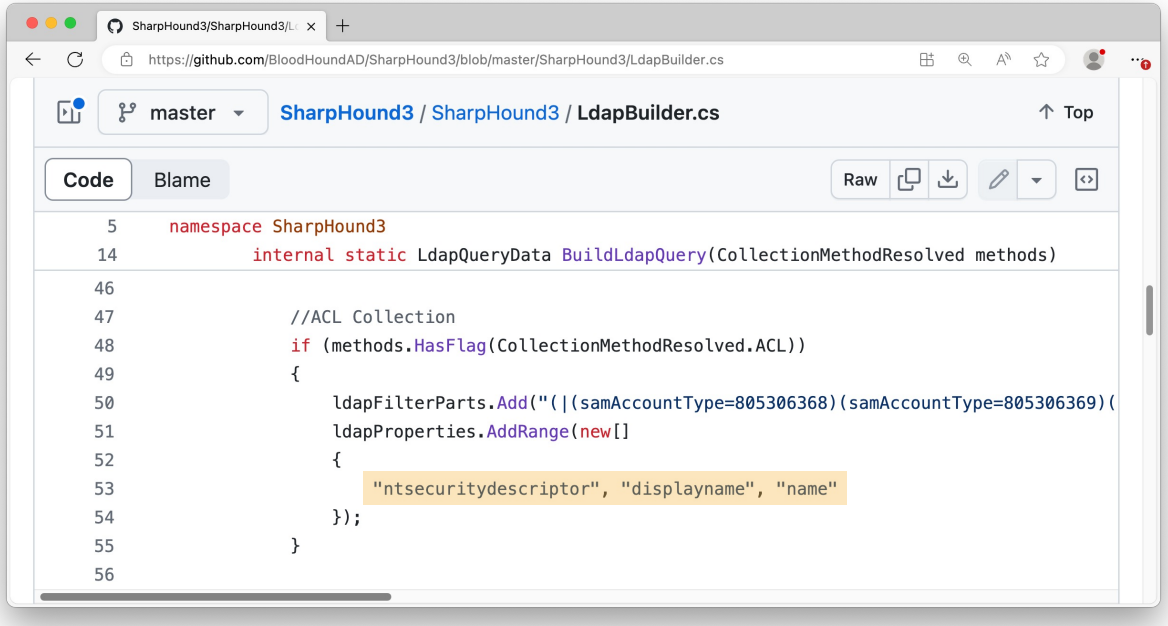
Obfuscation::BaseObject

- BaseObject
  - Casing
  - Hex encoding
  - OID (Object Identifiers) notation
  - Prepended 0's
  - Whitespace
  - Double quotes

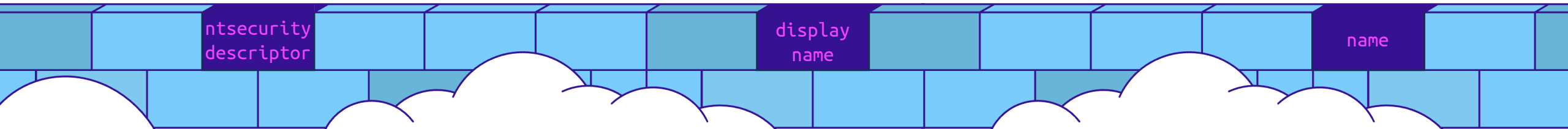
```
LDAP: / /  0.9.0002342.19200300.100.1.25 = "coNToSo" , OId.000.9.2342.19200300.100.0001.25 =  \63\4fM
```

