Natural Language Processing in Medicine

Kawasaki disease natural language processing tool

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Report outline

1 Background and Significance

I believe it is ideal to apply NLP techniques when diagnosing the Kawasaki disease (KD), because it rests mainly on acknowledging the presence of the traditional signs.

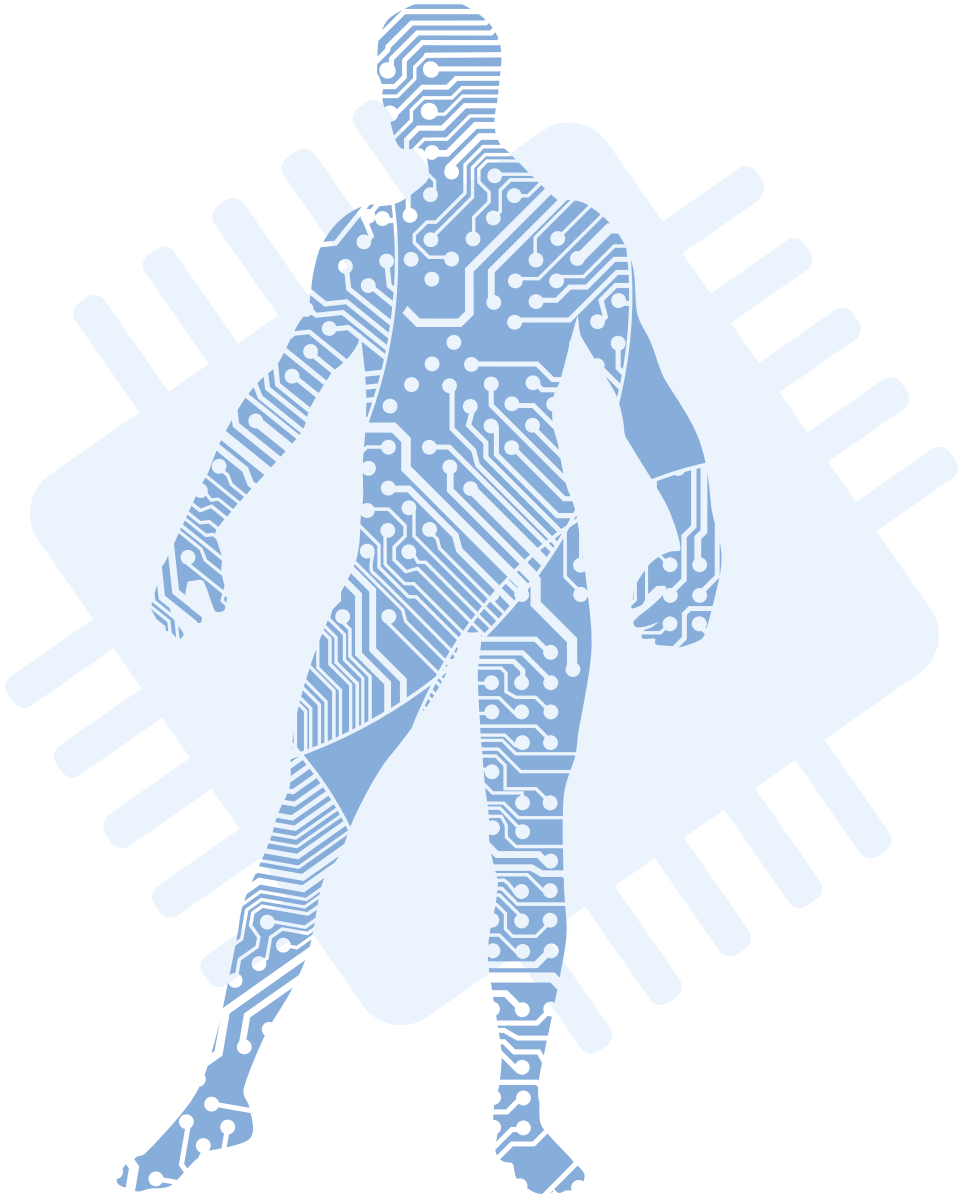
2 NLP in Biosurveillance

The pipeline of the KD-NLP tool consists of three main modules: the preprocessing, the KD tagger and the KD classifier.

