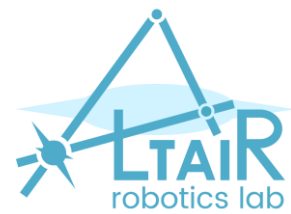




European
Research
Council



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Marseille

The Robotic Surgery Procedural Framebank

Marco Bombieri¹,
Marco Rospocher¹, Simone Paolo Ponzetto², Paolo Fiorini¹

1. University of Verona
2. University of Mannheim



UNIVERSITÀ
di **VERONA**



UNIVERSITÄT
MANNHEIM

Abstract



Robot-Assisted
minimally invasive surgery

Described in:



Tons of books and academic papers

Contain:

Surgical
Procedural
Knowledge



Useful for:

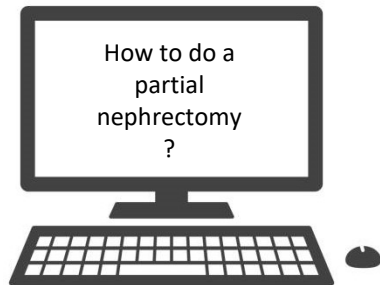
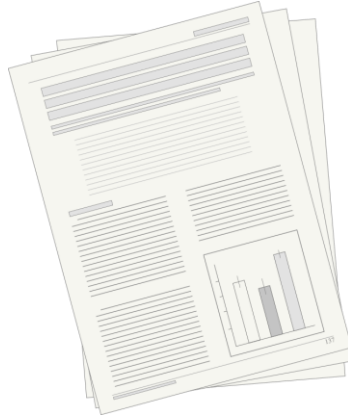
We need:

Development
of clinical
decision
support
systems

Development
of
automation
methods for
some steps



A lot of procedural surgical texts



Surgical
Procedural
Knowledge

"After the dissection of the hilar vessels Gerota's fascia is incised to expose the tumor."

Actions, instruments, surgical technique, anatomical parts, spatial or temporal attributes, purpose, ...

Surgical
Non-Procedural
Knowledge

"The renal fascia separates the adipose capsule of kidney from the overlying parental fat."

Surgical procedural knowledge: the one possessed by an intelligent agent able to perform a task.

Procedural surgical NLP applications

Improving
situation
awareness
modules

Developing
knowledge-based
decision-making
techniques

Summarization
systems

Automatic
generation of
procedural
guidelines

Drafting safety
checklist

Semantic Role
Labeling
(SRL)

Lexical
resources

PropBank

FrameNet

Frames in
general-English
are different
from the ones of
surgery

RSPF
Robotic Surgery
Procedural
Framebank

PropBank coverage for the robotic-surgical domain

SPKS
Dataset^[1]



Verbs

Nominalized-verbs

PropBank (PB)
comparison

PRESENT

PB has a frame file that adequately describes the use of the predicate

~41% in SPKS

MISSING ROLE

PB has a frame for the predicate, but does not include domain-specific semantic roles often used in our domain.

~36% in SPKS

MISSING FRAME

The lemma is already present in PB, but a proper frame is missing as the existing ones describe different meanings.

