CLINICAL SOLID WASTE CLASSIFICATION

An Artificial Intelligence-based Approach

BACKGROUND WORK

Neves *et. al*

BACKGROUND WORK

Neves *et. al*

BIOMEDICAL ENGINEERING

BACKGROUND WORK

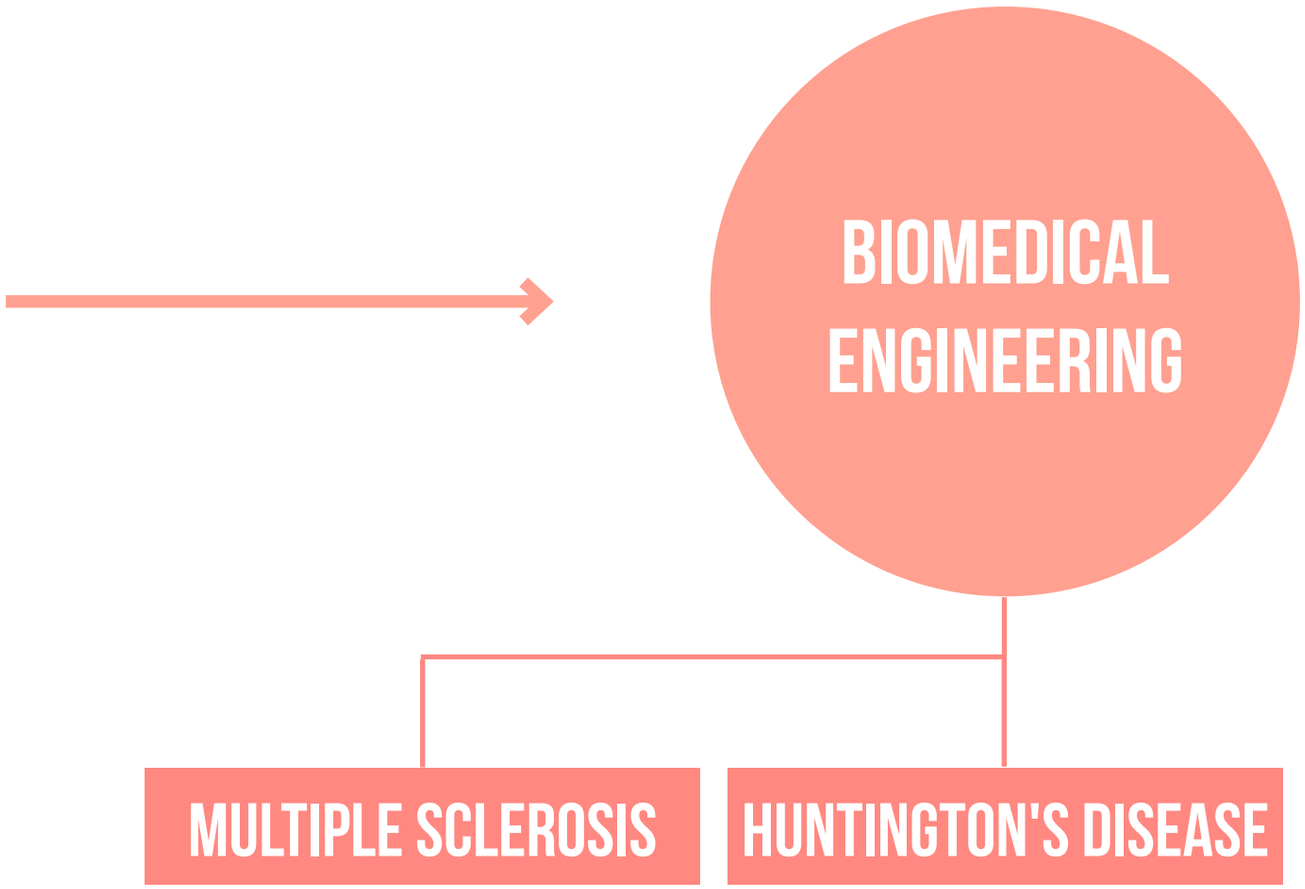
Neves *et. al*

BIOMEDICAL ENGINEERING

MULTIPLE SCLEROSIS

BACKGROUND WORK

Neves *et. al*



BACKGROUND WORK

Neves *et. al*

BIOMEDICAL ENGINEERING

MULTIPLE SCLEROSIS

HUNTINGTON'S DISEASE

CLINICAL WASTE

BACKGROUND WORK

Neves *et. al*

BIOMEDICAL ENGINEERING

MULTIPLE SCLEROSIS

HUNTINGTON'S DISEASE

CLINICAL WASTE

CLINICAL SOLID WASTE

Definition

"(...) clinical solid waste consist of solid waste materials which are generated during diagnosis, treatment, vaccination, research or in the production or testing of biological products for humans and animals, including syringes, live vaccines, blood and other waste contaminated with bodily fluids and removed body organs, among others."

