



Terminology-based medication safety checking

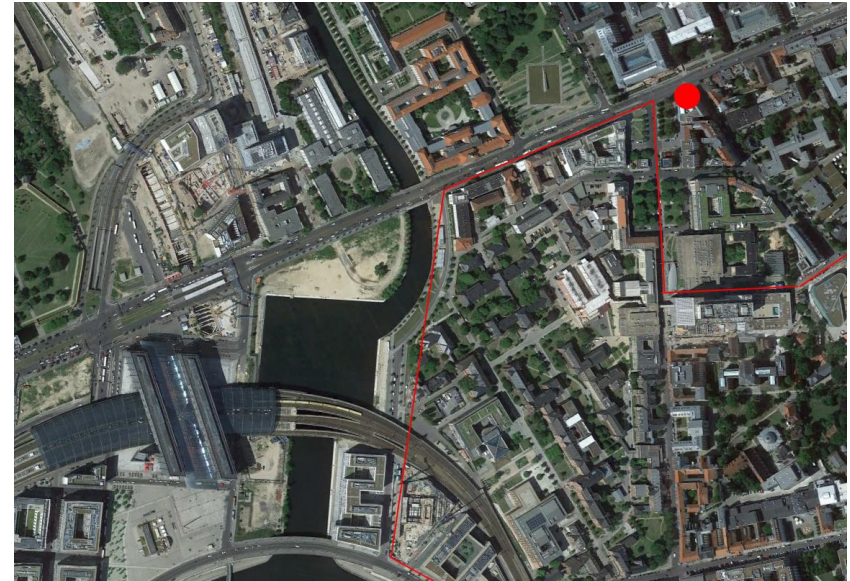
A new approach that combines
ontology-based algorithms with rule-
based expert knowledge

André Sander, ID Berlin

eHealth/HIMSS Summit,
Vienna/Austria, 23 May 2017

What is ID Berlin?

- Founded in 1985
- Based in Berlin, Germany
- 75 employees
 - Physicians, pharmacists, economists, linguists, developers
- 1400 customers in 6 countries
- 6 active languages
- Maintainer of the Wingert-Nomenclature and ID MACS®



Why „medication safety„?

- Almost every person in a hospital gets a medication
- Germany had 18.073.956 inbound cases in 2015¹

Z38 Liveborn infants according to place of birth

I50 Heart failure

I48 Atrial fibrillation and atrial flutter

S06 Intracranial injury

J18 Angina pectoris

I63 Cerebral infarction

I10 Essential (primary) hypertension

J18 Pneumonia, organism unspecified

I21 Acute myocardial infarction

K80 Cholelithiasis

- 11.3% of GDP is spent on healthcare²
- 15.4% of costs are for drugs (53bn)³

1 <https://browser.inek.org/Begleitforschung/views/PrimaryDiagsProcsInpatientPdCat.xhtml?dataYear=2015>

2 <https://www.destatis.de/DE/ZahlenFakten/GesellschaftStaat/Gesundheit/Gesundheitsausgaben/Gesundheitsausgaben.html>

3 https://www-genesis.destatis.de/genesis/online/logon?language=de&sequenz=tabellen&selectionname=23611*

Current Situation

- In 10% of these cases errors occur
→ 1.76 million cases (w/o deliveries)
- 10% need a treatment of these errors (severe complications)
→ 176.000 cases
- 10% of these cases result in death
→ 17.600 cases ... roughly¹

That are ~2% of all deaths (over all 925.200 deaths in 2015)²

Traffic deaths: ~3500³ → 5 timer lower!

¹ <http://www.ncbi.nlm.nih.gov/pubmed/11606147>

² <https://www.destatis.de/DE/ZahlenFakten/GesellschaftStaat/Gesundheit/Todesursachen/Tabellen/GestorbeneAnzahl.html>

³ <http://de.wikipedia.org/wiki/Verkehrstod>

What data is being checked?