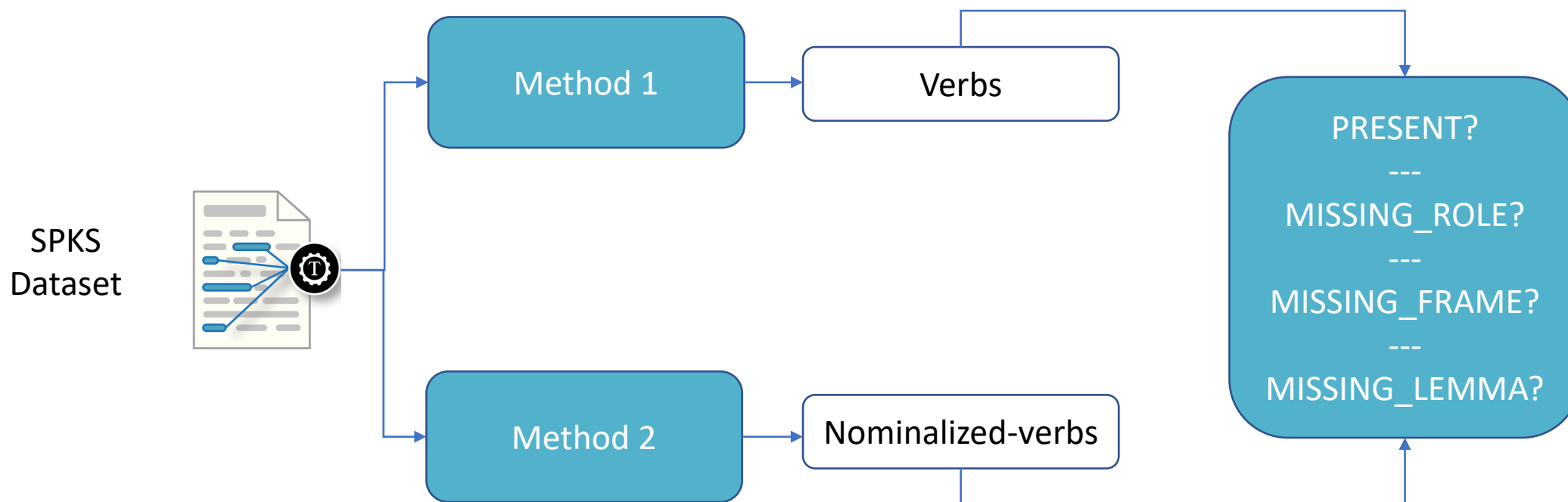
~21% in SPKS

MISSING LEMMA

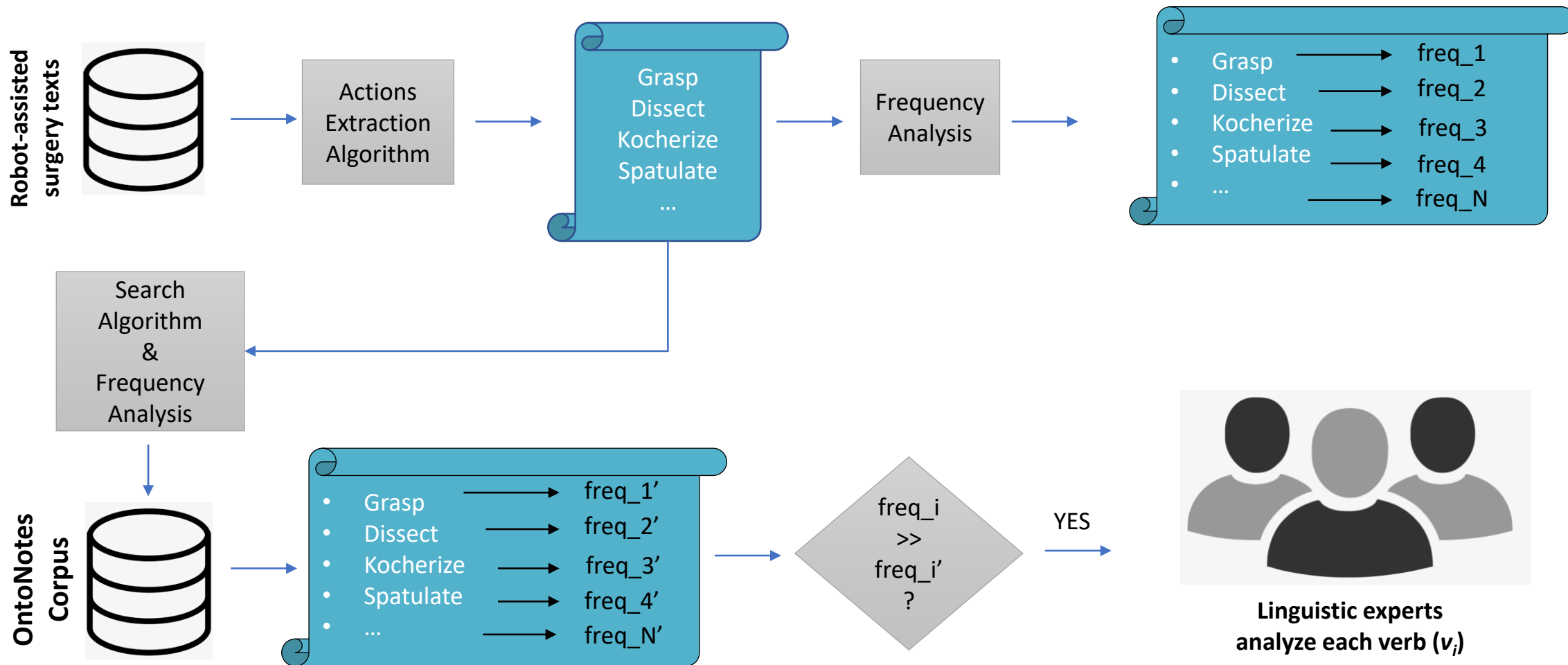
The lemma is not present in PB.