Obfuscation::AttributeSelection

- AttributeSelection

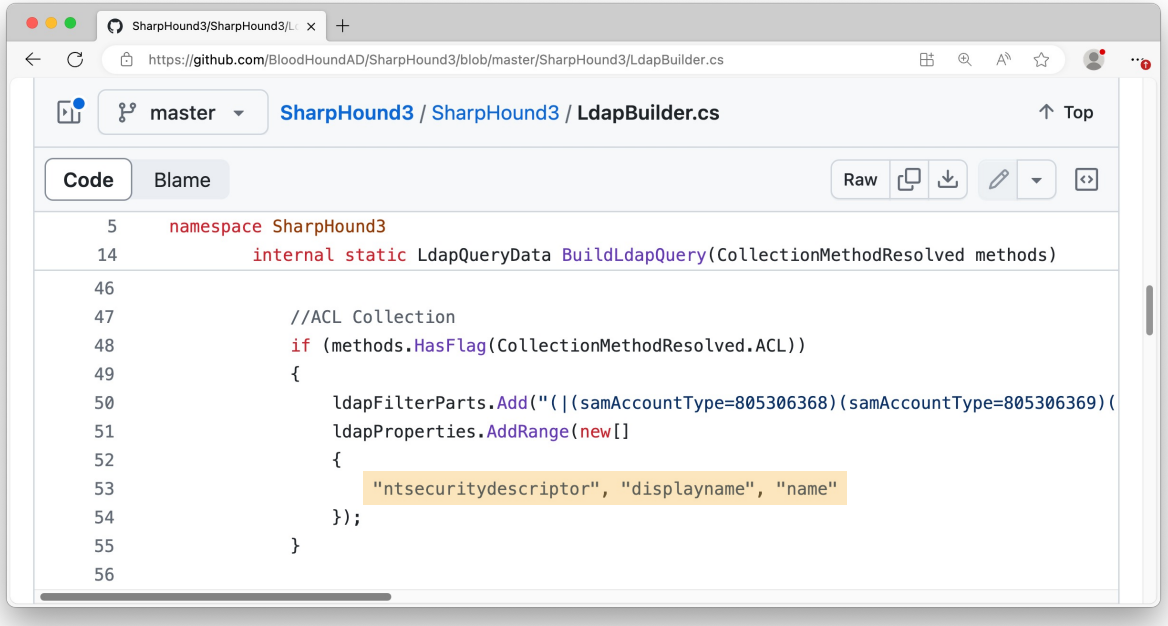


ntsecuritydescriptor,displayname,name

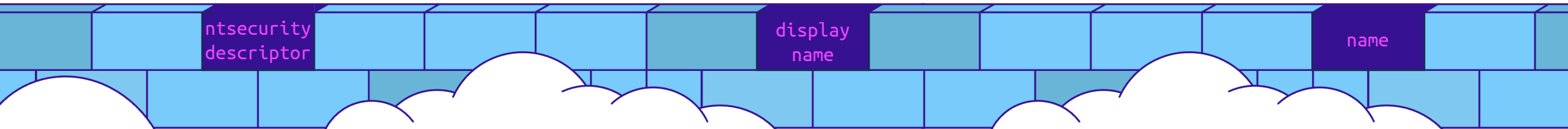


Obfuscation::AttributeSelection

- AttributeSelection
  - Casing

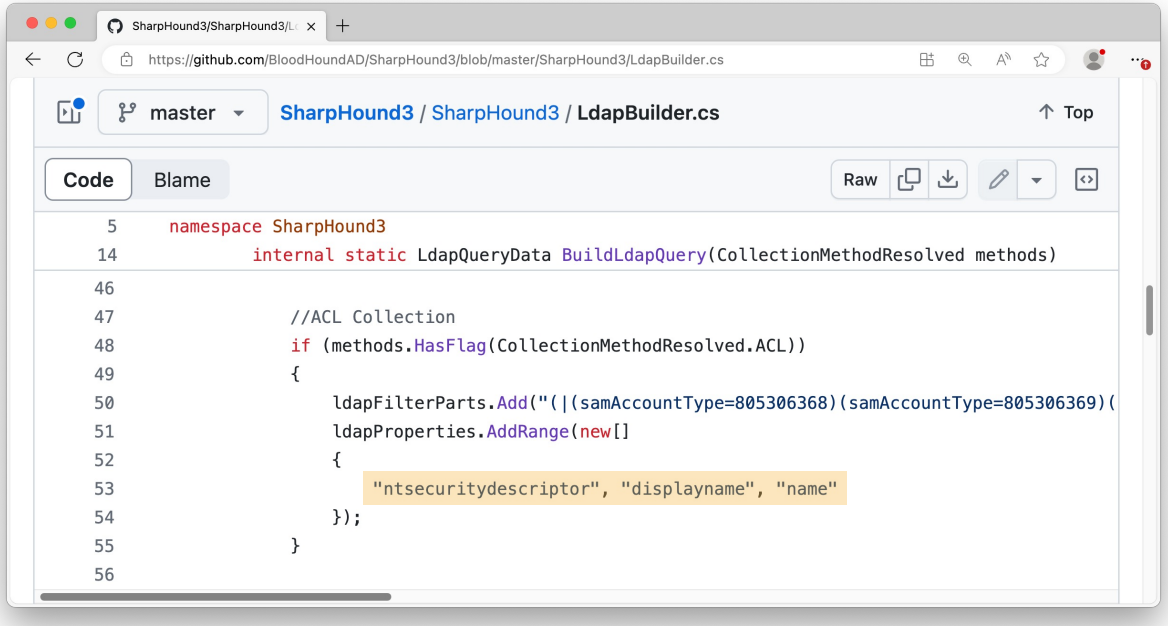


ntSECurITydeSCRIPTor,displayNAme,naMe

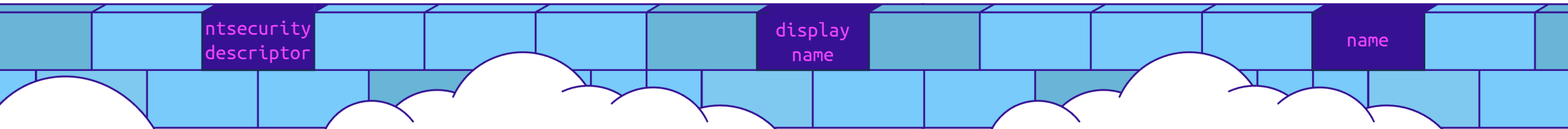


Obfuscation::AttributeSelection

- AttributeSelection
  - Casing
  - OID (Object Identifiers) notation

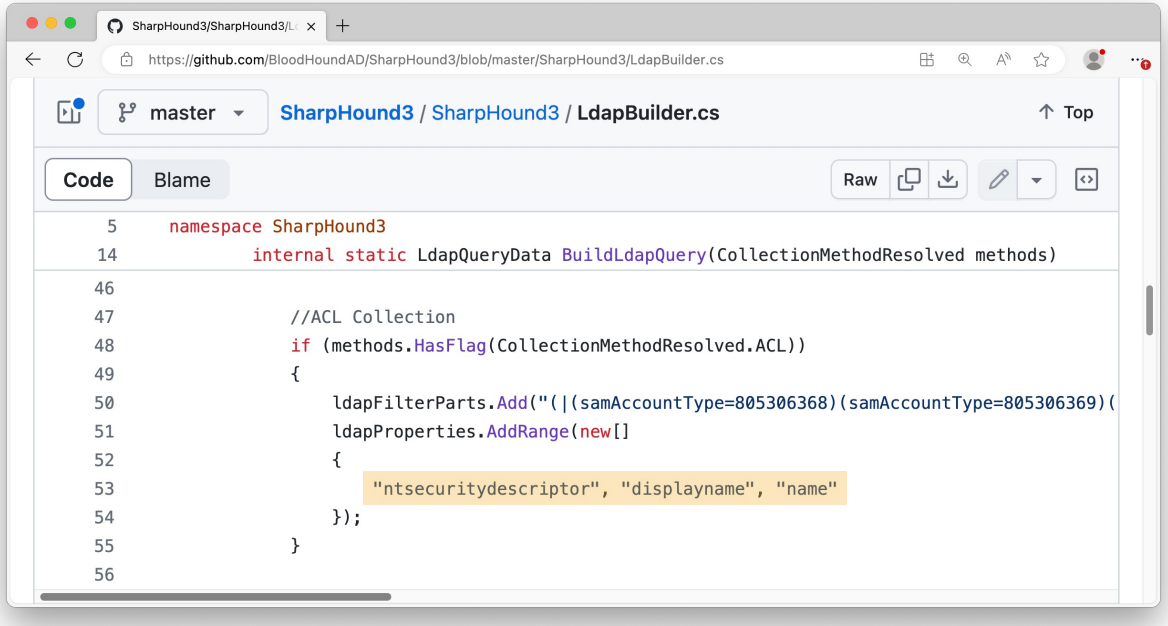


1.2.840.113556.1.2.281,displayNAme,naMe

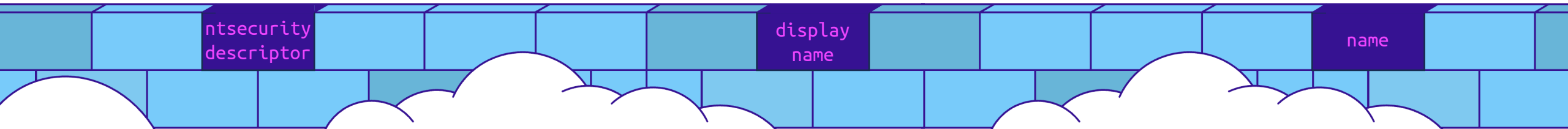


Obfuscation::AttributeSelection

- AttributeSelection
  - Casing
  - OID (Object Identifiers) notation
  - Prepended 0's