- Demographic data
 - Age, gender, height, weight
- Medical data
 - Allergies (free text)
 - Pregnancy state, lactation, child wish, ...
 - Gene / metabolism related data
- Diagnostic data
 - ICD, free text
- Prescriptions / Administrations
 - Drug, ATC or free text based
- Laboratory values
 - Used for reasoning of diagnoses

How is it checked?

- Correct indication, missing indication
- Contraindications, Interactions
- Adverse reactions
- Allergies
- Dosage (absolute and lab value related)
- Dosage schema (length, application times,...)
- Route of administration
- CYP related effects
- Cumulated effects (QT prolonging drugs, enhanced AR risk)
- Off label use
- Urgent information (Dear Doctor Letter, etc.)

Why rules engines?

- Specific knowledge for
 - Dosages
 - Indications (off label)
 - Lab value interpretation
 - Urgent information

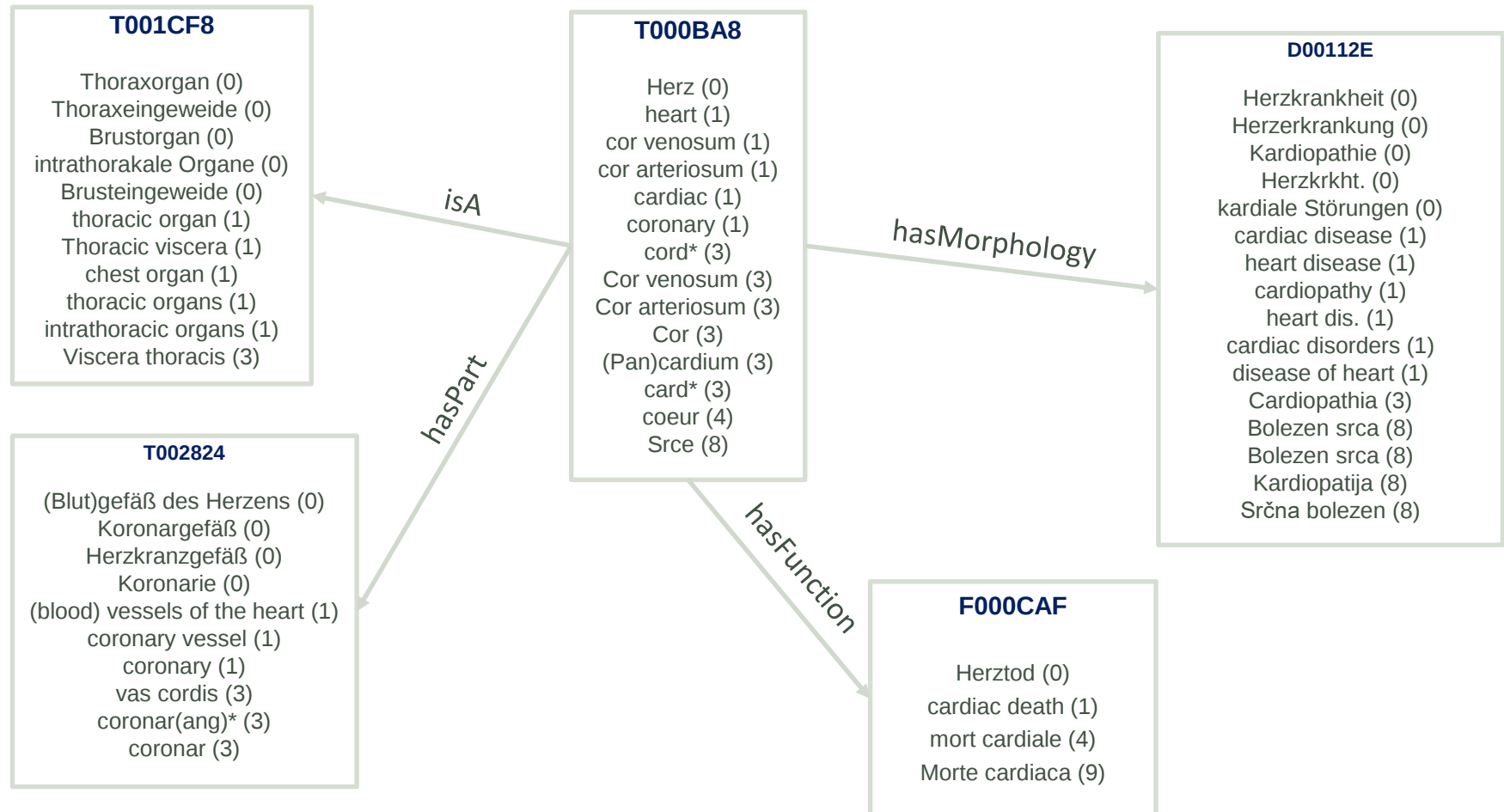
Why rules engines?