~2% in SPKS

PropBank coverage for the robotic-surgical domain



Method 1. Harvesting frame-evoking verbs



Method-2. Harvesting frame-evoking nouns

In medical English, a lot of actions are expressed using nouns rather than verbs.

- *At this point a **suturation** of the vein is carried out*
- *The **exposure** of renal hilum is now performed*
- ...



Unsupervised
keyword
extraction
problem

Filtering out
words ending
with specific
suffixes*

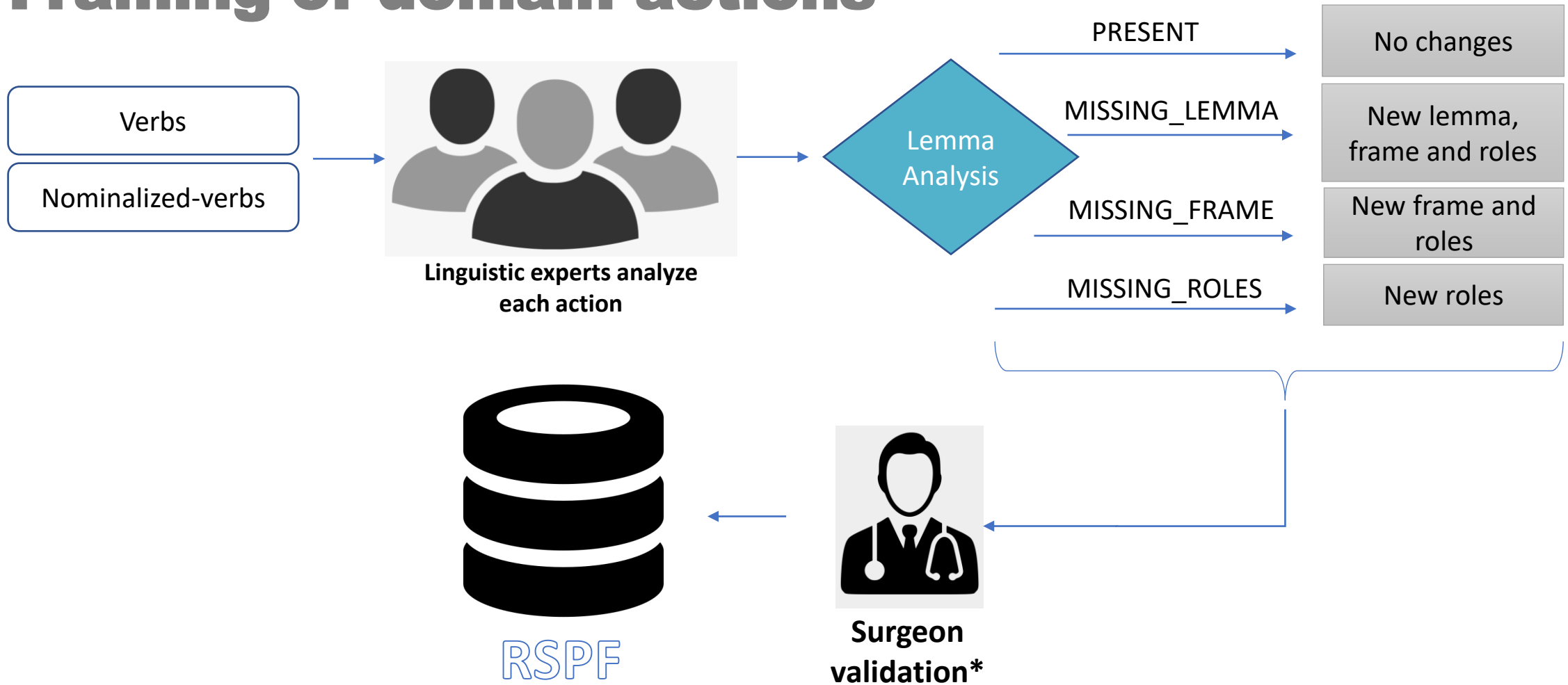
Manual
revision

Linguistic experts
analyze each noun



*suffixed analysed: *-sion* , *-son* , *-tion* , *-ment* , *-ery* , *-ence* , *-ance* , *-ure* , *-ize* , *-ify*

Framing of domain-actions



*of some lemmas

Verbs and nouns describing actions – examples

Action	Modification
Extraperitonealize	MISSING_LEMMA
Resect	MISSING_ROLE
Spatulate	MISSING_LEMMA
Skeletonize	MISSING_LEMMA
Kocherize	MISSING_LEMMA
Insufflate	MISSING_LEMMA
Redock	MISSING_LEMMA
Detubularize	MISSING_LEMMA
Grasp	MISSING_FRAME
Incise	MISSING_ROLE

Action	Ref. Verb	Modification
Placement	Place	PRESENT
Reflection	Reflect	MISSING_FRAME
Retraction	Retract	MISSING_ROLE
Resection	Resect	MISSING_ROLE
Mobilization	Mobilize	MISSING_FRAME
Exposure	Expose	PRESENT
Traction	---	MISSING_LEMMA
Administration	Administer	PRESENT
Identification	Identify	MISSING_FRAME
Excision	Excise	MISSING_ROLE

Some examples

```
<frameset>
  <predicate Lemma="skeletonize.01">
    <roleset id="skeletonize.01"
      name="the stripping of serosal tissues from certain structures,
      e.g., the round ligament, fallopian tube, to facilitate clamping
      or excision and minimize bleeding.">
      <note>Frames file for 'skeletonize' based on a definition given by