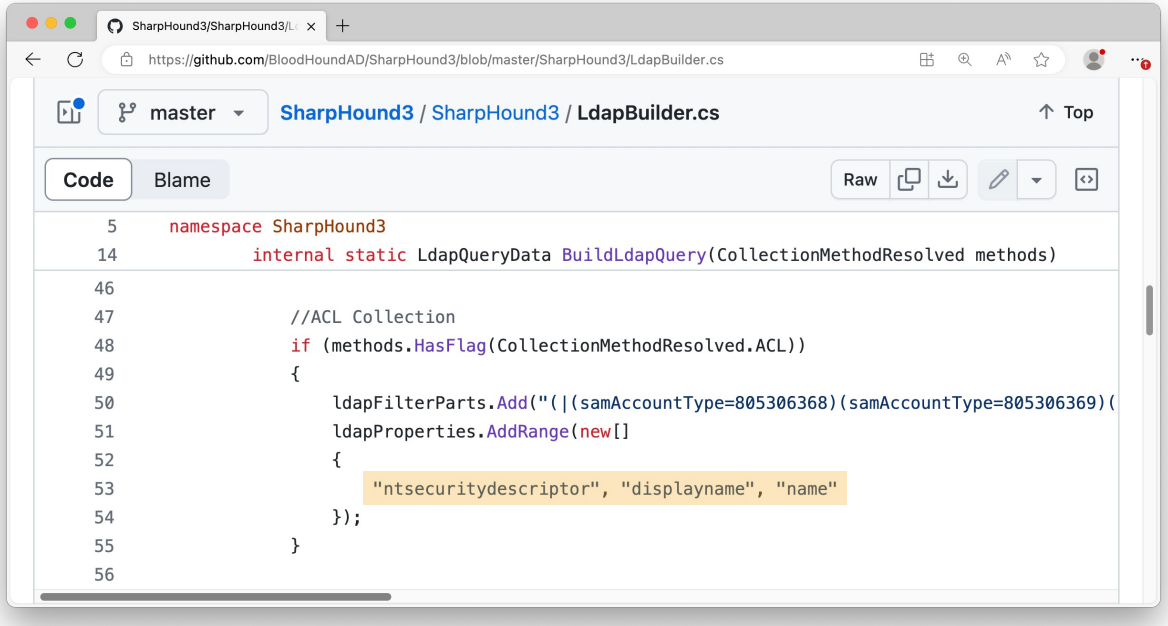


oID.0000**1**.2.840.113556.1.2.**000**281,displayNAme,naMe

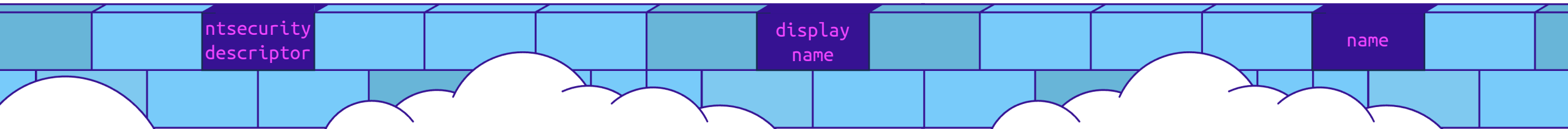


Obfuscation::AttributeSelection

- AttributeSelection
  - Casing
  - OID (Object Identifiers) notation
  - Prepended 0's
  - Whitespace

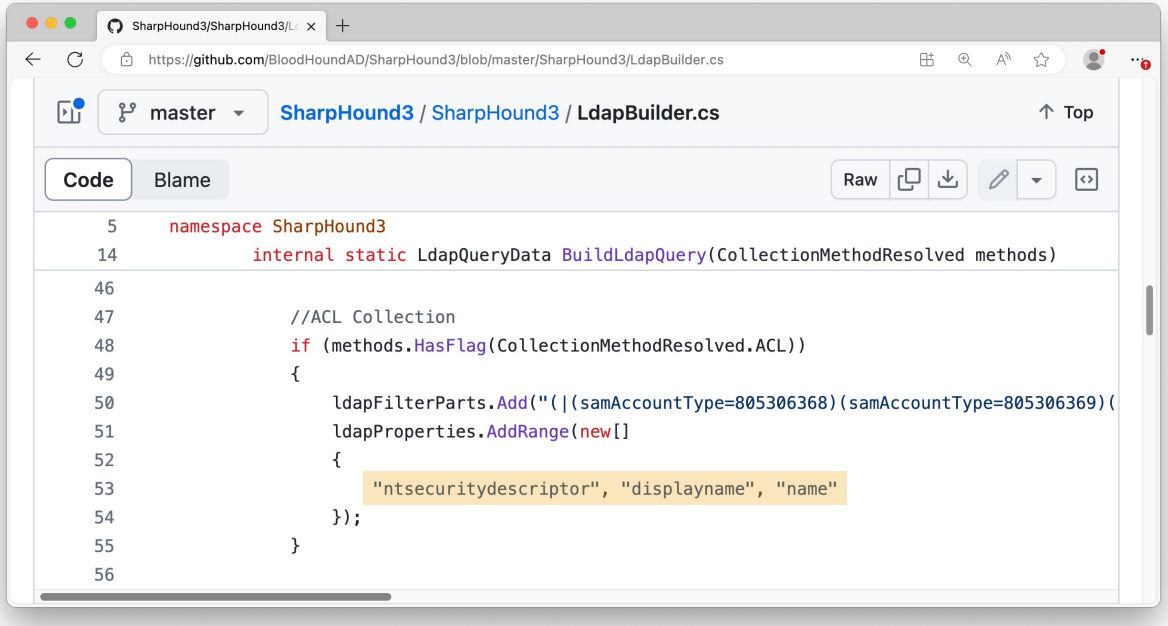


oID.00001.2.840.113556.1.2.000281 ,displayNAme,naMe

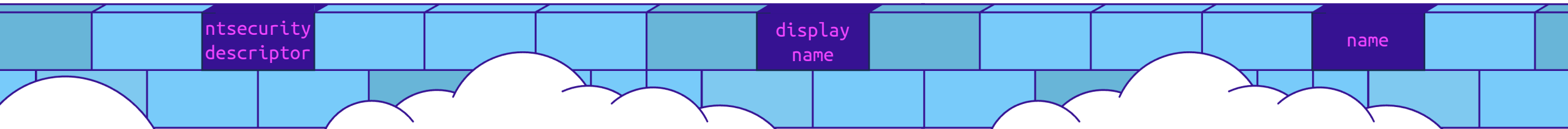


Obfuscation::AttributeSelection

- AttributeSelection
  - Casing
  - OID (Object Identifiers) notation
  - Prepended 0's
  - Whitespace
  - Duplicate attributes

