MISP and Decaying of Indicators

An indicator scoring method and ongoing implementation in MISP

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February 16, 2021

Expiring IOCs: Why and How?

Indicators - Problem Statement

- **Sharing information** about threats **is crucial**
- Organisations are sharing more and more

Contribution by **unique organisation** (`Orgc.name`) on MISPPriv:

Date	Unique Org
2013	17
2014	43
2015	82
2016	105
2017	118
2018	125
2019-10	135

```json
{
    "distribution": [1, 2, 3]
}
```

Indicators - Problem Statement

- Various users and organisations can share data via MISP, multiple parties can be involved
  - **Trust**, **data quality** and **time-to-live** issues
  - Each user/organisation has **different use-cases** and interests
    - Conflicting interests such as operational security, attribution,... (depends on the user)

→ Can be partially solved with *Taxonomies*

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→ Can be partially solved with *Taxonomies*

- Attributes can be shared in large quantities (more than 7.3 million on `MISPPRIV`)
  - Partial info about their **freshness** (*Sightings*)
  - Partial info about their **validity** (last update)

→ Can be partially solved with our *Decaying model*

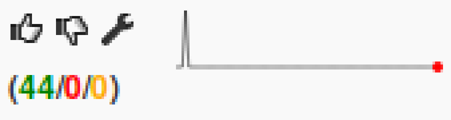
Requirements to enjoy the decaying feature in MISP

- Starting from **MISP 2.4.116**, the decaying feature is available
- Don't forget to update the decay models and enable the ones you want
- The decaying feature has no impact on the information in MISP, it's just an overlay to be used in the user-interface and API
- Decay strongly relies on *Taxonomies* and *Sightings*, don't forget to review their configuration

Sightings - Refresher

Sightings add temporal context to indicators. A user, script or an IDS can extend the information related to indicators by reporting back to MISP that an indicator has been `seen`, or that an indicator can be considered as a `false-positive`

- *Sightings* give more credibility/visibility to indicators
- This information can be used to **prioritise and decay indicators**



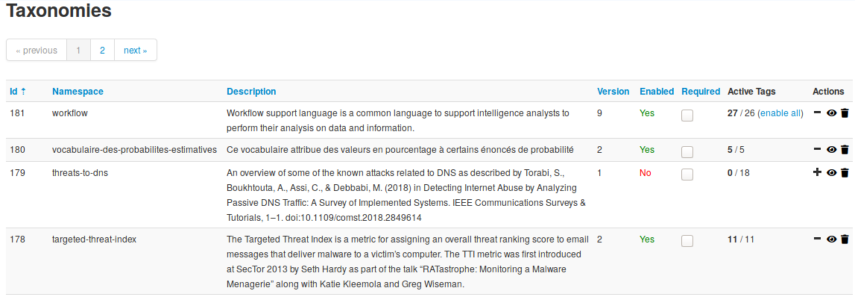
Organisations opt-in - setting a level of confidence

MISP is a peer-to-peer system, information passes through multiple instances.

- **Producers can add context** (such as tags from *Taxonomies*, *Galaxies*) about their asserted confidence or the reliability of the data
- Consumers can have **different levels of trust** in the producers and/or analysts themselves
- Users might have other contextual needs

→ Achieved thanks to *Taxonomies*

Taxonomies - Refresher (1)



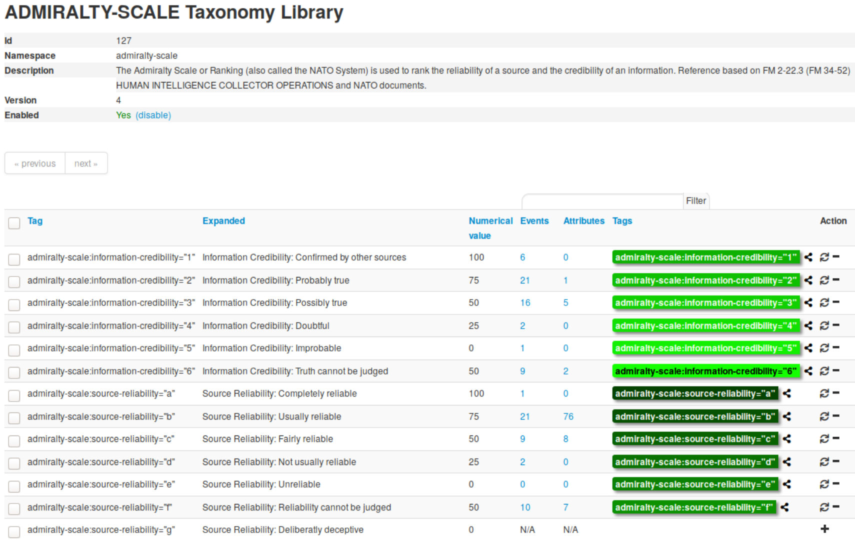
Taxonomies

« previous | 1 | 2 | next »