Medical Waste Tracking Act
1988

CLINICAL SOLID WASTE

Relevance

WASTE MANAGEMENT

CLINICAL SOLID WASTE

Relevance

WASTE MANAGEMENT

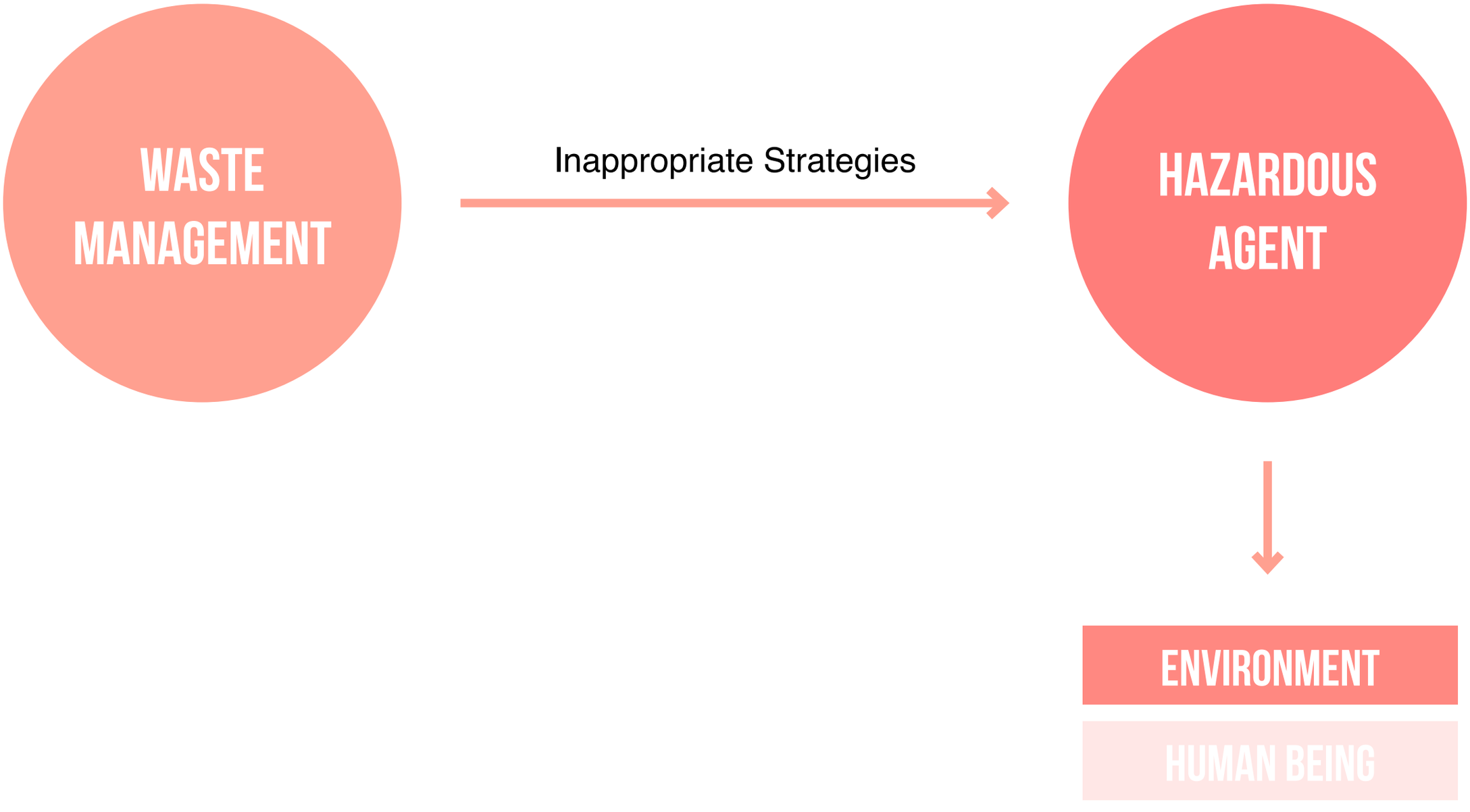
Inappropriate Strategies

CLINICAL SOLID WASTE

Relevance

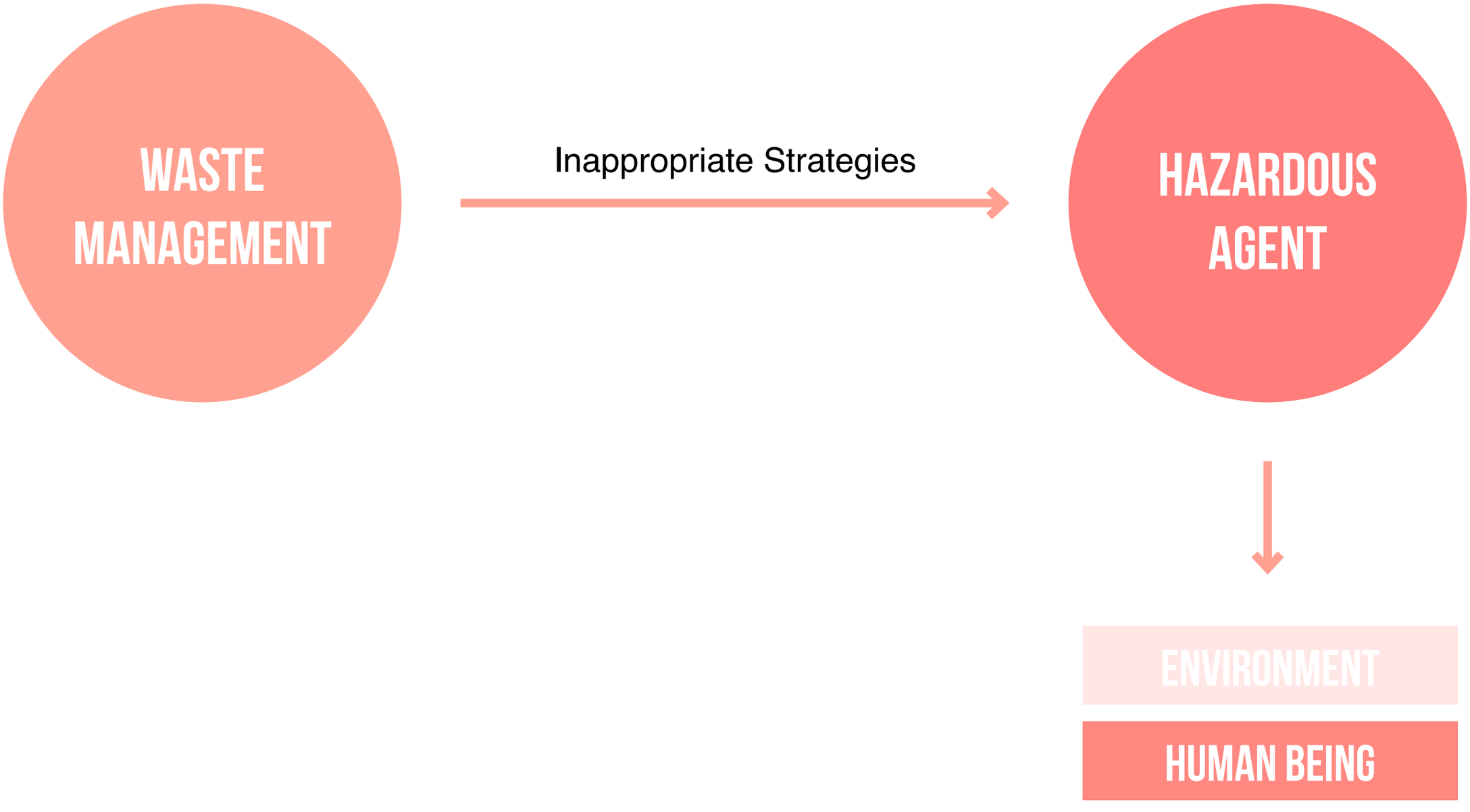
CLINICAL SOLID WASTE

Relevance



CLINICAL SOLID WASTE

Relevance



CLINICAL SOLID WASTE

Relevance

WASTE MANAGEMENT

Inappropriate Strategies

HAZARDOUS AGENT

Healthcare Workers

Waste Handlers

General Public

ENVIRONMENT

HUMAN BEING

CLINICAL SOLID WASTE

Motivation

WASTE CLASSIFICATION

Human Factor

ERRORS

CLINICAL SOLID WASTE

Motivation

ERRORS

Artificial Intelligence

DECISION SUPPORT SYSTEM

CASE STUDY

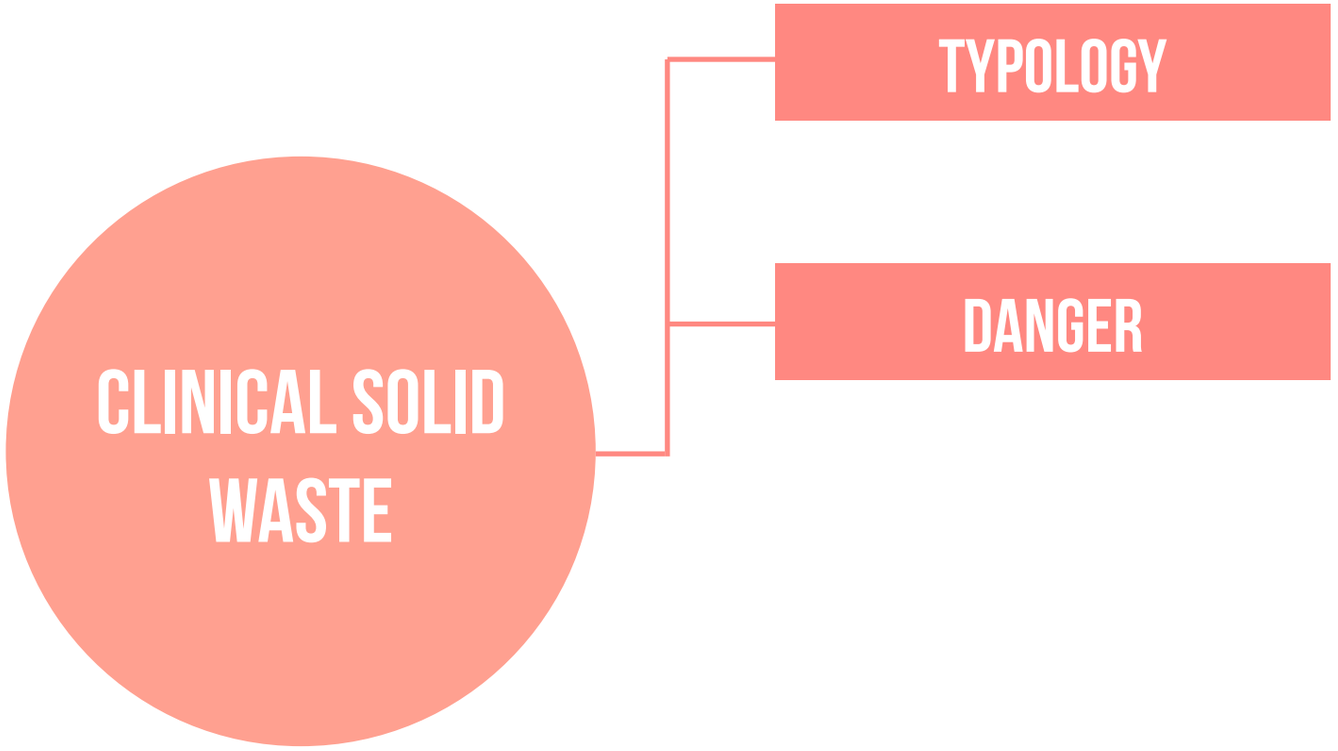
Classification of Clinical Solid Waste

