Metrics

USING NUVA TO ANALYSE CODE SYSTEMS

Objective

Provide to code systems designers a tool to evaluate the ability of a code system to represent precisely and exhaustively every vaccination administration record.

Help them in improving their codifications.

Gather and distribute alignments across code systems.

International Vaccine Codes

Method

- Based upon the unified nomenclature of vaccines NUVA, that:
  - Gathers the concepts from any available code system
  - Describes the function of each vaccine through its valences
  - Allows to navigate through different levels of precision with the hierarchy of valences.
- Map every NUVA concept to the most precise possible equivalent in the candidate code system.
- Completeness is the percentage of NUVA concepts that could be mapped
- Precision is the average number of NUVA concepts that are confused within a same code from the candidate code system.

International Vaccine Codes

Mapping rule

If the NUVA code matches exactly an external code, then the mapping exists and is univocal (NUVA VAC0551 = CVX130)

Otherwise, the NUVA code is considered as mappable if:

- It contains all valences of the candidate code (or more precise versions of the same valences)
- It does not contain any valence that is not in the candidate code

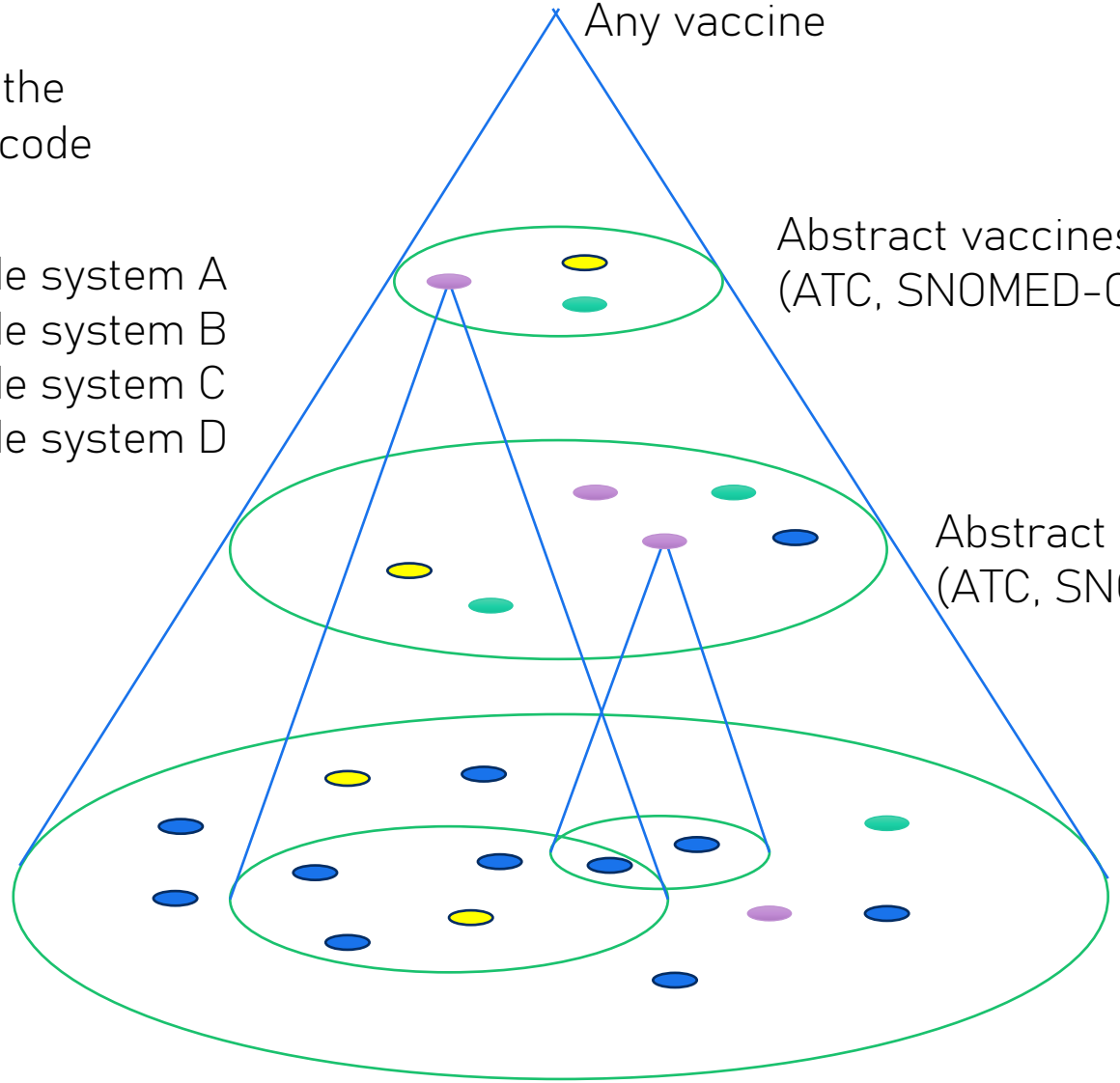
Vaccine	Precise valences	Parent valences	CVX code
AMBIRIX	HepA-bv-PED	HepA-I	104
	rGBsAg-20	HepB	