Id ↑	Namespace	Description	Version	Enabled	Required	Active Tags	Actions
181	workflow	Workflow support language is a common language to support intelligence analysts to perform their analysis on data and information.	9	Yes	□	**27** / 26 (enable all)	− 👁 🗑
180	vocabulaire-des-probabilites-estimatives	Ce vocabulaire attribue des valeurs en pourcentage à certains énoncés de probabilité	2	Yes	□	**5** / 5	− 👁 🗑
179	threats-to-dns	An overview of some of the known attacks related to DNS as described by Torabi, S., Boukhtouta, A., Assi, C., & Debbabi, M. (2018) in Detecting Internet Abuse by Analyzing Passive DNS Traffic: A Survey of Implemented Systems. IEEE Communications Surveys & Tutorials, 1–1. doi:10.1109/comst.2018.2849614	1	No	□	**0** / 18	+ 👁 🗑
178	targeted-threat-index	The Targeted Threat Index is a metric for assigning an overall threat ranking score to email messages that deliver malware to a victim's computer. The TTI metric was first introduced at SecTor 2013 by Seth Hardy as part of the talk "RATastrophe: Monitoring a Malware Menagerie" along with Katie Kleemola and Greg Wiseman.	2	Yes	□	**11** / 11	− 👁 🗑

- Tagging is a simple way to attach a classification to an *Event* or an *Attribute*
- Classification must be globally used to be efficient

Taxonomies - Refresher (2)



ADMIRALTY-SCALE Taxonomy Library

Id	127
Namespace	admiralty-scale
Description	The Admiralty Scale or Ranking (also called the NATO System) is used to rank the reliability of a source and the credibility of an information. Reference based on FM 2-22.3 (FM 34-52) HUMAN INTELLIGENCE COLLECTOR OPERATIONS and NATO documents.
Version	4
Enabled	Yes (disable)

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Filter

□	Tag	Expanded	Numerical value	Events	Attributes	Tags	Action
□	admiralty-scale:information-credibility="1"	Information Credibility: Confirmed by other sources	100	6	0	admiralty-scale:information-credibility="1"	⟳ −
□	admiralty-scale:information-credibility="2"	Information Credibility: Probably true	75	21	1	admiralty-scale:information-credibility="2"	⟳ −
□	admiralty-scale:information-credibility="3"	Information Credibility: Possibly true	50	16	5	admiralty-scale:information-credibility="3"	⟳ −
□	admiralty-scale:information-credibility="4"	Information Credibility: Doubtful	25	2	0	admiralty-scale:information-credibility="4"	⟳ −
□	admiralty-scale:information-credibility="5"	Information Credibility: Improbable	0	1	0	admiralty-scale:information-credibility="5"	⟳ −
□	admiralty-scale:information-credibility="6"	Information Credibility: Truth cannot be judged	50	9	2	admiralty-scale:information-credibility="6"	⟳ −
□	admiralty-scale:source-reliability="a"	Source Reliability: Completely reliable	100	1	0	admiralty-scale:source-reliability="a"	⟳ −
□	admiralty-scale:source-reliability="b"	Source Reliability: Usually reliable	75	21	76	admiralty-scale:source-reliability="b"	⟳ −
□	admiralty-scale:source-reliability="c"	Source Reliability: Fairly reliable	50	9	8	admiralty-scale:source-reliability="c"	⟳ −
□	admiralty-scale:source-reliability="d"	Source Reliability: Not usually reliable	25	2	0	admiralty-scale:source-reliability="d"	⟳ −
□	admiralty-scale:source-reliability="e"	Source Reliability: Unreliable	0	0	0	admiralty-scale:source-reliability="e"	⟳ −
□	admiralty-scale:source-reliability="f"	Source Reliability: Reliability cannot be judged	50	10	7	admiralty-scale:source-reliability="f"	⟳ −
□	admiralty-scale:source-reliability="g"	Source Reliability: Deliberatly deceptive	0	N/A	N/A		+