CLINICAL SOLID WASTE

TYPOLOGY

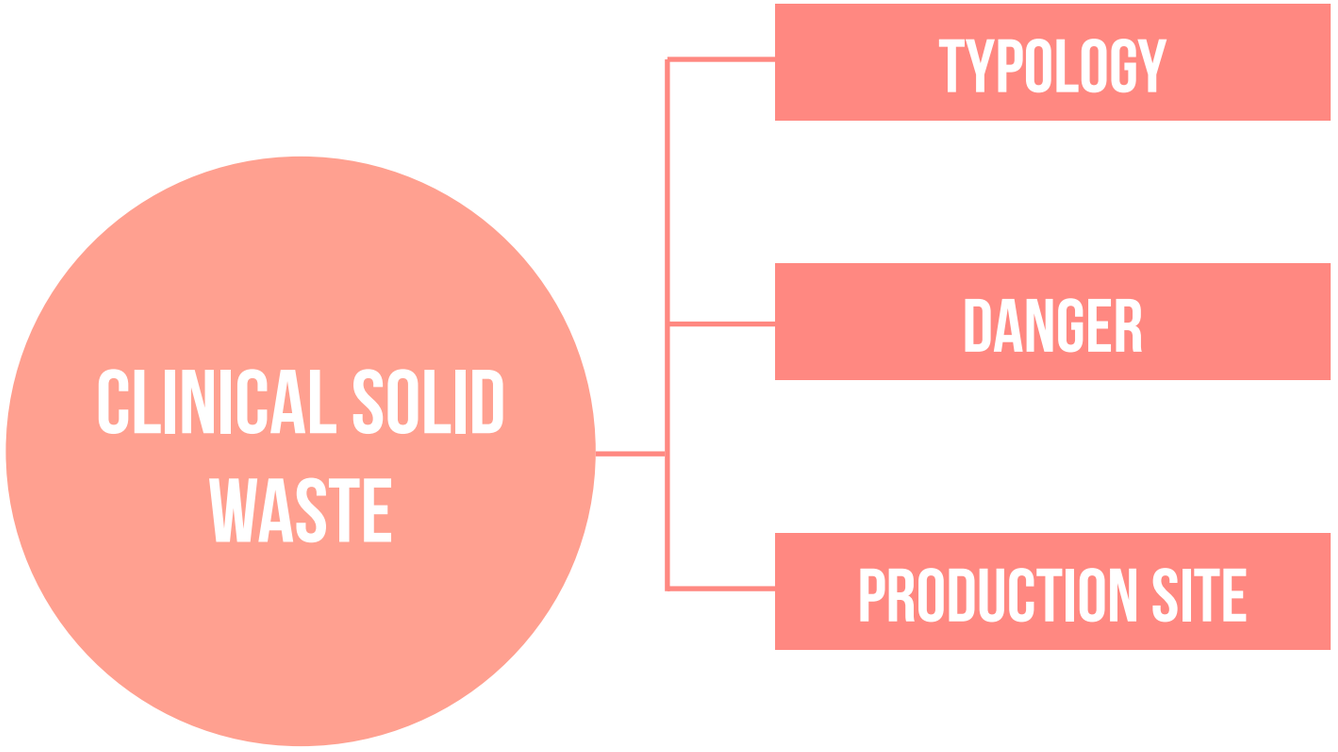
CASE STUDY

Classification of Clinical Solid Waste



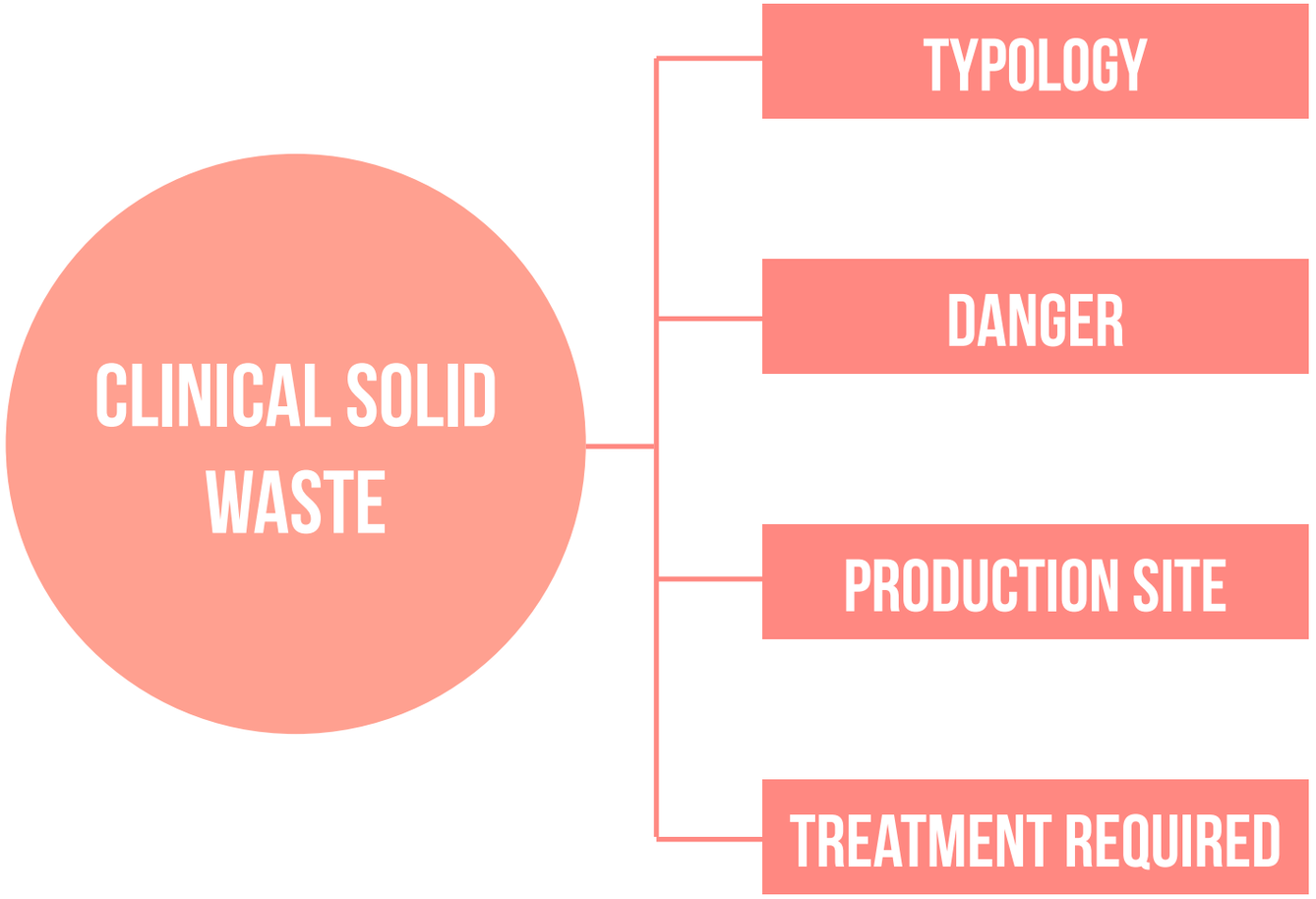
CASE STUDY

Classification of Clinical Solid Waste



CASE STUDY

Classification of Clinical Solid Waste



CASE STUDY

Portuguese Classification System

Class	Class Description
C1	Equivalent to Municipal Solid Waste (MSW).
C2	Non-biohazardous hospital waste.
C3	Biohazardous hospital waste.
C4	Specific hospital waste.

CASE STUDY

Database Model

TYPOLOGY

PRODUCTION SITE

DANGER

TREATMENT REQUIRED

CASE STUDY

Database Model

TYPOLOGY — TYPE

PRODUCTION SITE — SOURCE

DANGER — CONTAMINATION

TREATMENT REQUIRED

CASE STUDY

Database Model

TYPOLOGY — TYPE

PRODUCTION SITE — SOURCE

DANGER — CONTAMINATION

TREATMENT REQUIRED