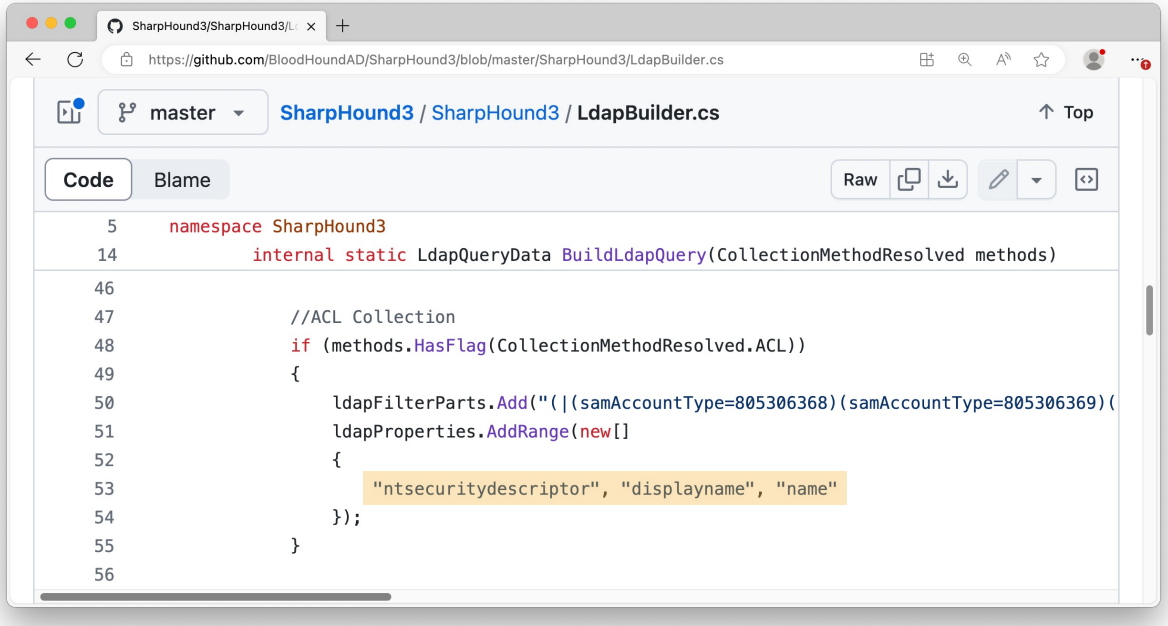


oID.00001.2.840.113556.1.2.000281 ,displayNAme,naMe,NAME

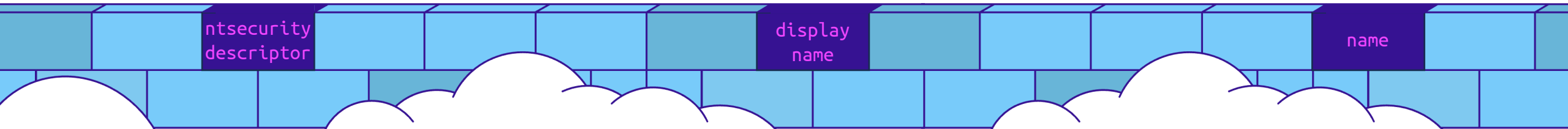


Obfuscation::AttributeSelection

- AttributeSelection
  - Casing
  - OID (Object Identifiers) notation
  - Prepended 0's
  - Whitespace
  - Duplicate attributes
  - Garbage attributes

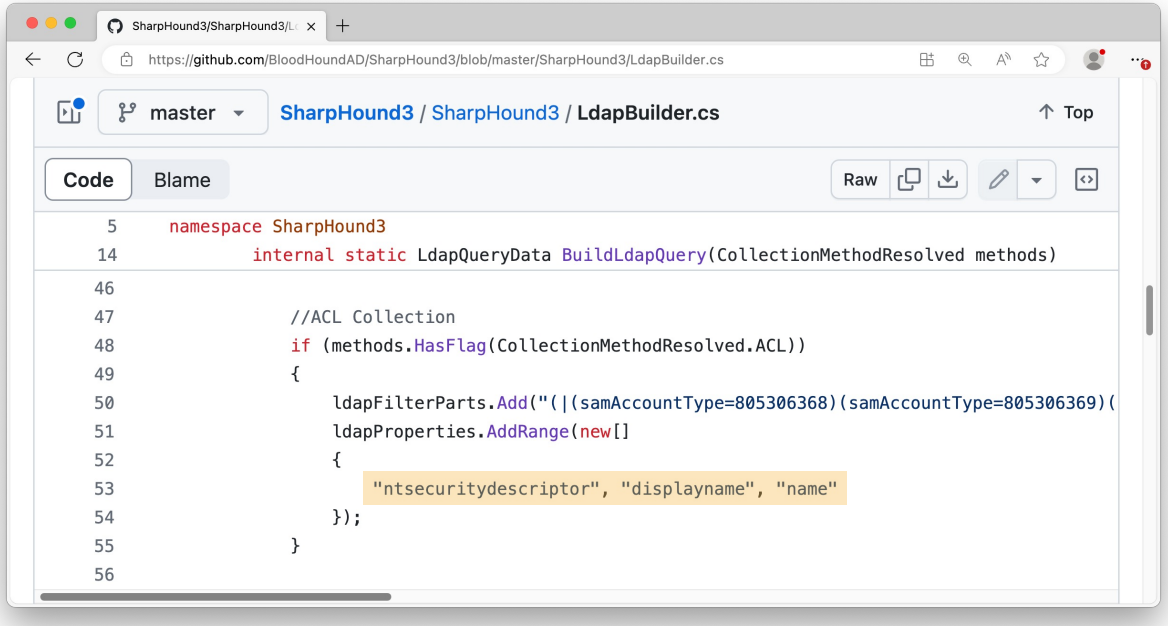



```
oID.00001.2.840.113556.1.2.000281    ,displayNAme,naMe,NAME,AnythingYouWant
```

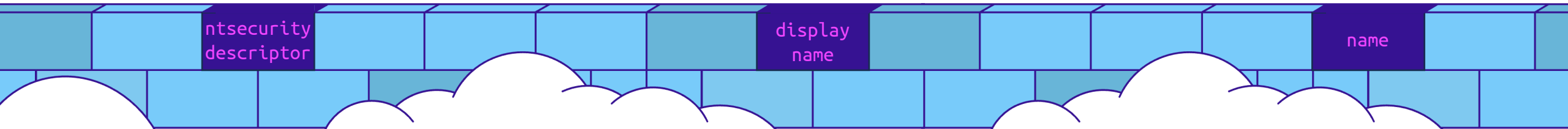


Obfuscation::AttributeSelection

- AttributeSelection
  - Casing
  - OID (Object Identifiers) notation
  - Prepended 0's
  - Whitespace
  - Duplicate attributes
  - Garbage attributes

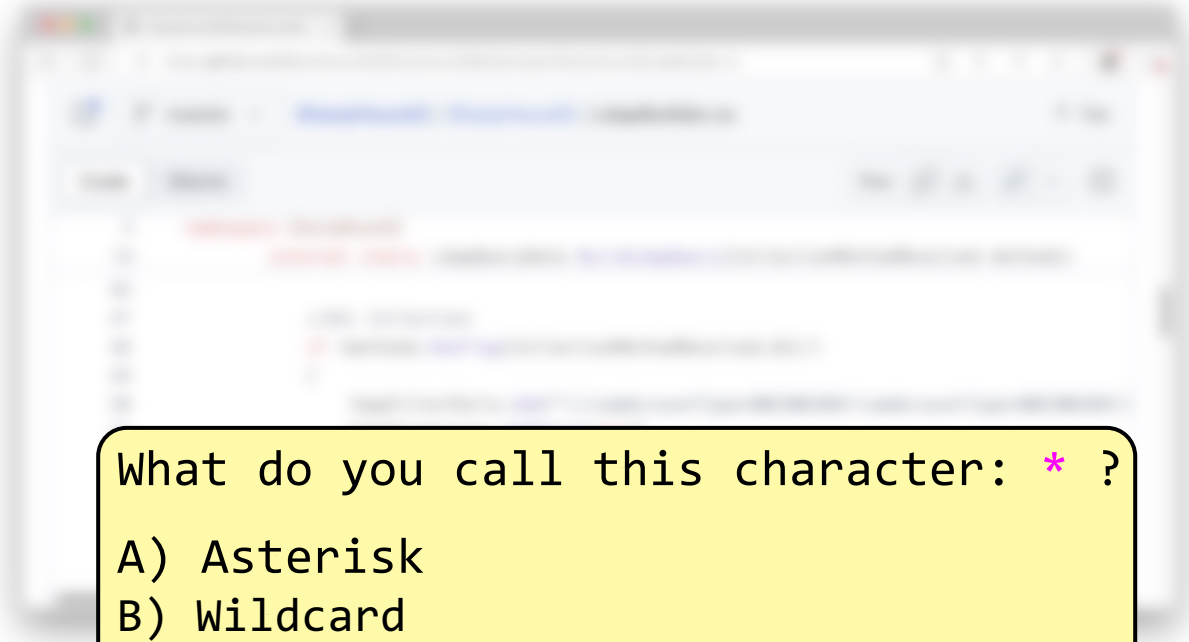


`oID.00001.2.840.113556.1.2.000281` `,displayNAme,naMe,NAME,AnythingYouWant,*`



Obfuscation::AttributeSelection

- AttributeSelection
  - Casing
  - OID (Object Identifiers) notation
  - Prepended 0's
  - Whitespace
  - Duplicate attributes
  - Garbage attributes