→ Cherry-pick allowed *Tags*

Taxonomies - Refresher (3)

- Some taxonomies have `numerical_value`
  → Can be used to prioritise *Attributes*

Description	Value
Completely reliable	100
Usually reliable	75
Fairly reliable	50
Not usually reliable	25
Unreliable	0
Reliability cannot be judged	50 **?**
Deliberatly deceptive	0 **?**

Description	Value
Confirmed by other sources	100
Probably true	75
Possibly true	50
Doubtful	25
Improbable	0
Truth cannot be judged	50 **?**

Scoring Indicators: Our solution

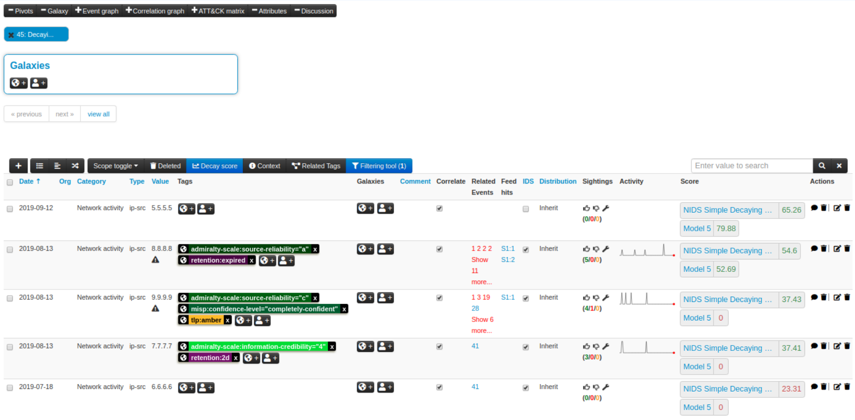
$$\mathtt{score}(_{\mathtt{Attribute}}) = \mathtt{base\_score}(_{\mathtt{Attribute},\ \mathtt{Model}}) \bullet \mathtt{decay}(_{\mathtt{Model},\ \mathtt{time}})$$

Where,

- $\mathtt{score} \in [0, +\infty$
- $\mathtt{base\_score} \in [0, 100]$
- `decay` is a function defined by model's parameters controlling decay speed
- `Attribute` Contains *Attribute*'s values and metadata (*Taxonomies*, *Galaxies*, ...)
- `Model` Contains the *Model*'s configuration

Current implementation in MISP

Implementation in MISP: Event/view



□	Date ↑	Org	Category	Type	Value	Tags	Galaxies	Comment	Correlate	Related Events	Feed hits	IDS	Distribution	Sightings	Activity	Score	Actions
□	2019-09-12		Network activity	ip-src	5.5.5.5				☑			□	Inherit	(0/0/0)		NIDS Simple Decaying ... 65.26 Model 5 79.88	
□	2019-08-13		Network activity	ip-src	8.8.8.8 ⚠	admiralty-scale:source-reliability="a" x retention:expired x			☑	1 2 2 2 Show 11 more...	S1:1 S1:2	☑	Inherit	(5/0/0)		NIDS Simple Decaying ... 54.6 Model 5 52.69	
□	2019-08-13		Network activity	ip-src	9.9.9.9 ⚠	admiralty-scale:source-reliability="c" x misp:confidence-level="completely-confident" x tlp:amber x			☑	1 3 19 28 Show 6 more...	S1:1	☑	Inherit	(4/1/0)		NIDS Simple Decaying ... 37.43 Model 5 0	
□	2019-08-13		Network activity	ip-src	7.7.7.7	admiralty-scale:information-credibility="4" x retention:2d x			☑	41		☑	Inherit	(3/0/0)		NIDS Simple Decaying ... 37.41 Model 5 0	
□	2019-07-18		Network activity	ip-src	6.6.6.6				☑	41		☑	Inherit	(0/0/0)		NIDS Simple Decaying ... 23.31 Model 5 0	

- Decay score toggle button
  - Shows Score for each *Models* associated to the *Attribute* type