      "Concise Dictionary of Modern Medicine"</note>
      <roles>
        <role descr="agent" f="" n="0"> </role>
        <role descr="anatomical part skeletonized" f="" n="1"> </role>
      </roles>
      <example name="skeletonize - surgery" src="" type="">
        <text>The uterine vessels are then carefully skeletonized.</text>
        <arg f="" n="1">The uterine vessels</arg>
        <arg f="MNR" n="m">carefully</arg>
        <rel f="">skeletonized</rel>
      </example>
    </roleset>
  </predicate>
</frameset>
```

MISSING_LEMMA

```
<roleset id="approximate.02" name="To come near in position, to bring near.">
  <note>Frames file for 'approximate' based on survey of sentences in
  the SPKS corpus.</note>
  <roles>
    <role descr="agent" f="" n="0"></role>
    <role descr="entity coming close" f="" n="1"></role>
    <role descr="entity coming close to" f="" n="2"></role>
    <role descr="instrument" f="" n="3"></role>
    <role descr="other useful spatial indications" f="" n="4"></role>
  </roles>
  <example name="approximate - surgery" src="" type="">
    <text>Next, the musculofascial plate of the rectourethralis is
    approximated to the posterior neobladder, approximately 2-cm
    posterior to the planned urethral aperture, using 3-0
    polyglactin suture.</text>
    <arg f="tmp" n="m">Next</arg>
    <arg f="" n="1">the musculofascial plate of the rectourethralis</arg>
    <rel f="">approximated</rel>
    <arg f="" n="2">to the posterior neobladder</arg>
    <arg f="" n="4">approximately 2-cm posterior to the planned urethral
    aperture</arg>
    <arg f="" n="3">using 3-0 polyglactin suture</arg>
  </example>
</roleset>
```