ID_Waste	Class	ID_Source	ID_Type	ID_Contamination
1	C	6	1	1
2	C	4	2	5
3	C	6	4	5
4	C	3	6	{2, 3}
5	C	{5, 6}	3	4
6	C	⊥	1	5

ID_Source	GS	SS	WS	HS	LS	MS
1	1	0	0	0	0	0
2	0	1	0	0	0	0
3	0	0	1	0	0	0
4	0	0	0	1	0	0
5	0	0	0	0	1	0
6	0	0	0	0	0	1

ID_Type	GP	FW	CP	OM	DP	IP	MW	NB	SW	IB	MD	CH	AC	CO
1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	1	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	1	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	1	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	1	0	0	0	0	0	0	0	0	0
			...				...				...			
10	0	0	0	0	0	0	0	0	0	1	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	1	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	1	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	1	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	1

ID_Contamination	BL	OF	IA	CA
1	1	0	0	0
2	0	1	0	0
3	0	0	1	0
4	0	0	0	1
5	0	0	0	0
	...		...	
12	1	1	1	0
13	1	0	1	1
14	0	1	1	1
15	1	1	0	1
16	1	1	1	0

CASE STUDY

Cases

ID_Waste	Case Description
1	Scalpel contaminated with blood, provenient from the operating room.
2	Food waste collected from the maternity services.
3	Non-contaminated plaster piece from the orthopedic services.
4	Pair of medical gloves used in waste handling, contaminated with blood, organic fluids or both.
5	Package contaminated with cytostatic agents, either provenient from the labs or medical services.
6	Non-contaminated generic package, provenient from an unknown source.

CASE STUDY

Cases | Incomplete Knowledge

ID_Waste	Case Description
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CASE STUDY