- Specific knowledge for
 - Dosages
 - Indications (off label)
 - Lab value interpretation
 - Urgent information
- Knowledge that
 - changes over time
 - is dependent from certain constraints
 - likely being adapted by users

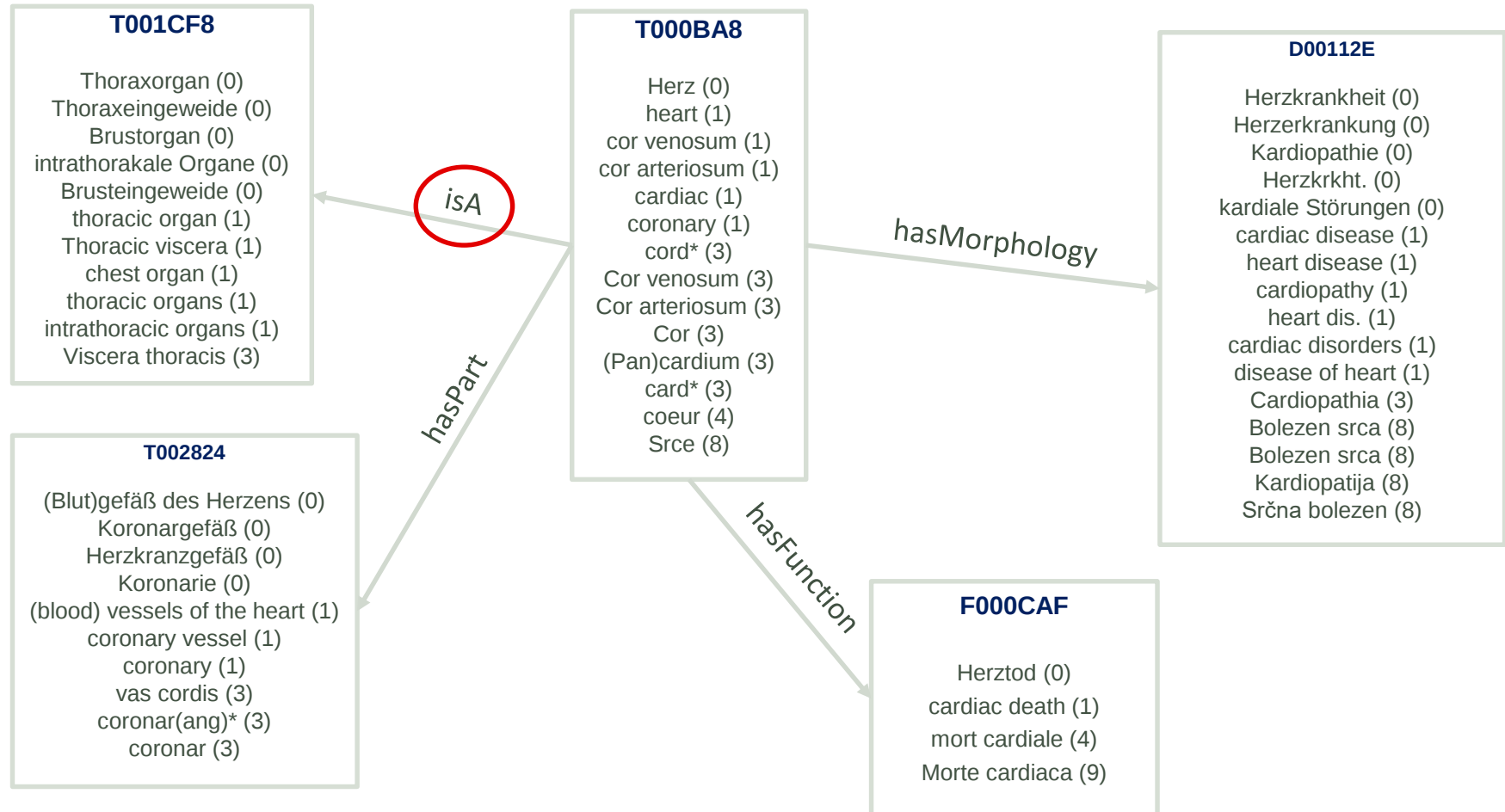
Why Ontologies?