International Vaccine Codes

The abstraction cone

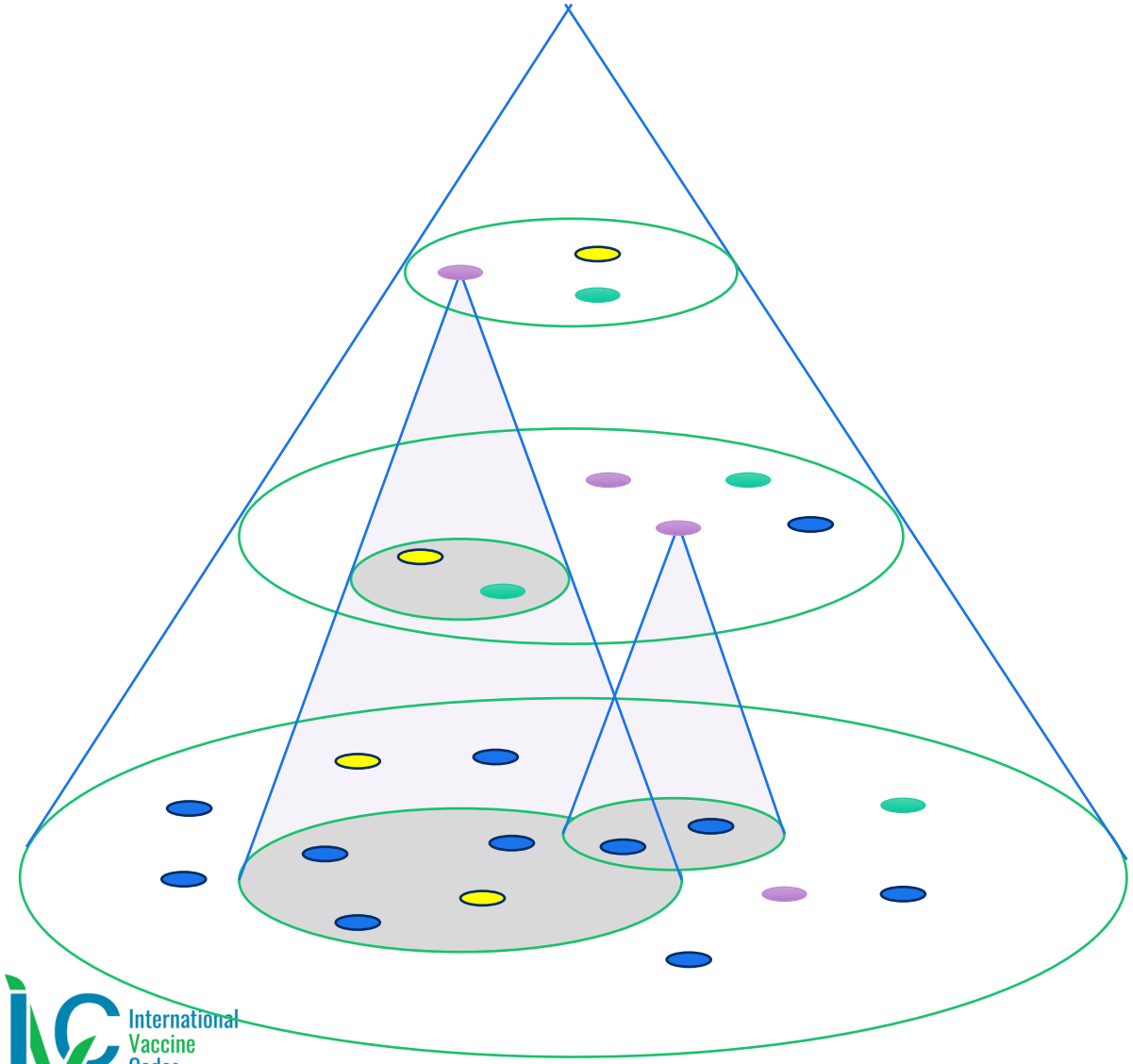
NUVA aggregates the concepts from all code systems.