Implementation in MISP: API result

/attributes/restSearch

```
"Attribute": [
  {
    "category": "Network activity",
    "type": "ip-src",
    "to_ids": true,
    "timestamp": "1565703507",
    [...]
    "value": "8.8.8.8",
    "decay_score": [
      {
        "score": 54.475223849544456,
        "decayed": false,
        "DecayingModel": {
          "id": "85",
          "name": "NIDS Simple Decaying Model"
        }
      }
    ],
[...]
```

Implementation in MISP: Playing with Models

- **Automatic scoring** based on default values
- **User-friendly UI** to manually set *Model* configuration (lifetime, decay, etc.)
- **Simulation** tool
- Interaction through the **API**
- Opportunity to create your **own** formula or algorithm

Decaying Models in Depth

Scoring Indicators: base_score (1)

$$\texttt{score}(\texttt{Attribute}) = \texttt{base\_score}(\texttt{Attribute, Model}) \bullet \texttt{decay}(\texttt{Model, time})$$

When scoring indicators[1], multiple parameters[2] can be taken into account. The **base score** is calculated with the following in mind:

- Data reliability, credibility, analyst skills, custom prioritisation tags (economical-impact), etc.
- Trust in the source

$$\texttt{base\_score} = \omega_{tg} \cdot \mathit{tags} + \omega_{sc} \cdot \mathit{source\_confidence}$$

Where,

$$\omega_{sc} + \omega_{tg} = 1$$

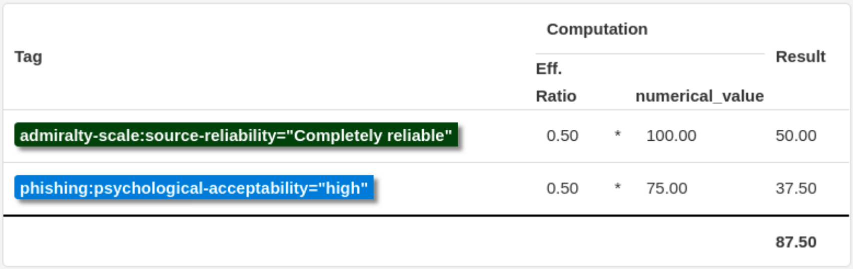
[1] Paper available: https://arxiv.org/pdf/1803.11052

[2] at a variable extent as required

Scoring Indicators: base_score (2)

Current implentation ignores source_confidence:

→ base_score = *tags*



Tag	Computation			Result
	Eff. Ratio		numerical_value	
admiralty-scale:source-reliability="Completely reliable"	0.50	*	100.00	50.00
phishing:psychological-acceptability="high"	0.50	*	75.00	37.50
				87.50

→ The base_score can be use to prioritize attribute based on their attached context and source

Scoring Indicators: decay speed (1)

$$\texttt{score}(\texttt{Attribute}) = \texttt{base\_score}(\texttt{Attribute, Model}) \bullet \texttt{decay}(\texttt{Model, time})$$

The `decay` is calculated using:

- The `lifetime` of the indicator
  - May vary depending on the indicator type
  - short for an IP, long for an hash
- The `decay rate`, or speed at which an attribute loses score over time
- The `time` elapsed since the latest update or sighting

Scoring Indicators: putting it all toghether

→ `decay rate` is **re-initialized upon sighting** addition, or said differently, the `score` is reset to its base score as new *sightings* are applied.

$$\mathit{score} = \mathit{base\_score} \cdot \left(1 - \left(\frac{t}{\tau}\right)^{\frac{1}{\delta}}\right)$$

- $\tau =$ `lifetime`
- $\delta =$ `decay speed`

Implementation in MISP: Models definition

↱ $score = base\_score \cdot \left(1 - \left(\frac{t}{\tau}\right)^{\frac{1}{\delta}}\right)$

Models are an instanciation of the formula where elements can be defined:

- Parameters: `lifetime, decay_rate, threshold`
- `base_score`
- `default base_score`
- formula
- associate *Attribute* types
- creator organisation