Structured and language independent view
of the world („domain“)

Ontology sample



Ontology sample



How is it combined?

- A simple challenge:

“Create a rule, that alerts if a patient has a reduced bone density and gets a proton pump inhibitor!”

How is it combined?

Alert if a patient has a
[reduced bone density]
and gets a
[proton pump inhibitor]!

Implementation

maintenance:

```
title:  PPI and Reduced Bone Density;;  
mlmname:  PPI_ReducedBoneDensity;;  
arden: Version 2.5;;  
version:  1.00;;  
institution:  ID;;  
author:  AS;;  
specialist:  Dr. Maximillian Koenig;;  
date:  2017-03-10;;  
validation:  testing;;
```

library:

```
purpose:  PPI are suspected to enhance the risk of osteoporis;;  
explanation:  see action.;;  
keywords: PPI (E003230), Osteopenia (M002BF8), Osteoporosis (M0006E0);;  
citations:  ;;  
links:  ;;
```

Implementation

maintenance:

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mlmname: PPI_ReducedBoneDensity;;  
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explanation: see action;;  
keywords: PPI (E003230), Osteopenia (M002BF8), Osteoporosis (M0006E0);;  
citations: ;;  
links: ;;
```

Implementation

knowledge:

```
type: data-driven;;
```

```
data:
```

```
trigger:= event {E003230}; /* PPI */
```

```
wncMatches:= interface {wncMatches};
```

```
pznMatches:= interface {pznMatches};
```

```
tradeNameMatches:= interface {tradeNameMatches};
```

```
hasIndex:= interface {hasIndex};
```

```
urlDoc := "";
```

```
;;
```

```
evoke: any of (trigger);;
```

```
logic:
```

```
has_BoneDensityReduction:= call hasIndex with "M0023ED";
```

```
conclude has_BoneDensityReduction;
```

```
;;
```

```
action:
```

```
has_Osteoporosis:= call hasIndex with "M0006E0";
```

```
if (has_Osteoporosis) then
```

```
return "-1|-1|WN|393219|V0010AE|${rs_PCHK_TYPE_393219L}|${E003230}|${rs_PH_WN_PPI_OSTEOPOROSIS}|||0|" || urlDoc ||  
"|E003230";
```

```
else
```

```
return "-1|-1|WN|393219|V0010AE|${rs_PCHK_TYPE_393219L}|${E003230}|${rs_PH_WN_PPI_BONE_DENSITY_REDUCTION}|||0|" || urlDoc ||  
"|E003230";
```