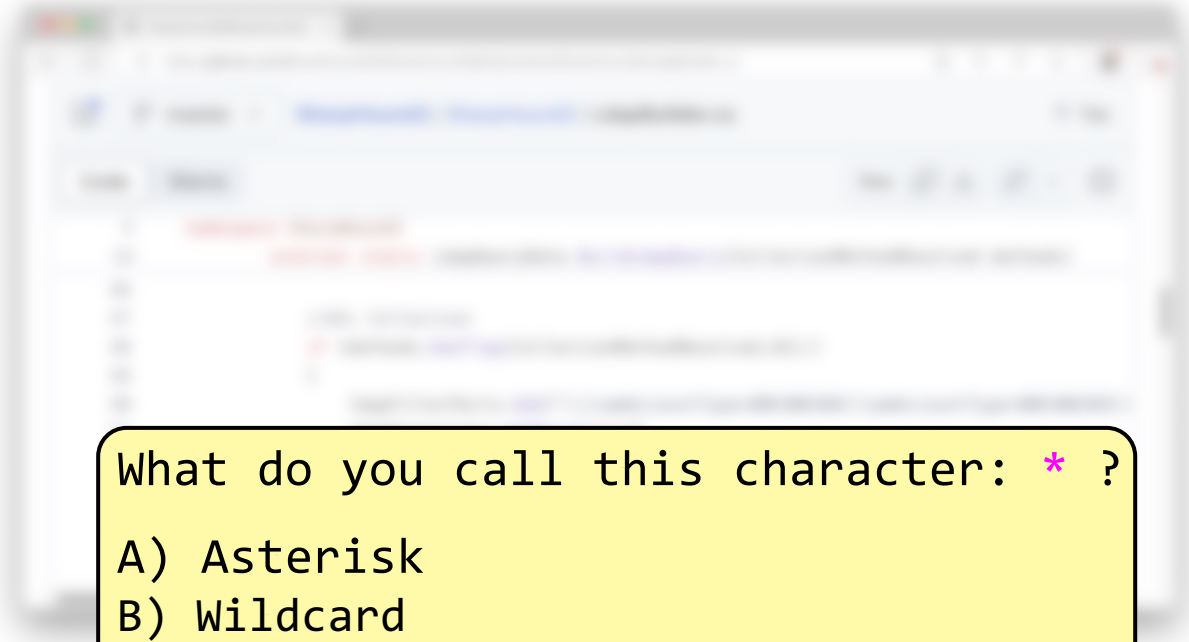


What do you call this character: * ?

A) Asterisk
B) Wildcard
C) Splat

Obfuscation::AttributeSelection

- AttributeSelection
  - Casing
  - OID (Object Identifiers) notation
  - Prepended 0's
  - Whitespace
  - Duplicate attributes
  - Garbage attributes

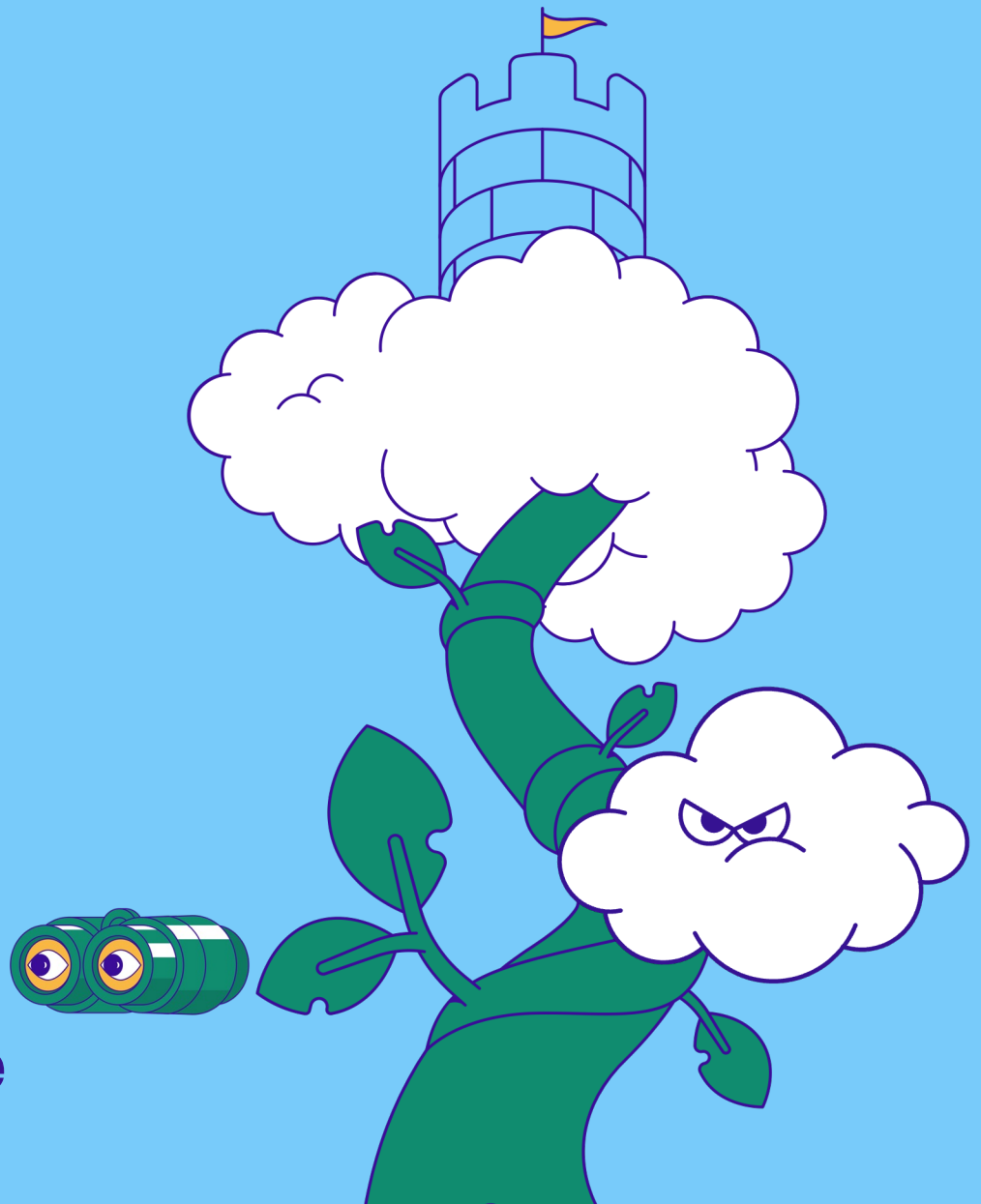


What do you call this character: * ?