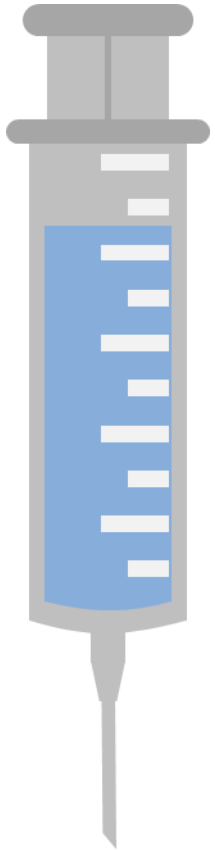
3 Final Remarks

The tool is considered to be a reliable source of knowledge utilized to identify a low or a high likelihood of a patient to suffer from Kawasaki disease, not as a proper tool to diagnose it.

4 References

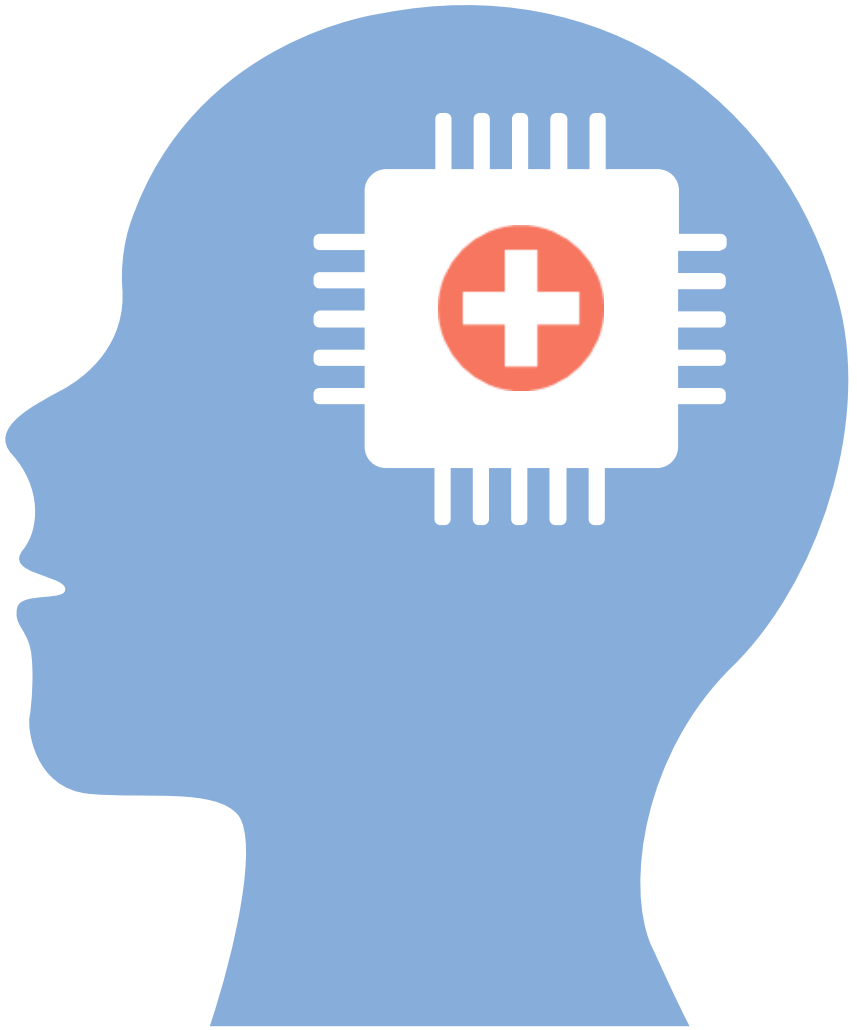


What is Kawasaki disease?



Signs and symptoms of the first phase may include:

- a fever that is often higher than 102.2° F (39° C) and lasts more than three days;
- extremely red eyes without a thick discharge;
- a rash on the main part of the body and in the genital area;
- red, dry, cracked lips and an extremely red, swollen tongue;
- swollen, red skin on the palms of the hands and the soles of the feet;
- swollen lymph nodes in the neck and perhaps elsewhere.



Creating a standard of criteria

I The numbers

To develop the NLP tool

- convenience sample of notes belonging to **22** children from the EMR of Rady Children's Hospital San Diego.