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CASE STUDY

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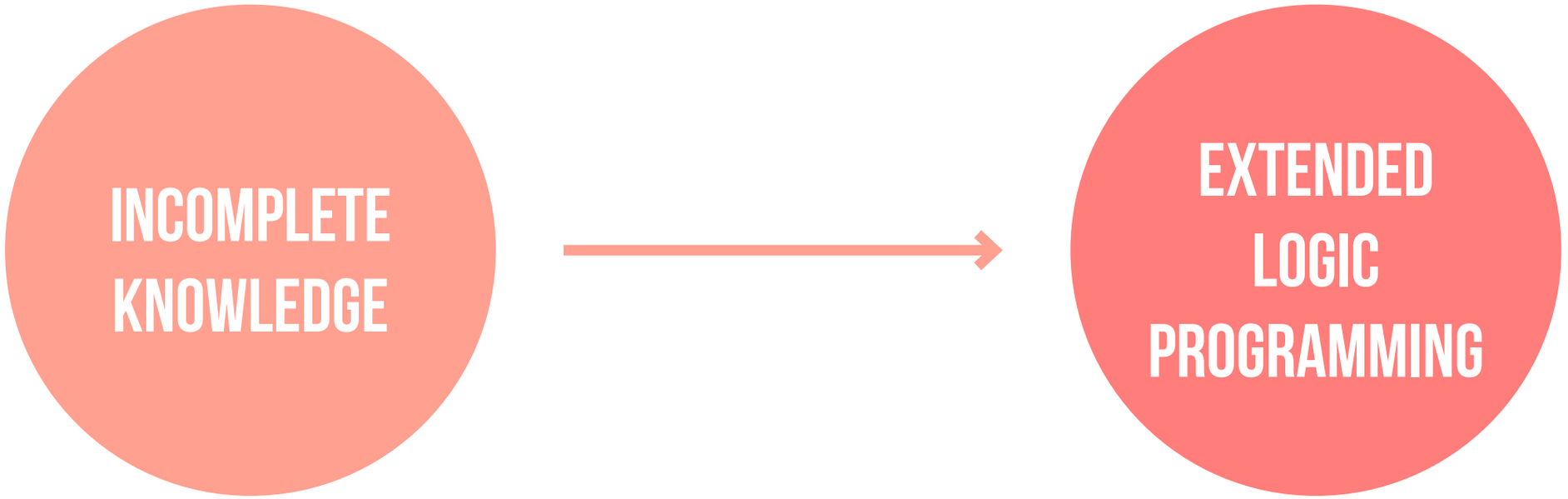
KNOWLEDGE REPRESENTATION

Logic Paradigm



KNOWLEDGE REPRESENTATION

Predicates

WASTE	ID_WS , CLASS , ID_SR , ID_TY , ID_CT
SOURCE	ID_SR , GS , SS , WS , HS , LS , MS
TYPE	ID_TY , GP , FW , CP , OM , DP , OM , IP , MW , NB , SW , IB , MD , CH , AC , CO
CONTAMINATION	ID_CT , BL , OF , IA , CA

KNOWLEDGE REPRESENTATION

Extended Logic Program

WASTE

$$\neg \text{waste}\ (\text{ID\_WS}, \text{CL}, \text{ID\_SR}, \text{ID\_TY}, \text{ID\_CT}) \leftarrow$$
$$\text{not}(\text{waste}\ (\text{ID\_WS}, \text{CL}, \text{ID\_SR}, \text{ID\_TY}, \text{ID\_CT})),$$
$$\text{not}(\text{abducible}_{waste}\ (\text{ID\_WS}, \text{CL}, \text{ID\_SR}, \text{ID\_TY}, \text{ID\_CT}))$$

$$\text{waste}(1,C,6,1,1).$$
$$\text{waste}(2,C,4,2,5).$$
$$\text{waste}(3,C,6,4,5).$$
$$\text{waste}(4,C,3,6,\{2,3\}).$$
$$\text{waste}(5,C,\{5,6\},3,4).$$
$$\text{waste}(6,C,\bot,1,5).$$