- Code system A
- Code system B
- Code system C
- Code system D



International Vaccine Codes

Completeness



What share of concepts is covered by a code system.

According to the purpose, it may be measured:

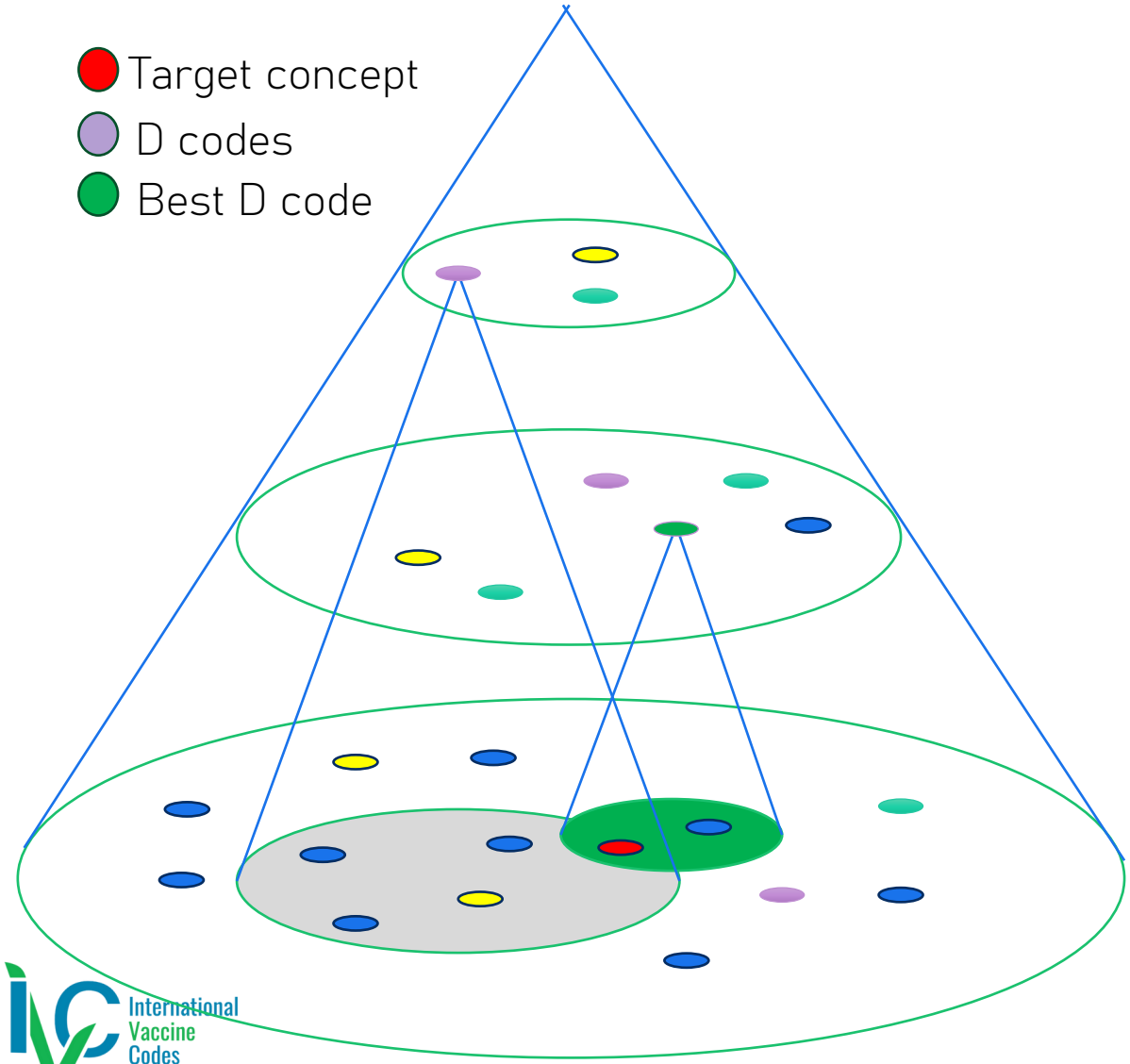
- Against all concepts
- Against abstract vaccine concepts