To evaluate the performance of the NLP tool

- convenience sample of subjects – **166** notes from the EMR of *Rady Children's Hospital San Diego* and **87** notes from the EMR of *Children's Healthcare of Atlanta.*

II The ideas

All of the 253 notes have been manually reviewed by medical specialists. They analyzed individually each note provided by the ED to validate the absence or presence of one or more of the KD signs, without having access to subjects information.

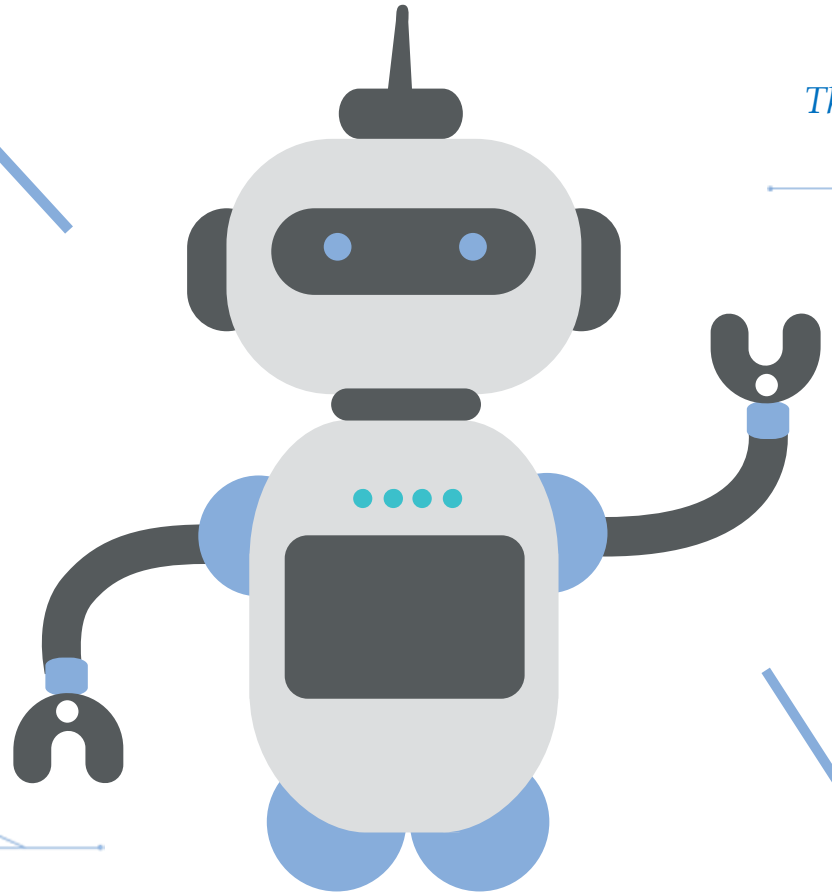
Then, the assessments were compared and discussed until a uniformly concluded standard has been stated.

KD-NLP overview

There are three main components

KD tagger

The KD tagger recognizes fever and KD signs from clinical text.



Preprocessing

KD classifier

This module assigns a subject as high suspicion for KD if the KD tagger detects fever and three or more KD signs; otherwise, it assigns the subject as low suspicion for KD.