```
endif;
```

```
;;
```

Implementation

knowledge:

type: data-driven;;

data:

trigger:= event {E003230}; */* DPI */*

wncMatches:= interface {wncMatches};

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urlDoc := "";

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action:

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if (has_Osteoporosis) then

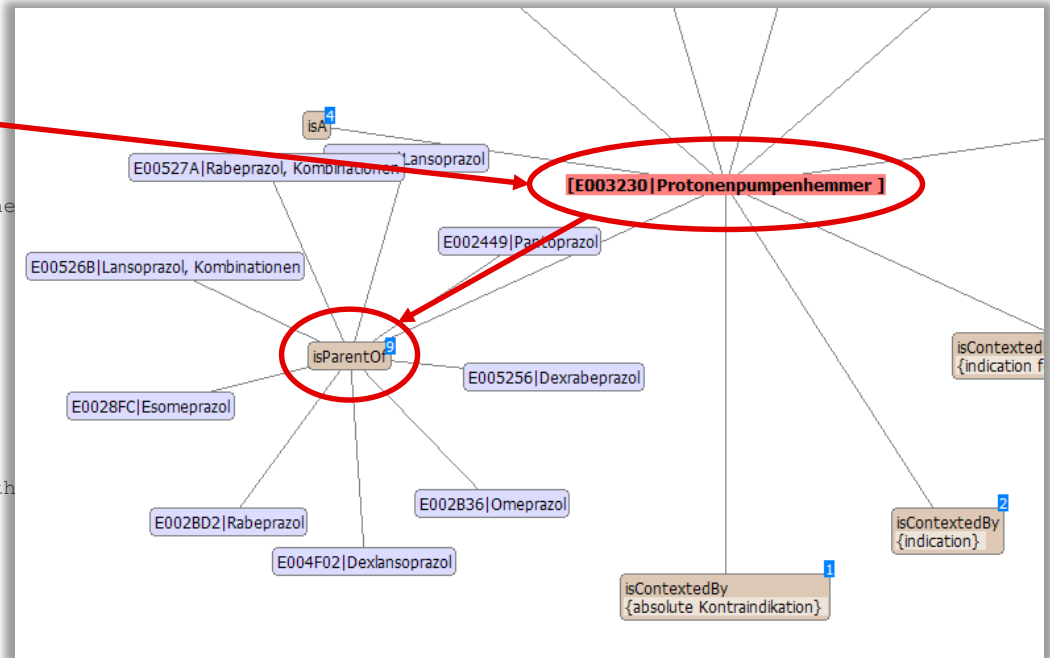
return "-1|-1|WN|393219|V0010AE|\${rs_PCHK_TYPE_393219L}|\${E003230}|\${rs_PH_WN_PPI_OSTEOPOROSIS}|||0|" || urlDoc ||
" |E003230";

else

return "-1|-1|WN|393219|V0010AE|\${rs_PCHK_TYPE_393219L}|\${E003230}|\${rs_PH_WN_PPI_BONE_DENSITY_REDUCTION}|||0|" || urlDoc ||
" |E003230";

endif;

;;



Implementation

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```

```
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```
  wncMatches:= interface {wncMatches};
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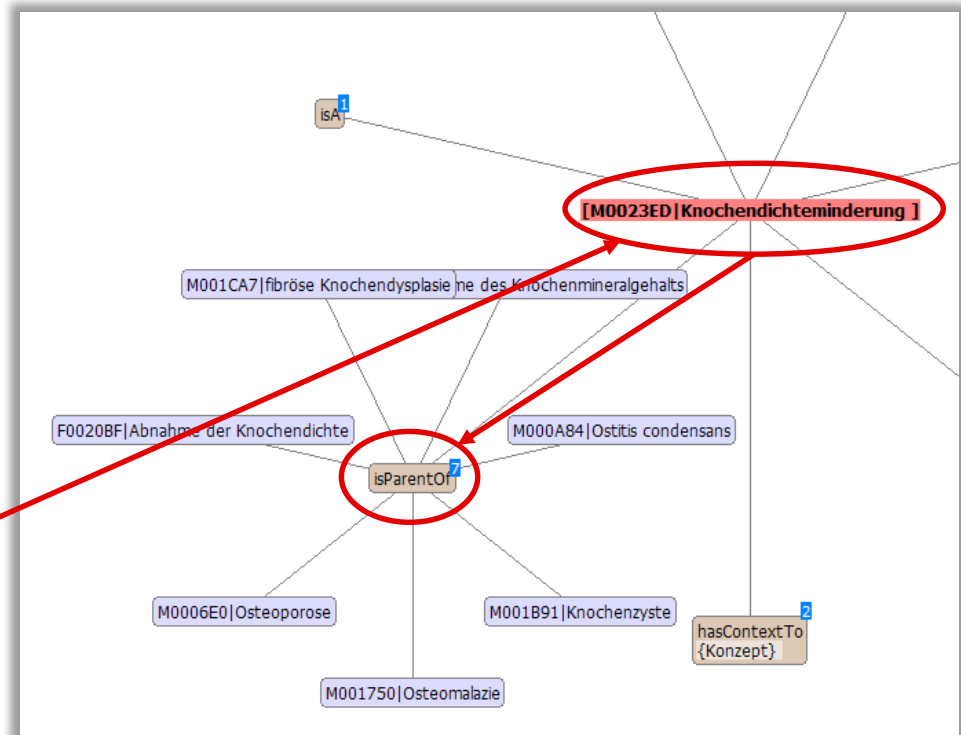
```
    return "-1|-1|WN|393219|V0010AE|${rs_PCHK_TYPE_393219L}|${E003230}|${rs_PH_WN_PPI_OSTEOPOROSIS}|||0|" || urlDoc ||  
    "|E003230";
```

```
  else
```

```
    return "-1|-1|WN|393219|V0010AE|${rs_PCHK_TYPE_393219L}|${E003230}|${rs_PH_WN_PPI_BONE_DENSITY_REDUCTION}|||0|" || urlDoc ||  
    "|E003230";
```

```
  endif;
```

```
;;
```