MISSING_FRAME

Some examples

```
<frameset>
  <predicate Lemma="retract">
    <roleset id="retract.01" name="to take back.">
      <aliases>[...]</aliases>
      <roles>
        <role descr="taker back, agent" f="PAG" n="0">
          <vnrole vncls="10.1" vntheta="Agent"/>
        </role>
        <role descr="thing retracted" f="PPT" n="1">
          <vnrole vncls="10.1" vntheta="Theme"/>
        </role>
        <!--ADDED-->
        <role descr="instrument used for retraction" f="" n="2">
          </role>
        <role descr="technique / manner" f="" n="3"></role>
        <role descr="ending point or how much" n="4"></role>
        <!--*****-->
      </roles>
    </roleset>
  </predicate>
  [...]
  MISSING_ROLE
```

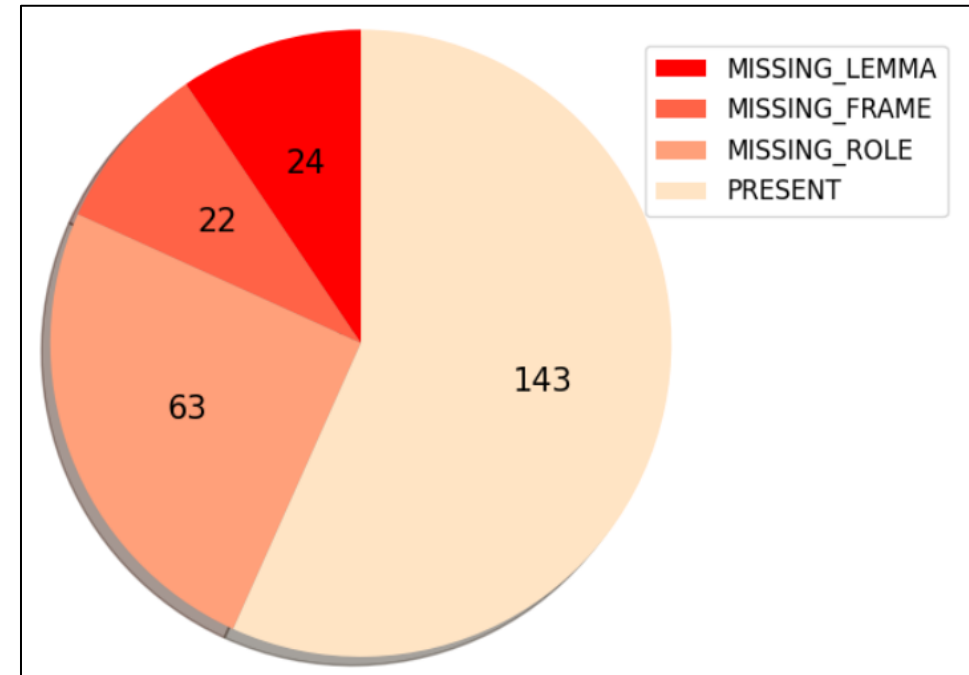
```
<!--ADDED-->
[...]
```

```
<example name="Surgery with arg2 and arg4" src="" type="">
  <text>The mediastinal pleura is then retracted posteriorly
  with cadiere forceps (arm 3).</text>
  <arg f="" n="1">The mediastinal pleura</arg>
  <arg f="tmp" n="m">then</arg>
  <rel f="">retracted</rel>
  <arg f="" n="4">posteriorly</arg>
  <arg f="" n="2">with cadiere forceps (arm 3)</arg>
</example>
<example name="Surgery with arg3" src="" type="">
  <text>The left lobe of the liver can easily be retracted
  using the suture-gauze liver suspension method.</text>
  <arg f="" n="1">The left lobe of the liver</arg>
  <rel f="">retracted</rel>
  <arg f="" n="3">using the suture-gauze liver suspension
  method.</arg>
</example>
[...]
```