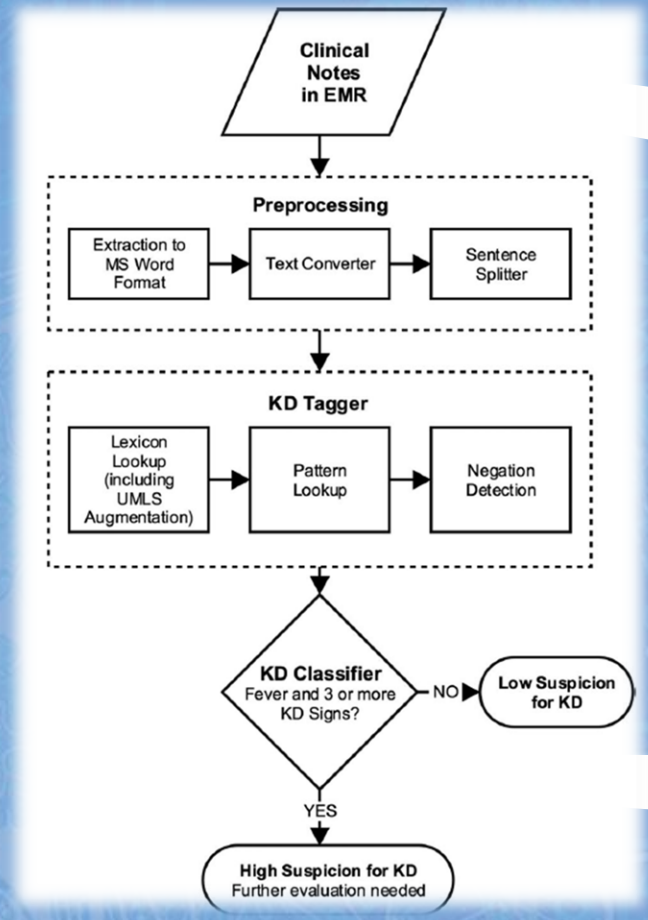
KD tagger

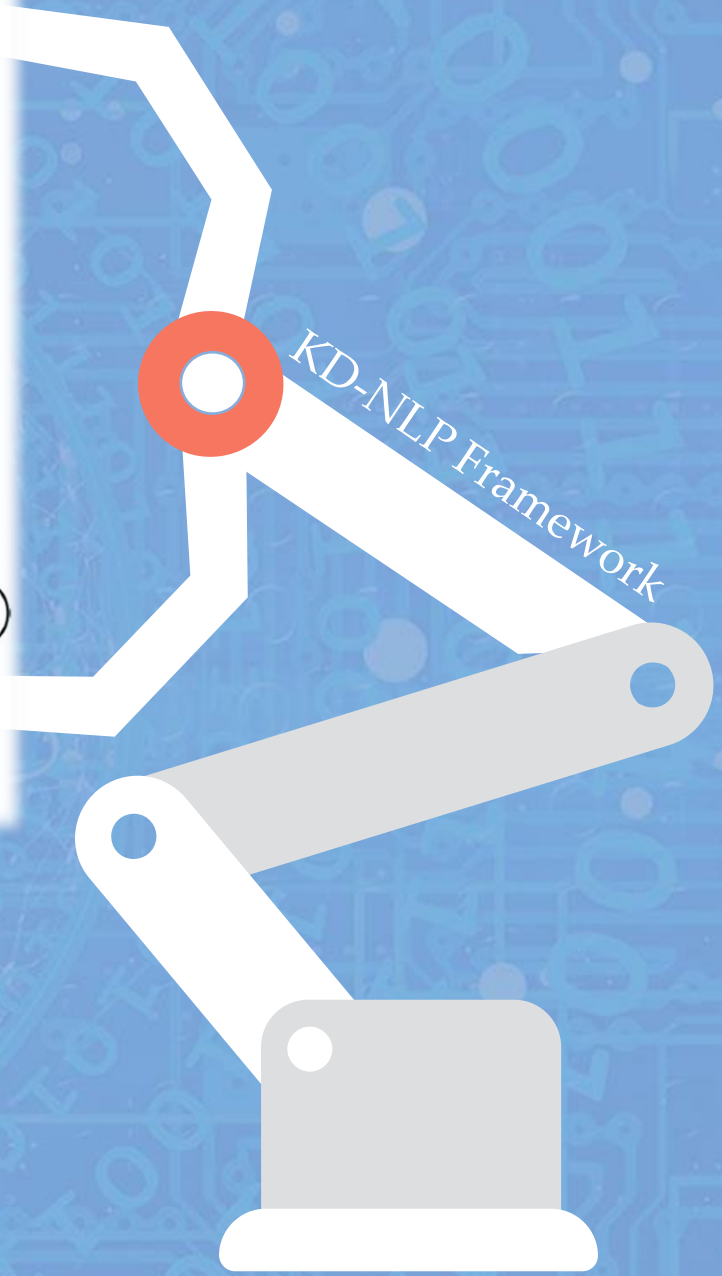
Consists of three parts:

- **Lexicon look-up** – 313 keywords or key phrases were part of the preliminary lexicon, while the final lexicon contained a number of 28 580 keywords.

- **Pattern look-up** – As an example: for the changes in the extremities, where we have the tag EXTREMITIES CHANGES, if we consider the given sentence "*hands and feet appeared red and swollen*", changes in extremities goes with the common statement *hands* or *feet* or *hands and feet* or *hands or feet* (are) *red* or *swollen* or *red and swollen*.

- Negation detection – i.e. "*no swollen feet*". This negation detection control gives us the means to not annotate some wrong sign of KD as a KD semantic tag.