A) Asterisk
B) Wildcard
C) Splat
D) Logically same as **null** (RFC-4522)
E) Logging resolves to **[all_with_list]**
F) All of the above

AGENDA

- Introduction
- LDAP Overview
- PROBLEM: Obfuscating LDAP
- SOLUTION: Parse, Enrich, Detect
- MaLDAPtive Tool Demo + Release



Solution::Parse

- Wrote custom parser for LDAP SearchFilters
  - C# State Machine
  - Tokenizer

Solution::Parse

- Wrote custom parser for LDAP SearchFilters
  - C# State Machine
  - Tokenizer

Solution::Parse

- Wrote custom parser for LDAP SearchFilters
  - C# State Machine
  - Tokenizer
  - Syntax Tree

Solution::Enrich

1) String

MaLDAPtive — pwsh

```
(|(name=sabi)(1.2.840.113556.1.4.1=\64\62\6F))
```

2) Tokens

MaLDAPtive — pwsh

Type	Content	ContentDecoded	Start	Length	Depth
GroupStart	(	(	0	1	0
BooleanOperator	|	|	1	1	1
GroupStart	(	(	2	1	1
Attribute	name	name	3	4	1
ComparisonOperator	=	=	7	1	1
Value	sabi	sabi	8	4	1
GroupEnd	)	)	12	1	1
GroupStart	(	(	13	1	1
Attribute	1.2.840.113556.1.4.1	name	14	20	1
ComparisonOperator	=	=	34	1	1
Value	\64\62\6F	dbo	35	9	1
GroupEnd	)	)	44	1	1
GroupEnd	)	)	45	1	0

Decoding

3) Filters & Branches

MaLDAPtive — pwsh

Content	ContentDecoded	Start	Length	Depth
(name=sabi)	(name=sabi)	2	11	1
(1.2.840.113556.1.4.1=\64\62\6F)	(name=dbo)	13	32	1

Solution::Detect

- **Find-Evil**
  - Parses
  - Enriches
  - Detects
  - Scores
  - Explains

65+ Rules

MaLDAPtive — pwsh

```
PS /> '(1.2.840.113556.1.4.8:1.2.840.113556.1.4.803:=1234)' | Find-Evil

Type           : Filter
Author         : Official_MaLDAPtive_Ruleset
Date           : 7/4/2024 12:00:00AM
ID             : SPECIFIC_BITWISE_ADDEND_FOR_DEFINED_ATTRIBUTE_USERACCOUNTCONTROL
Name           : Filter Contains Defined Attribute userAccountControl With
                 Specific Bitwise Addend ENCRYPTED_TEXT_PWD_ALLOWED (128) In
                 Actual Value: '1234'
Example        : (userAccountControl:1.2.840.113556.1.4.804:=65929)
Score          : 20
Depth          : 0
Start          : 0
Content        : (1.2.840.113556.1.4.8:1.2.840.113556.1.4.803:=1234)
ContentDecoded : (userAccountControl:1.2.840.113556.1.4.803:=1234)
```

MaLDAPtive — pwsh

```
PS /> $sfArr = @('(&(objectCategory=Person)(|(name=sabi)(name=dbo)))')*100000;
Measure-Command { $hits = $sfArr | Find-Evil } | Select-Object TotalSeconds

TotalSeconds
------------
   4.3747311
```