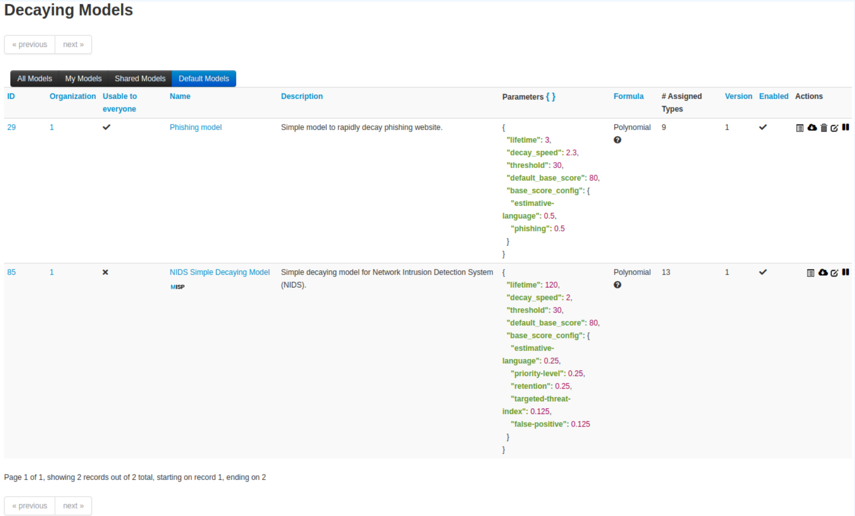
Implementation in MISP: Models Types

Multiple model types are available

- **Default Models**: Models created and shared by the community. Available from `misp-decaying-models` repository[3].
  - → Not editable
- **Organisation Models**: Models created by a user belonging to an organisation
  - These models can be hidden or shared to other organisation
  - → Editable

[3] `https://github.com/MISP/misp-decaying-models.git`

Implementation in MISP: Index



Decaying Models

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All Models | My Models | Shared Models | Default Models

ID	Organization	Usable to everyone	Name	Description	Parameters { }	Formula	# Assigned Types	Version	Enabled	Actions

29	1	✓	Phishing model	Simple model to rapidly decay phishing website.	{
					"lifetime": 3,
					"decay_speed": 2.3,
					"threshold": 30,
					"default_base_score": 80,
					"base_score_config": {
					"estimative-language": 0.5,
					"phishing": 0.5
					}
					}
						Polynomial	9	1	✓	

85	1	✗	NIDS Simple Decaying Model
			MISP
				Simple decaying model for Network Intrusion Detection System (NIDS).	{
					"lifetime": 120,
					"decay_speed": 2,
					"threshold": 30,
					"default_base_score": 80,
					"base_score_config": {
					"estimative-language": 0.25,
					"priority-level": 0.25,
					"retention": 0.25,
					"targeted-threat-index": 0.125,
					"false-positive": 0.125
					}
					}
						Polynomial	13	1	✓	

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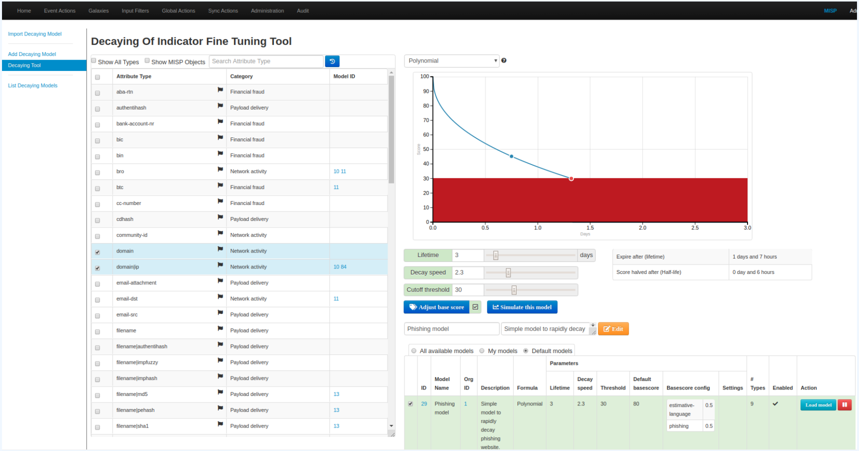
View, update, add, create, delete, enable, export, import

Implementation in MISP: Fine tuning tool



Decaying Of Indicator Fine Tuning Tool

□ Show All Types □ Show MISP Objects Search Attribute Type

□	Attribute Type	Category	Model ID
□	aba-rtn	Financial fraud	
□	authentihash	Payload delivery	
□	bank-account-nr	Financial fraud	
□	bic	Financial fraud	
□	bin	Financial fraud	
□	bro	Network activity	10 11
□	btc	Financial fraud	11
□	cc-number	Financial fraud	
□	cdhash	Payload delivery	
□	community-id	Network activity	
☑	domain	Network activity	
☑	domain|ip	Network activity	10 84
□	email-attachment	Payload delivery	
□	email-dst	Network activity	11
□	email-src	Payload delivery	
□	filename	Payload delivery	
□	filename|authentihash	Payload delivery	
□	filename|impfuzzy	Payload delivery	
□	filename|imphash	Payload delivery	
□	filename|md5	Payload delivery	13
□	filename|pehash	Payload delivery	13
□	filename|sha1	Payload delivery	13