KD classifier

- Only the subjects with febrile episodes at least 3 signs of Kawasaki disease would be considered with a high likelihood of having KD.

KD tagger philosophy

The AHA guidelines for KD was followed to define semantics tags for the five principal KD signs:

- EXTREMITY_CHANGES,
- POLYMORPHOUS_EXANTHEMA,
- ORAL_CHANGES,
- CONJUNCTIVAL_INJECTION,
- CERVICAL_LYMPHADENOPATHY,

in addition to FEVER.

Clinical Criterion	Tag name	Description and examples
Fever	FEVER	Fever or temperature at least 100.4°F or 38°C *Examples:* Fever Any mention of temperature 100.4°F (38°C) or above
Bilateral conjunctival injection	CONJUNCTIVAL_INJECTION	Bilateral bulbar conjunctival injection without exudate *Examples:* Redness of eyes Eyes: positive for redness
Changes of the oropharynx: injected pharynx, injected, fissured lips, strawberry tongue	ORAL_CHANGES	Changes in lips and oral cavity, including erythema, cracked lips, strawberry tongue, diffuse injection of oral and pharyngeal mucosae *Examples:* Red cracked lips Strawberry like tongue
Changes of the peripheral extremities: peripheral edema, palm/sole erythema, periungual desquamation	EXTREMITY_CHANGES	Changes in extremities: palms, soles, hands, feet, or periungual peeling of fingers or toes *Examples:* Redness of hands or feet Swelling of hands or feet
Polymorphous rash	POLYMORPHOUS_EXANTHEMA	Polymorphous exanthema *Examples:* Skin rash Pink blanching patches scattered on body
Cervical adenopathy > 1.5 cm	CERVICAL_LYMPHADENOPATHY	Cervical lymphadenopathy (≥1.5 cm diameter), usually unilateral *Examples:* Neck adenopathy Neck swelling

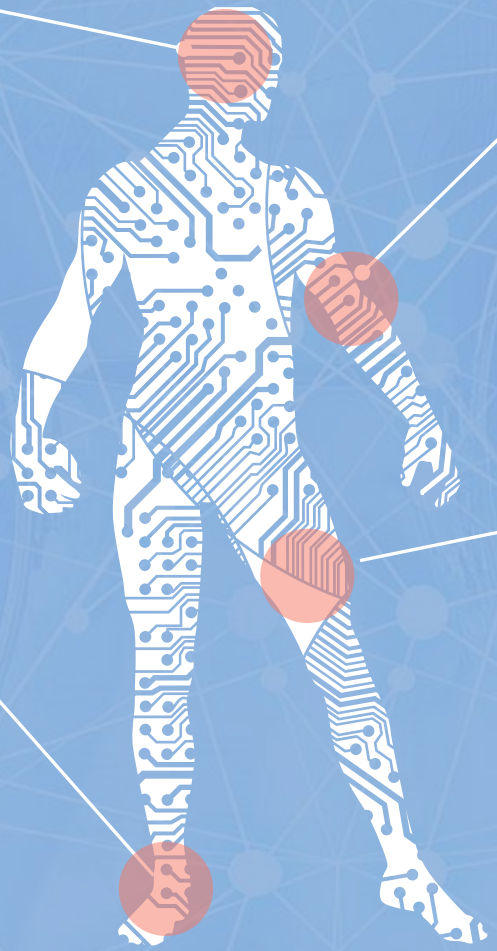
KD = Kawasaki disease.

Diagnostic Criteria for KD and List of Semantic Tags for KD Tagger With Examples

Statistics

Errors

The KD-NLP tool had some difficulties of misclassification. There were detected 11 false-negative low suspicious cases of KD patients (11 from a total of 173, i.e. 6.4%).



High performance

When identifying individual proofs of KD, the KD-NLP tool performed really well, with the highest sensitivity (> 95%) for *cervical lymphadenopathy*, *conjunctival injection* and *rash*.