Implementation

knowledge:

```
type: data-driven;;
```

```
data:
```

```
  trigger:= event {E003230}; /* PPI */
```

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  wncMatches:= interface {wncMatches};
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  pznMatches:= interface {pznMatches};
```

```
  tradeNameMatches:= interface {tradeNameMatches};
```

```
  hasIndex:= interface {hasIndex};
```

```
  urlDoc := "";
```

```
;;
```

```
evoke: any of (trigger);;
```

```
logic:
```

```
  has_BoneDensityReduction:= call hasIndex with "M0023FD";
```

```
  conclude has_BoneDensityReduction;
```

```
;;
```

```
action:
```

```
  has_Osteoporosis:= call hasIndex with "M0006E0"
```

```
  if (has_Osteoporosis) then
```

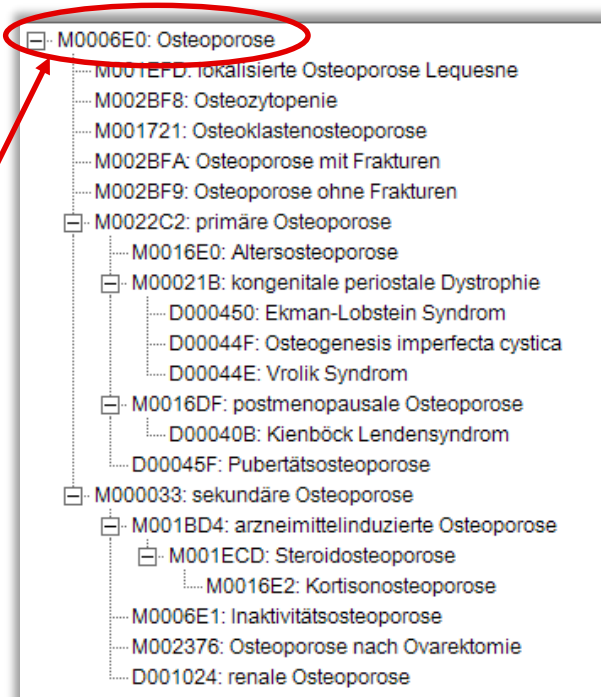
```
    return "-1|-1|WN|393219|V0010AE|${rs_PCHK_TYPE_393219L}|${E003230}|${rs_PH_WN_PPI_OSTEOPOROSIS}|0|" || urlDoc ||  
    "|E003230";
```

```
  else
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```
    return "-1|-1|WN|393219|V0010AE|${rs_PCHK_TYPE_393219L}|${E003230}|${rs_PH_WN_PPI_BONE_DENSITY_REDUCTION}|0|" || urlDoc ||  
    "|E003230";
```

```
  endif;
```

```
;;
```



Conclusion

- Efficient and compact way of creating rules
- Integrating free text into (otherwise) structured rules
- Separating immanent from rule based knowledge
- Todo: Using a more standardized syntax

Contact

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