KNOWLEDGE REPRESENTATION

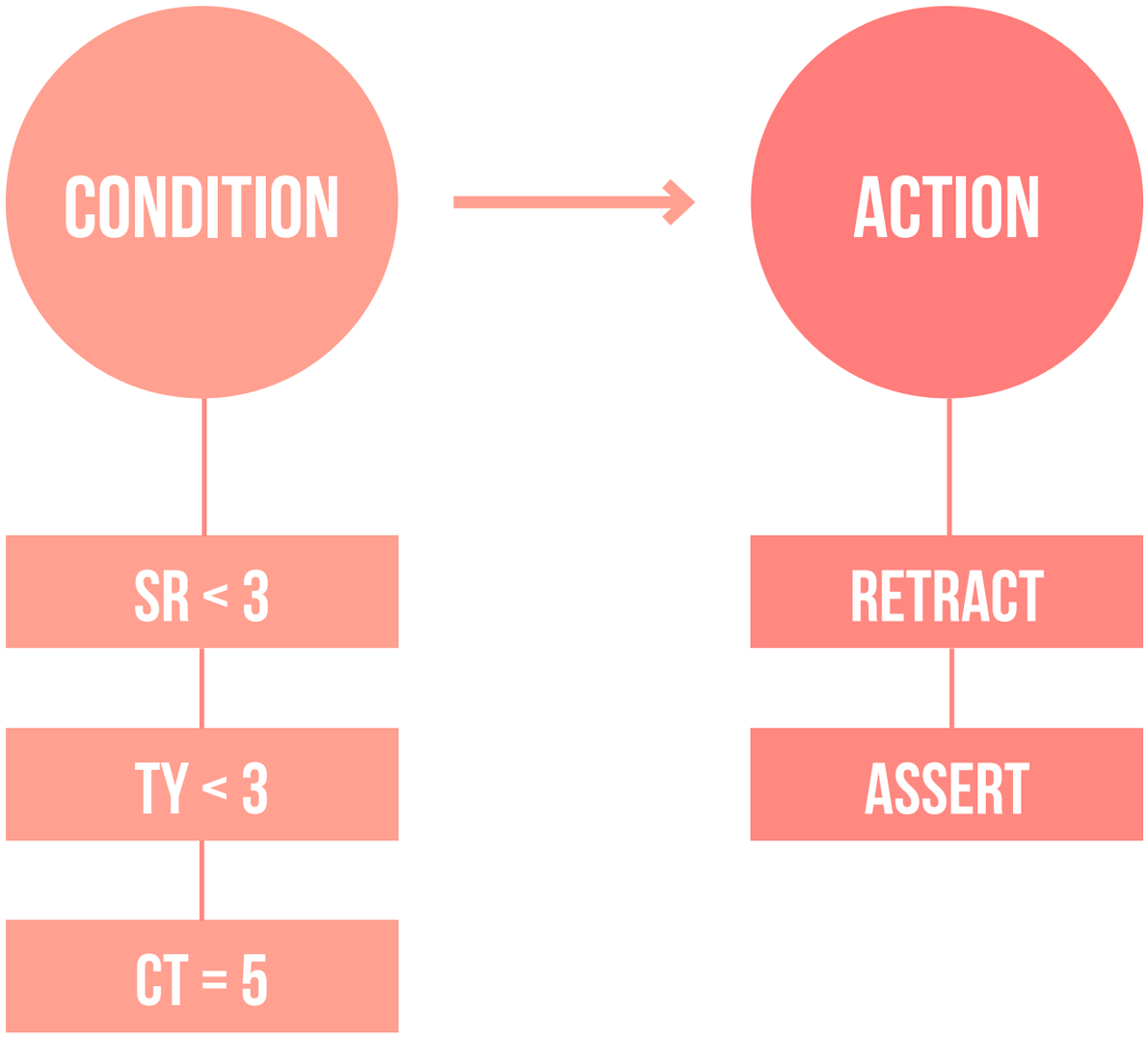
Extended Logic Program

WASTE

$\texttt{abducible}_{waste}$ (4, C, 3, 6, 2).
$\texttt{abducible}_{waste}$ (4, C, 3, 6, 3).
$\texttt{abducible}_{waste}$ (5, C, 5, 3, 4).
$\texttt{abducible}_{waste}$ (5, C, 6, 3, 4).
?(($\texttt{abducible}_{waste}$ (ID_WS, CL, $\texttt{ID\_SR}_1$, ID_TY, ID_CT)
$\vee$
$\texttt{abducible}_{waste}$ (ID_WS, CL, $\texttt{ID\_SR}_2$, ID_TY, ID_CT))
$\wedge$
$\neg$ ($\texttt{abducible}_{waste}$ (ID_WS, CL, $\texttt{ID\_SR}_1$, ID_TY, ID_CT)
$\wedge$
$\texttt{abducible}_{waste}$ (ID_WS, CL, $\texttt{ID\_SR}_2$, ID_TY, ID_CT)))
$\texttt{abducible}_{waste}$ (6, C, $\perp$, 1, 5).
$\texttt{abducible}_{waste}$ (ID_WS, CL, ID_SR, ID_TY, ID_CT) $\leftarrow$ waste (ID_WS, CL, $\perp$, ID_TY, ID_CT).