AGENDA

- Introduction
- LDAP Overview
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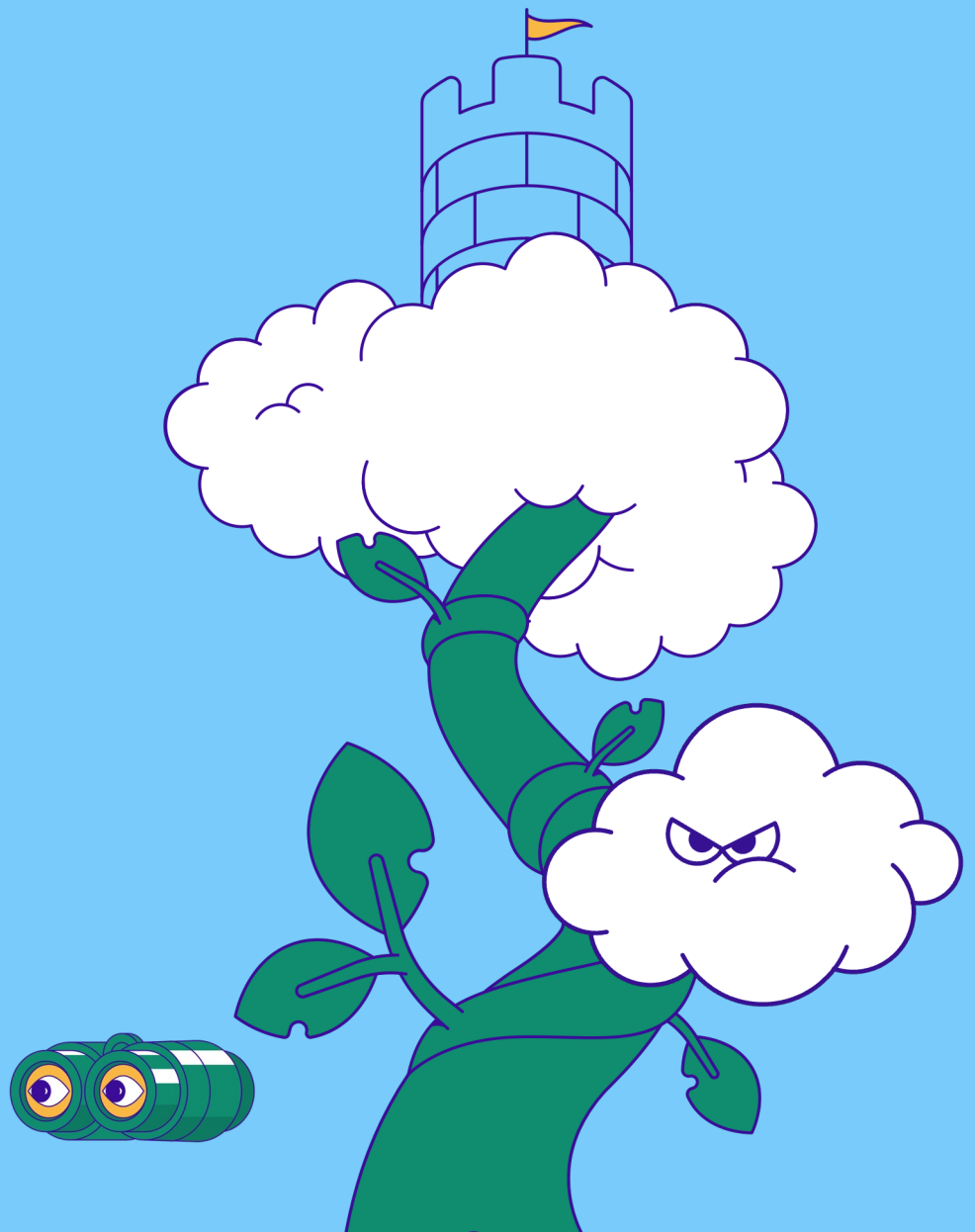
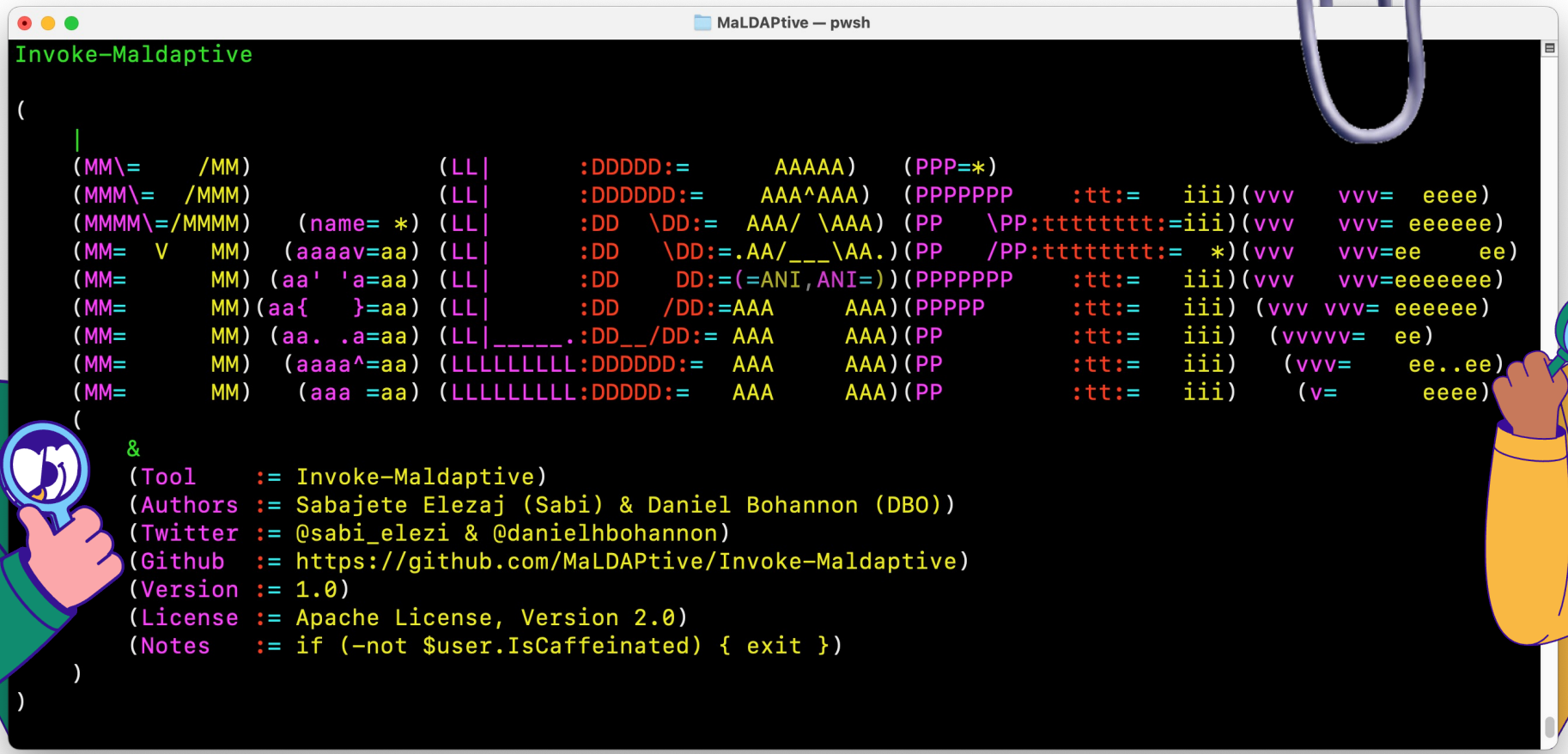
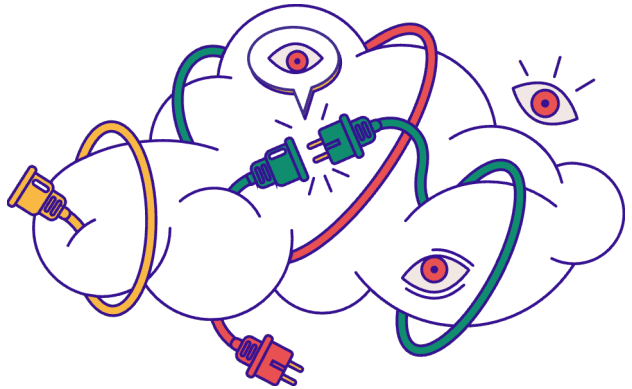
- SOLUTION: Parse, Enrich, Detect
- MaLDAPtive Tool Demo + Release



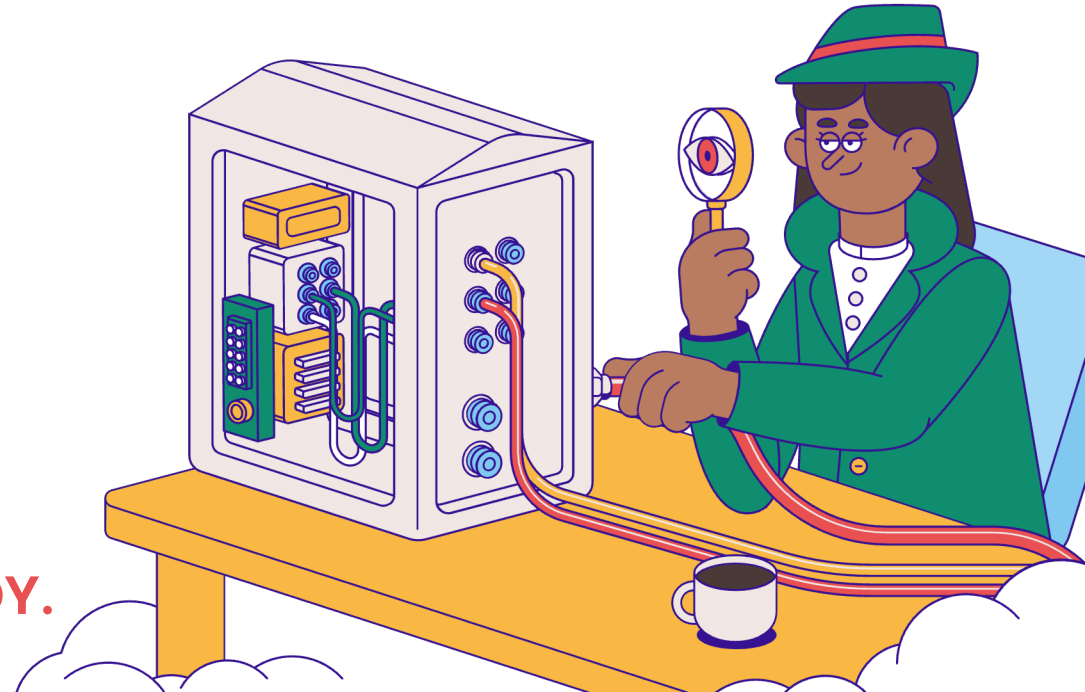
DEMO + Public Tool Release



What We Released Today



1. REMEMBER…we are **defenders**
2. From the beginning we decided on a **non-standard** release format
3. Today's **MaLDAPtive** release includes:
    1. Parser (tokenizer & syntax tree parser)
    2. *Obfuscation module
    3. Deobfuscation module
    4. Detection module
    5. Detection ruleset
    6. Obfuscation corpus