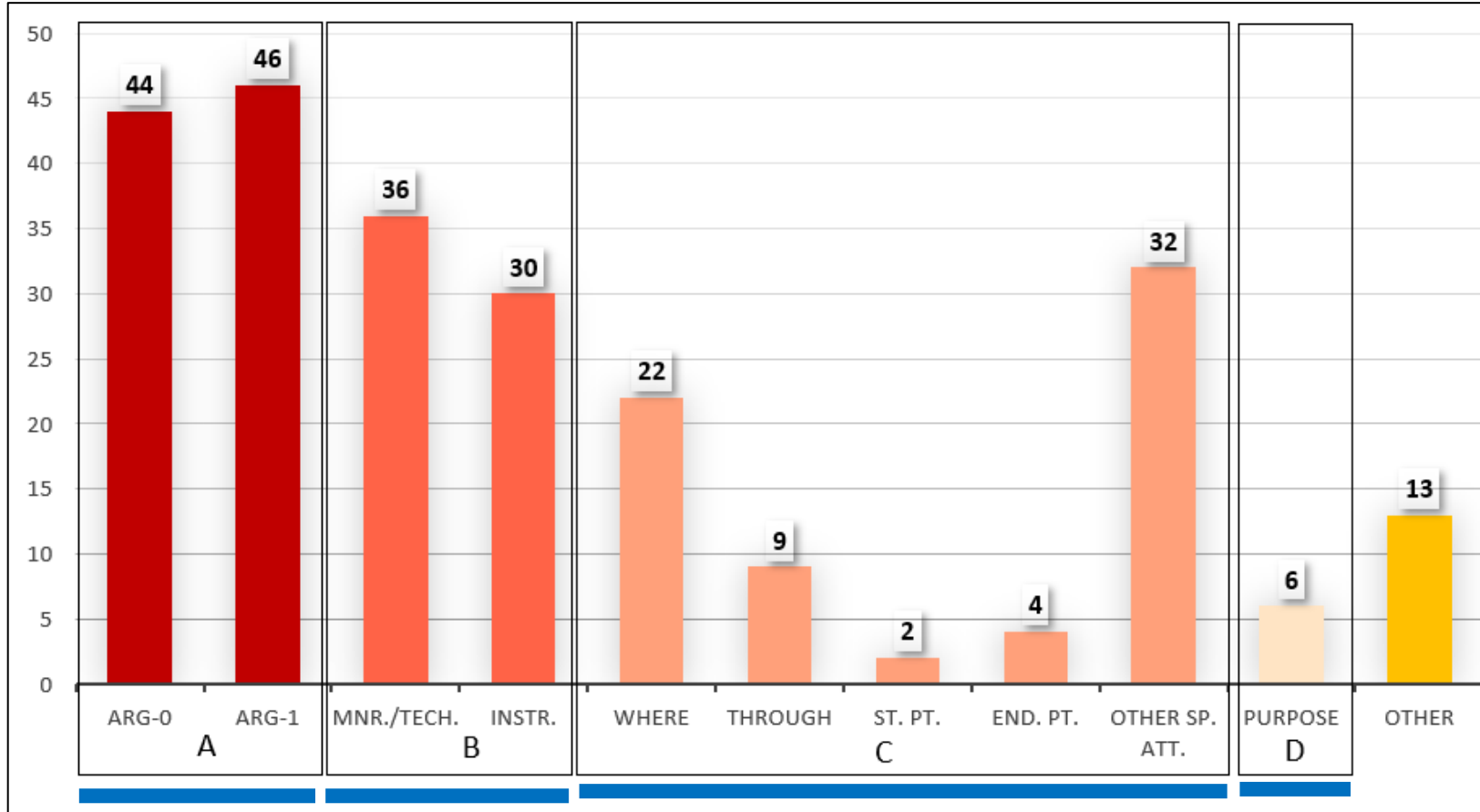
```
<!--*****-->
</roleset>
</predicate>
</frameset>
MISSING_ROLE
```