Code system	All	Abstract
ATC	83%	71%
CVX (US)	88%	82%
CVC (CAN)	80%	64%
CNK (BEL)	9%	-

Ex. There is no ATC code for a multivalent vaccine against Typhoid, Diphtheria and Tetanus.

International Vaccine Codes

Precision



Within the covered concepts, blur is the number of concepts that cannot be differentiated by their external code, once an optimal representation has been selected.
When several codes can be used for a same concept, use the one with the minimal blur.
Precision is the inverse of the average blur.

Code system	All	Abstract
ATC	9%	38%
CVX (US)	14%	56%
CVC (CAN)	24%	44%
CNK (BEL)	100%	-

Ex. On the average, an ATC code covers 11 concepts.

International Vaccine Codes

Illustration

- Completeness
  REPEVAX is a quadrivalent vaccine for Diphtheria, Pertussis, Poliomyelitis and Tetanus, with adult doses. There is no CVX code for such a combination (only CVX-130 for pediatric doses)
- Precision
  The best CVX code for FLUENZ TETRA is CVX-111. It makes it undiscernible from 3 other vaccines.

Vaccine	Valence	Valence description	#
FLUENZ TETRA	Inf-4L	Quadrivalent live attenuated influenza vaccine	1
CVX-111	Inf-L	Influenza vaccine, live attenuated	4
CVX-88	Inf	Influenza vaccine, unspecified	86

International Vaccine Codes

Redundancy

For a given external code, there is one and only one equivalent NUVA code.

But several codes in the external code system can match a same NUVA code since NUVA is blind to all aspects that are not relevant for long-term vaccination history:

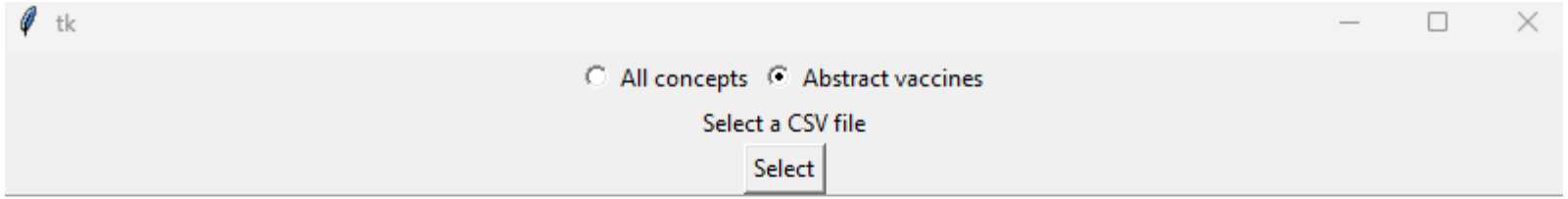
- CVX-120 and CVX-170 are both VAC0506-DTaP/IPV/HIB vaccine, used in the US or not.
- CNK-475946 and CNK-288461 are both VAC007-GARDASIL, with solvent presented in flask or in prefilled syringes.