*** Obfuscation module complete w/delayed release by EOY.**

Black Hat Sound Bytes

1. **LDAP SearchRequests are frequently used by attackers** in internal reconnaissance & privilege escalation phases of the attack lifecycle.
2. **Defensive awareness & visibility of LDAP SearchRequests are still relatively immature** with string-based detections being vulnerable to numerous classes of obfuscation & evasion.
3. **Brand new MaLDAPtive open-source framework can improve visibility, detection & deobfuscation of obfuscated LDAP SearchRequests** via custom LDAP parser & detection ruleset.


Rrofsh sa malet.

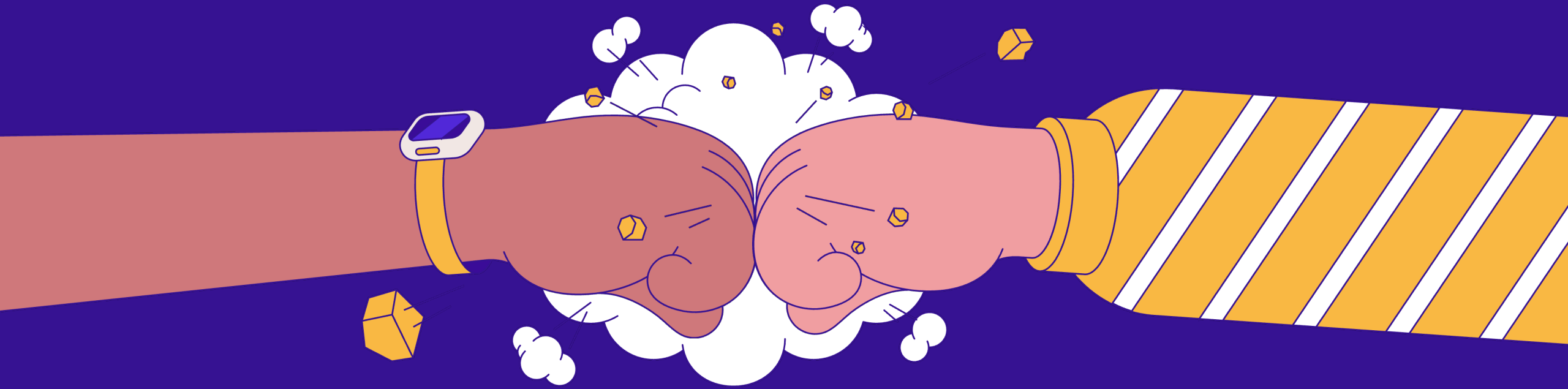
Rrofsh sa malet.

Live long like a mountain.


Rrofsh sa malet.
Live long like a mountain.
Të lutem jo më kapëse letrash.


Rrofsh sa malet.
Live long like a mountain.
Të lutem jo më kapëse letrash.
Please, no more paperclips.

THANKS FOR YOUR TIME!



Solaris

PERMISO

MaLDAPtive — pwsh

```
Invoke-Maldaptive

(
    |
    (MM\=    /MM)            (LL|      :DDDDD:=      AAAAA)   (PPP=*)
    (MMM\=  /MMM)            (LL|      :DDDDDD:=    AAA^AAA)  (PPPPPPP    :tt:=   iii)(vvv   vvv=  eeee)
    (MMMM\=/MMMM)   (name= *) (LL|      :DD  \DD:=  AAA/ \AAA) (PP   \PP:tttttttt:=iii)(vvv   vvv= eeeeee)
    (MM=  V   MM)  (aaaav=aa) (LL|      :DD   \DD:=.AA/___\AA.)(PP   /PP:tttttttt:=  *)(vvv   vvv=ee    ee)
    (MM=      MM) (aa' 'a=aa) (LL|      :DD    DD:=(=ANI,ANI=))(PPPPPPP    :tt:=   iii)(vvv   vvv=eeeeeee)
    (MM=      MM)(aa{   }=aa) (LL|      :DD   /DD:=AAA     AAA)(PPPPP      :tt:=   iii) (vvv vvv= eeeeee)
    (MM=      MM) (aa. .a=aa) (LL|_____.:DD__/DD:= AAA     AAA)(PP         :tt:=   iii)  (vvvvv=  ee)
    (MM=      MM)  (aaaa^=aa) (LLLLLLLLL:DDDDDD:=  AAA     AAA)(PP         :tt:=   iii)   (vvv=    ee..ee)
    (MM=      MM)   (aaa =aa) (LLLLLLLLL:DDDDD:=   AAA     AAA)(PP         :tt:=   iii)    (v=      eeee)
    (
        &
        (Tool    := Invoke-Maldaptive)
        (Authors := Sabajete Elezaj (Sabi) & Daniel Bohannon (DBO))
        (Twitter := @sabi_elezi & @danielhbohannon)
        (Github  := https://github.com/MaLDAPtive/Invoke-Maldaptive)
        (Version := 1.0)
        (License := Apache License, Version 2.0)
        (Notes   := if (-not $user.IsCaffeinated) { exit })
    )
)
```

“SABI”
SABAJETE ELEZAJ

“DBO”
DANIEL BOHANNON

sabajete_elezaj

danielhbohannon

@sabi_elezi

@danielhbohannon

https://github.com/MaLDAPtive/**Invoke-Maldaptive**

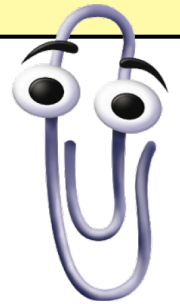
References

1. https://learn.microsoft.com/en-us/archive/technet-wiki/5392.active-directory-ldap-syntax-filters
2. https://learn.microsoft.com/en-us/windows/win32/ad/active-directory-schema
3. https://www.rfc-editor.org/rfc/rfc4511
4. https://ldap.or.kr/ldap-a-to-z/
5. https://www.binarydefense.com/resources/blog/uncovering-adversarial-ldap-tradecraft/
6. https://posts.specterops.io/an-introduction-to-manual-active-directory-querying-with-dsquery-and-ldapsearch-84943c13d7eb
7. https://posts.specterops.io/manual-ldap-querying-part-2-8a65099e12e3

Clippy Jokes Cut for Time (You're Welcome)

If I became an LDAP SearchRequest
then what kind of Filter would I be?

A Presence Filter – because I'm
ALWAYS HERE!



Okay, here's a non-LDAP joke:
Where do I live when not on screen?

C:\Windows\System32\clip.exe

Why do I exist?

To help you identify the cutoff between
millennials & GenZ without saying a word.