Polynomial

Lifetime 3 days

Decay speed 2.3

Cutoff threshold 30

Expire after (lifetime)	1 days and 7 hours
Score halved after (Half-life)	0 day and 6 hours

Phishing model

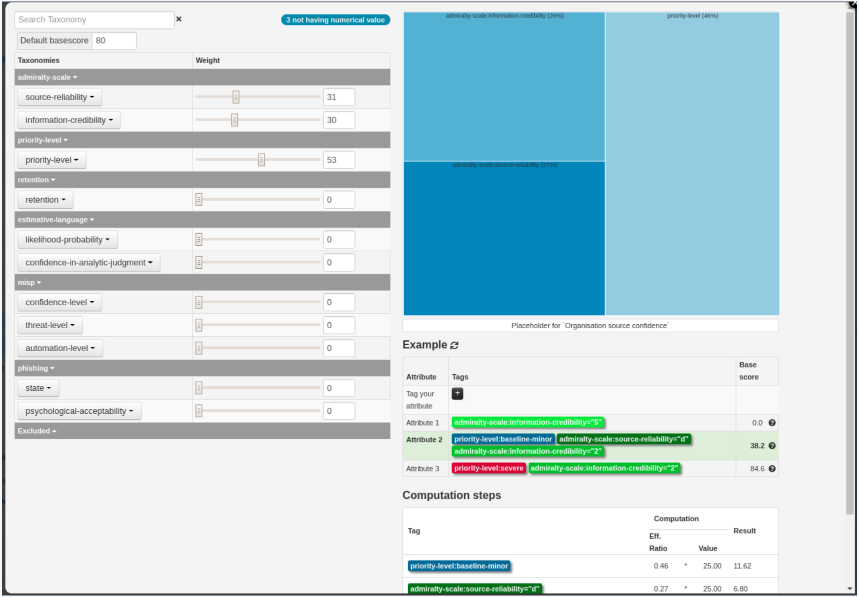
Simple model to rapidly decay

○ All available models ○ My models ● Default models

						Parameters								
	ID	Model Name	Org ID	Description	Formula	Lifetime	Decay speed	Threshold	Default basescore	Basescore config	Settings	# Types	Enabled	Action
☑	29	Phishing model	1	Simple model to rapidly decay phishing website.	Polynomial	3	2.3	30	80	estimative-language 0.5 phishing 0.5		9	✓	Load model

Create, modify, visualise, perform mapping

IMPLEMENTATION IN MISP: base_score TOOL



Search Taxonomy
3 not having numerical value
admiralty-scale:information-credibility (26%)
priority-level (46%)
admiralty-scale:source-reliability (27%)
Placeholder for `Organisation source confidence`

Default basescore 80

Taxonomies	Weight
admiralty-scale	
source-reliability	31
information-credibility	30
priority-level	
priority-level	53
retention	
retention	0
estimative-language	
likelihood-probability	0
confidence-in-analytic-judgment	0
misp	
confidence-level	0
threat-level	0
automation-level	0
phishing	
state	0
psychological-acceptability	0
Excluded	

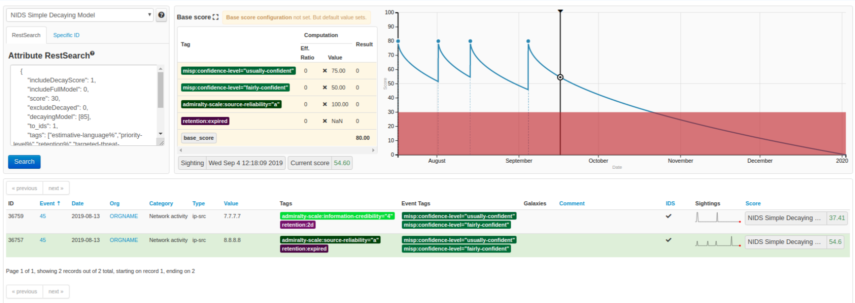
Example

Attribute	Tags	Base score
Tag your attribute	+	
Attribute 1	admiralty-scale:information-credibility="5"	0.0
Attribute 2	priority-level:baseline-minor admiralty-scale:source-reliability="d" admiralty-scale:information-credibility="2"	38.2
Attribute 3	priority-level:severe admiralty-scale:information-credibility="2"	84.6