Redundancy is measured as the average number of external codes for a NUVA code.

Code system	All	Abstract
ATC	1.0	1.0
CVX (US)	1.2	1.3
CVC (CAN)	1.1	1.1
CNK (BEL)	2.5	-

Tooling

Python script NUVA_Eval.py




```
Loading code graph
Retrieve the list of NUVA codes
Retrieve NUVA codes matching specific external codes
Retrieve NUVA codes matching abstract external codes
Create best codes report ATC/nuva_best_ATC_full.csv
Create reverse codes report ATC/nuva_reverse_ATC_full.csv
Create metrics report ATC/nuva_metrics_ATC_full.txt
```

Input is a CSV mapping file
(Label is optional)
Reference files are available
from https://ivci.org/nuva

	1	2	3
1	CVX	NUVA	Label
2	CVX-211	VAC1129	COVID-19 protein subunit vaccine, recombinant spike protein in nanoparticle
3	CVX-219	VAC1188	COVID-19 mRNA vaccine encoding the spike protein of SARS-CoV-2, original
4	CVX-183	VAC0111	Yellow fever vaccine, unspecified
5	CVX-48	VAC0345	Hib PRP-T conjugated vaccine, unspecified
6	CVX-90	VAC0131	Rabies vaccine, unspecified
7	CVX-41	VAC0713	Typhoid polysaccharide vaccine, unspecified
8	CVX-15	VAC0821	Inactivated influenza vaccine, split or subunit, unspecified
9	CVX-64	VAC0898	Leishmaniasis vaccine, unspecified
10	CVX-178	VAC0600	OPV bivalent 1-3, unspecified
11	CVX-19	VAC0134	BCG vaccine, unspecified
12	CVX-198	VAC0599	DTPerHibHepB pentavalent vaccine, unspecified
13	CVX-216	VAC1163	20-valent Pneumococcus conjugate vaccine, unspecified
14	CVX-35	VAC0132	Tetanus vaccine, unspecified
15	CVX-108	VAC0152	Unconjugated meningococcal vaccine ACWY, unspecified
16	CVX-103	VAC0150	Meningococcal conjugate vaccine C, unspecified
17	CVX-130	VAC0551	DTaPIPV vaccine, standard dose, unspecified

International Vaccine Codes

Tooling results

Metrics

```
NUVA version :1.0.898

Number of NUVA concepts : 1331
Number of unmapped concepts: 156
Completeness: 88.3%

Number of aligned codes: 252
Average blur of aligned codes 7.1
Precision: 14.1%
Redundancy: 1.25
```

Best options in code system for each concept

	NUVA	Label	IsAbstract	Cardinality	Best CVX
2	VAC0001	ACT-HIB	false	10	['CVX-48']
3	VAC0002	AGRIPPAL	false	49	['CVX-168']
4	VAC0003	AVAXIM 160 (	false	5	['CVX-52']
5	VAC0004	D.T. POLIO M	false	8	['CVX-195']
6	VAC0005	DUKORAL	false	2	['CVX-172']
7	VAC0006	FLUVIRINE	false	49	['CVX-168']
8	VAC0007	GARDASIL	false	5	['CVX-62']
9	VAC0008	GRIPGUARD	false	49	['CVX-168']
10	VAC0009	HBVAXPRO 1	false	15	['CVX-42', 'CVX-08']
11	VAC0010	HBVAXPRO 4	false	5	['CVX-44']
12	VAC0011	HBVAXPRO 5	false	40	['CVX-45']
13	VAC0012	IMMUGRIP	false	49	['CVX-168']