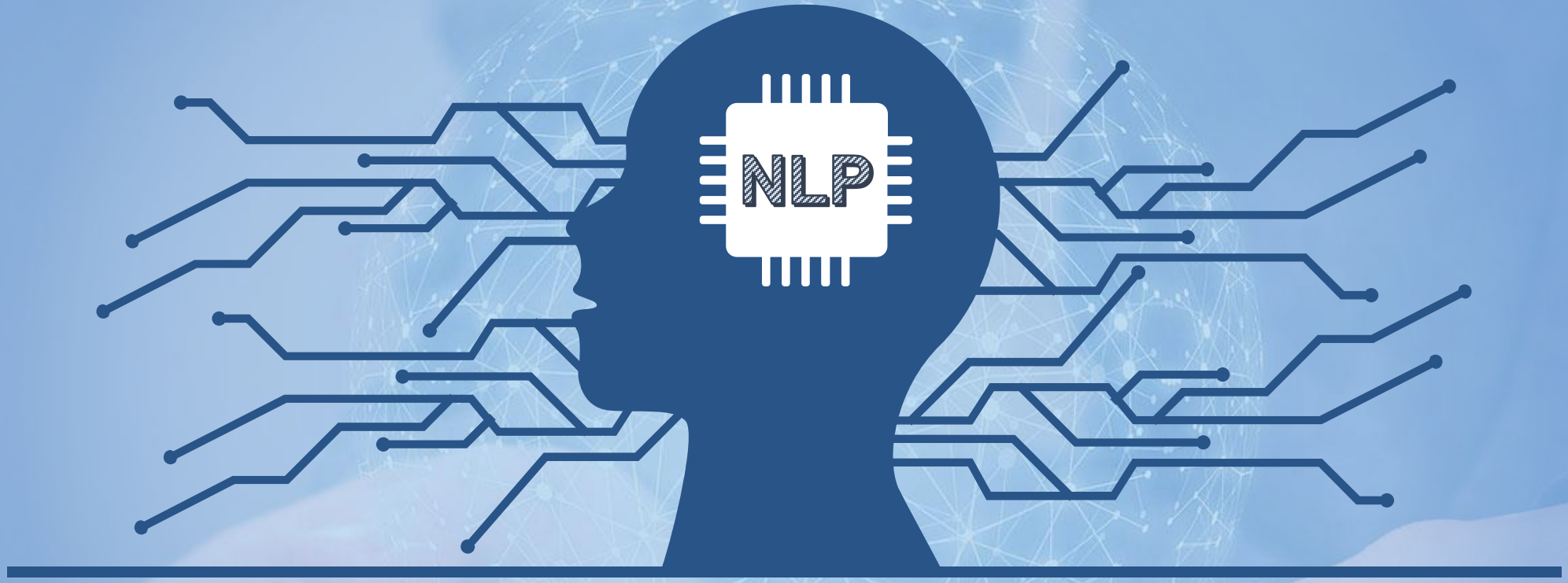
And 18 false-negative high suspicious cases of KD subjects (18 from a total of 180, i.e. 10%).

Also, the NLP tool was capable to distinguish all the patients suffering from fever.

Results

False-negative cases 11	False-positive cases 18
9 – (81.8%) **due to omission or misclassification of string patterns or keywords,** e.g., *"erythema of palms and soles"* was classified as POLYMORPHOUS_ EXANTHEMA rather than EXTREMITY_CHANGES due to the word erythema being common to both tags	**12 – (66.6%)** **due to assigning the wrong KD sign to a pattern** e.g., "erythema of pharynx" or "erythematous pharynx" as POLYMORPHOUS_EXANTHEMA
1 – (9.1%) **due to misspelling,** e.g., *"midl swelling to hands"*	**5 – (27.8%)** **due to failing to recognize the negation** e.g., *"neck without rigidity or adenopathy"*
1 – (9.1%) **due to preprocessing,** e.g., line break in sentence splitting	**1 – (5.6%)** **due to a hypothetical sentence in the discharge instructions** e.g., *"monitor at home for peeling of hands and feet"*

Sites	Sensitivity	Specificity
Site 1	92.7 (87.8 – 97.6)	79.0 (68.4 – 89.5)
Site 2	95.3 (90.1 – 100.0	73.9 (56.0 – 91.9)
Site 1 and Site 2 combined	93.6 (90.9 – 97.3)	77.5 (68.4 – 86.7)
Data is reported as % (CI) – confidence intervals		



Closing remarks

I want to mention once more, that the tool is considered to be a reliable source of knowledge utilized to identify a low or a high likelihood of a patient to suffer from Kawasaki disease, not as a proper tool to diagnose Kawasaki disease.


Thank You