The Robotic Surgery Procedural Framebank

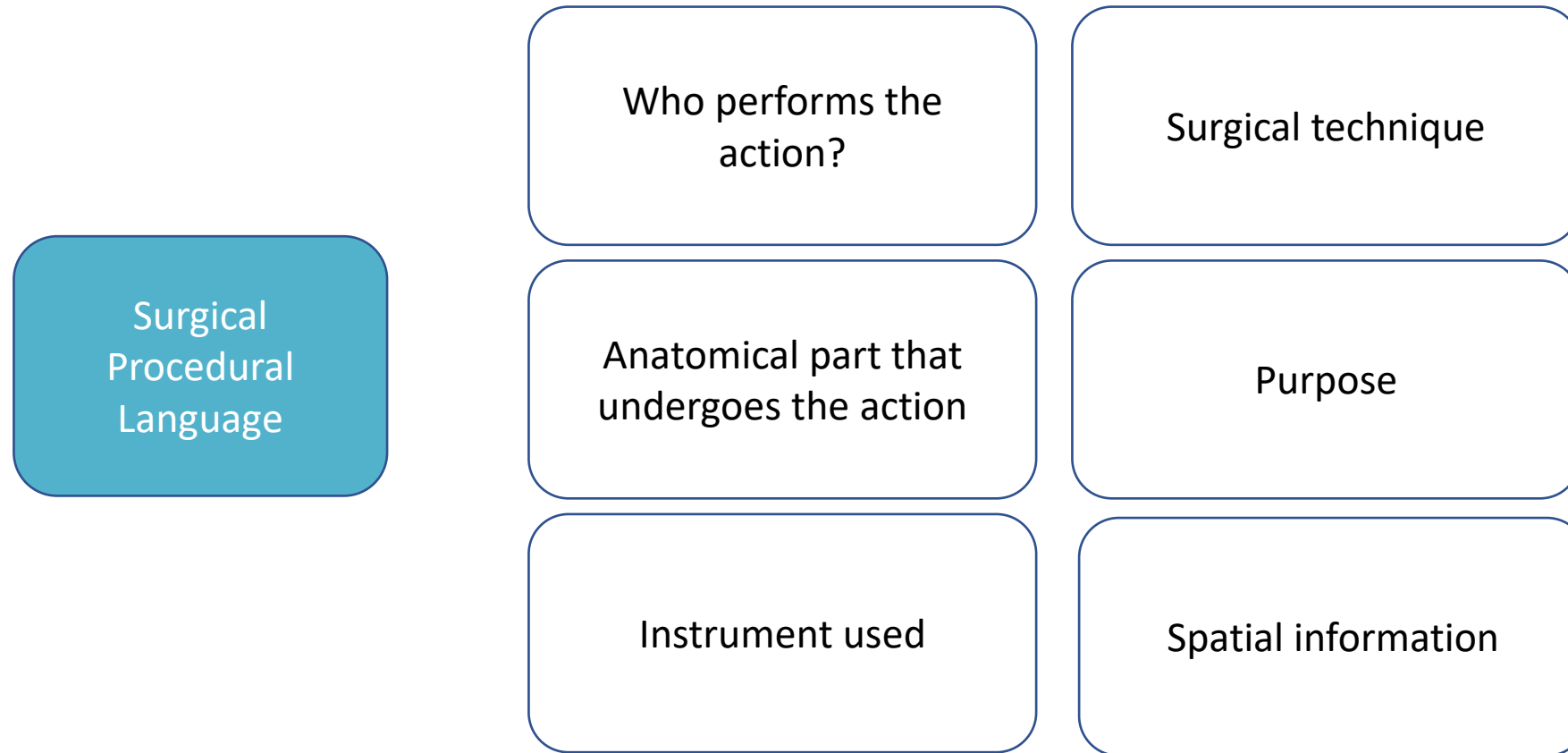
252 analyzed lemmas



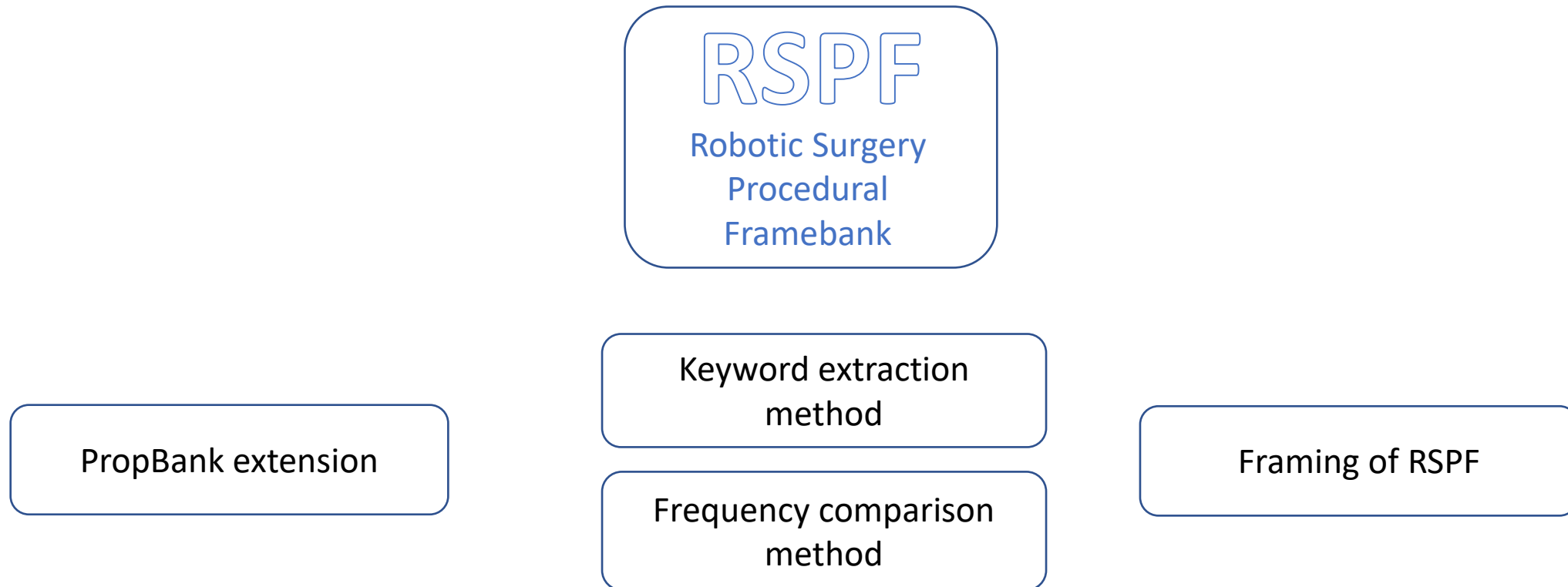
The Robotic Surgery Procedural Framebank



The Robotic Surgery Procedural Framebank



Conclusions



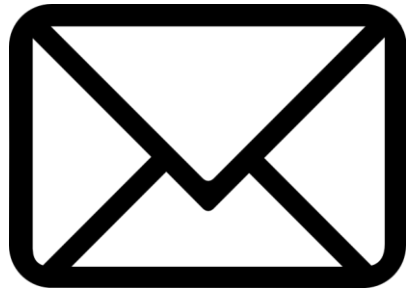
Future works

Annotating domain-specific texts with SRL information

Investigate the benefit of training/fine-tuning using domain specific annotations

Benchmark the coverage and quality of SOTA systems

Thanks for the attention!



E-MAIL:
marco.bombieri_01@univr.it



WEB-SITE:
<https://gitlab.com/altairLab/robotic-surgery-propositional-bank>