Codable concepts for each code

	CVX	Label	Cardinality	May code	Blur	Best code for
29	CVX-307	BEYFORTUS 100 mg (nirsevimab)	1	['VAC1050']	1	['VAC1050']
30	CVX-520	COMIRNATY ORIGINAL/OMICRON BA.1 (15/15 Â	1	['VAC1021']	1	['VAC1021']
31	CVX-29	CMV immune globulin	2	['VAC1097', 'VAC1062']	2	['VAC1062', 'VAC1097']
32	CVX-146	Hexavalent vaccine DTPCaHibHepB - Diphtheri	9	['VAC0552', 'VAC0510', 'VAC(	9	['VAC0014', 'VAC0098', 'VAC0507', 'VAC0
33	CVX-166	Quadrivalent influenza vaccine, unspecified	15	['VAC0706', 'VAC0563', 'VAC1	15	['VAC0517', 'VAC0562', 'VAC0563', 'VAC0
34	CVX-24	Adjuvanted adsorbed anthrax vaccine	5	['VAC0948', 'VAC0200', 'VAC1	5	['VAC0193', 'VAC0200', 'VAC0948', 'VAC1
35	CVX-315	Respiratory Syncytial Virus monoclonal antibo	6	['VAC0923', 'VAC1050', 'VAC1	2	['VAC0923', 'VAC1147']
36	CVX-64	Leishmaniasis vaccine, unspecified	1	['VAC0898']	1	['VAC0898']
37	CVX-228	COVID-19 mRNA vaccine, original virus, 25 Âµg	1	['VAC1072']	1	['VAC1072']
38	CVX-67	Malaria vaccine, unspecified	4	['VAC0154', 'VAC1383', 'VAC1	4	['VAC0154', 'VAC1056', 'VAC1237', 'VAC1
39	CVX-177	10-valent Pneumococcus conjugate vaccine, u	2	['VAC1233', 'VAC0083']	2	['VAC0083', 'VAC1233']
40	CVX-52	Inactivated hepatitis A vaccine, adult dose, un	5	['VAC0166', 'VAC1020', 'VAC(	5	['VAC0003', 'VAC0049', 'VAC0166', 'VAC0
41	CVX-36	Varicella-Zoster immunoglobulin, unspecified	3	['VAC1091', 'VAC0442', 'VAC(	3	['VAC0442', 'VAC0864', 'VAC1091']
42	CVX-196	Diphtheria-tetanus Td vaccine, unspecified	15	['VAC0962', 'VAC1310', 'VAC1	15	['VAC0175', 'VAC0491', 'VAC0731', 'VAC0
43	CVX-176	Chicken embryo rabies vaccine, unspecified	6	['VAC0781', 'VAC0942', 'VAC(	6	['VAC0028', 'VAC0253', 'VAC0355', 'VAC0
44	CVX-137	HPV Vaccine	13	['VAC0156', 'VAC1284', 'VAC(	2	['VAC0156', 'VAC1278']

International Vaccine Codes

Interpreting the metrics

The metrics are not quality indicators by themselves, their importance depends upon the purpose of the given code system.

Completeness and Precision are often contradictory.
"Any vaccine" code would be 100% complete but totally unprecise.
Pharmaceutical codes are 100% precise but cannot cope with historical abstract records.

Redundancy is legitimate for codes that address other dimensions than the NUVA scope.
If needed, the abstraction code could be extended downward to address such dimensions.

Code system	Complete	Precise	Redundant
ATC	83%	71%	1.0
CVX (US)	88%	82%	1.2
CVC (CAN)	80%	64%	1.1
CNK (BEL)	9%	-	2.5