Computation steps

Tag	Computation			Result
	Eff. Ratio		Value	
priority-level:baseline-minor	0.46	*	25.00	11.62
admiralty-scale:source-reliability="d"	0.27	*	25.00	6.80

Implementation in MISP: simulation tool



NIDS Simple Decaying Model

RestSearch | Specific ID

Attribute RestSearch

```
{
    "includeDecayScore": 1,
    "includeFullModel": 0,
    "score": 30,
    "excludeDecayed": 0,
    "decayingModel": [85],
    "to_ids": 1,
    "tags": ["estimative-language%","priority-
level%","retention%","targeted-threat-
```

Search

Base score Base score configuration not set. But default value sets.

Tag	Computation			Result
	Eff. Ratio		Value	
misp:confidence-level="usually-confident"	0	×	75.00	0
misp:confidence-level="fairly-confident"	0	×	50.00	0
admiralty-scale:source-reliability="a"	0	×	100.00	0
retention:expired	0	×	NaN	0
base_score				80.00

Sighting: Wed Sep 4 12:18:09 2019 | Current score: 54.60

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ID	Event	Date	Org	Category	Type	Value	Tags	Event Tags	Galaxies	Comment	IDS	Sightings	Score
36759	45	2019-08-13	ORGNAME	Network activity	ip-src	7.7.7.7	admiralty-scale:information-credibility="4" retention:2d	misp:confidence-level="usually-confident" misp:confidence-level="fairly-confident"			✓		NIDS Simple Decaying ... 37.41
36757	45	2019-08-13	ORGNAME	Network activity	ip-src	8.8.8.8	admiralty-scale:source-reliability="a" retention:expired	misp:confidence-level="usually-confident" misp:confidence-level="fairly-confident"			✓		NIDS Simple Decaying ... 54.6

Page 1 of 1, showing 2 records out of 2 total, starting on record 1, ending on 2

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Simulate *Attributes* with different *Models*

Implementation in MISP: API query body

/attributes/restSearch

```
{
    "includeDecayScore": 1,
    "includeFullModel": 0,
    "excludeDecayed": 0,
    "decayingModel": [85],
    "modelOverrides": {
        "threshold": 30
    }
    "score": 30,
}
```

Creating a new decay algorithm (1)

The current architecture allows users to create their **own** formulae.

1. Create a new file `$filename` in `app/Model/DecayingModelsFormulas/`
2. Extend the Base class as defined in `DecayingModelBase`
3. Implement the two mandatory functions `computeScore` and `isDecayed` using your own formula/algorithm
4. Create a `Model` and set the formula field to `$filename`

Use cases:

- Add support for **more feature** (expiration taxonomy)
- **Query external services** then influence the score
- Completely **different approach** (i.e streaming algorithm)
- ...

Creating a new decay algorithm (2)

```php
<?php
include_once ’Base.php’;

class Polynomial extends DecayingModelBase
{
    public const DESCRIPTION = ’The description of your new decaying algorithm’;

    public function computeScore($model, $attribute, $base_score, $elapsed_time)
    {
       // algorithm returning a numerical score
    }

    public function isDecayed($model, $attribute, $score)
    {
        // algorithm returning a boolean stating
        // if the attribute is expired or not
    }
}
?>

```

Decaying Models 2.0

- Improved support of *Sightings*
  - `False positive` *Sightings* should somehow reduce the score
  - `Expiration` *Sightings* should mark the attribute as decayed
- Potential *Model* improvements
  - Instead of resetting the score to `base_score` once a *Sighting* is set, the score should be increased additively (based on a defined coefficient); thus **prioritizing surges** rather than infrequent *Sightings*
  - Take into account related *Tags* or *Correlations* when computing score
- Increase *Taxonomy* coverage
  - Users should be able to manually override the `numerical_value` of *Tags*
- For specific type, take into account data from other services
  - Could fetch data from *BGP ranking*, *Virus Total*, *Passive X* for IP/domain/... and adapt the score