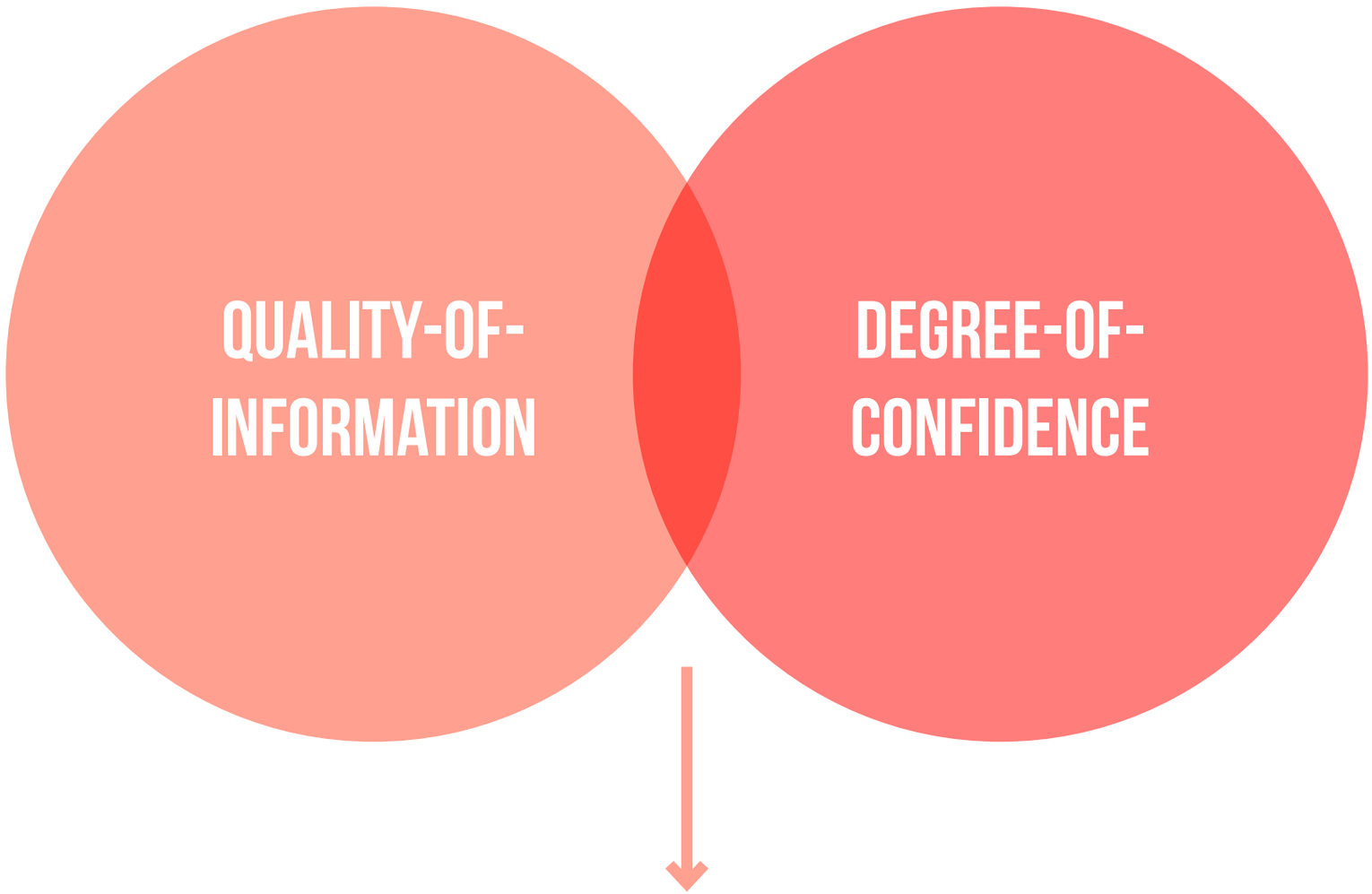
KNOWLEDGE REPRESENTATION

Production Rules and Actions | Class 1



KNOWLEDGE REPRESENTATION

Q_oI and D_oC



KNOWLEDGE REPRESENTATION

Scenarios

D_oC

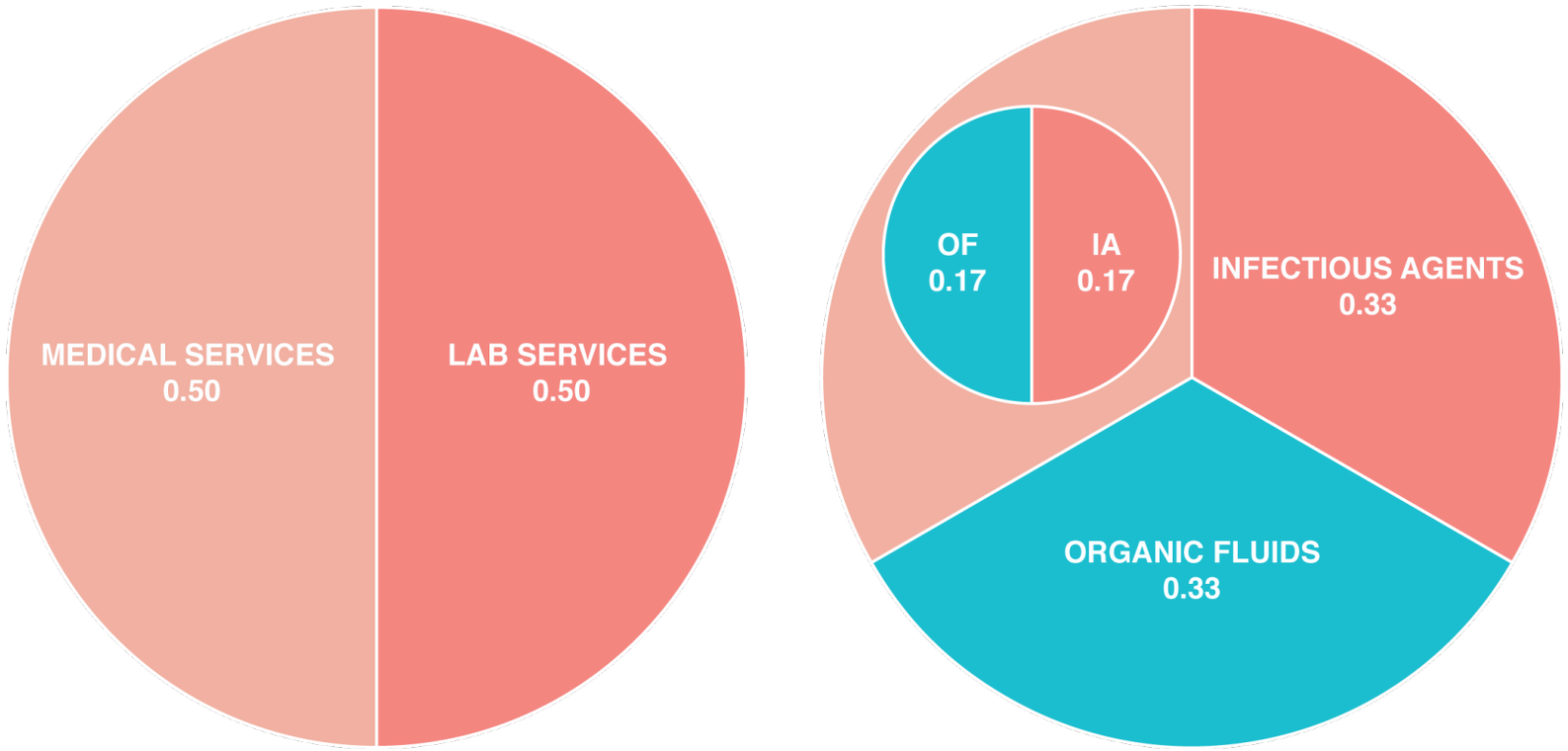
Scenario 3

```
waste(1, 1, C4, 6, 1, 1, 1).
waste(1, 2, C1, 4, 2, 5, 1).
waste(1, 3, C2, 6, 4, 5, 1).
abducible_waste(0.17, 4, C3, 3, 6, 2, 0.834).
abducible_waste(0.17, 4, C3, 3, 6, 3, 0.834).
abducible_waste(0.5, 5, C4, 5, 3, 4, 0.9).
abducible_waste(0, 6, C1, ⊥, 1, 5, 0.8).
```

Q_oI

KNOWLEDGE REPRESENTATION

Scenarios I Q_oI



A

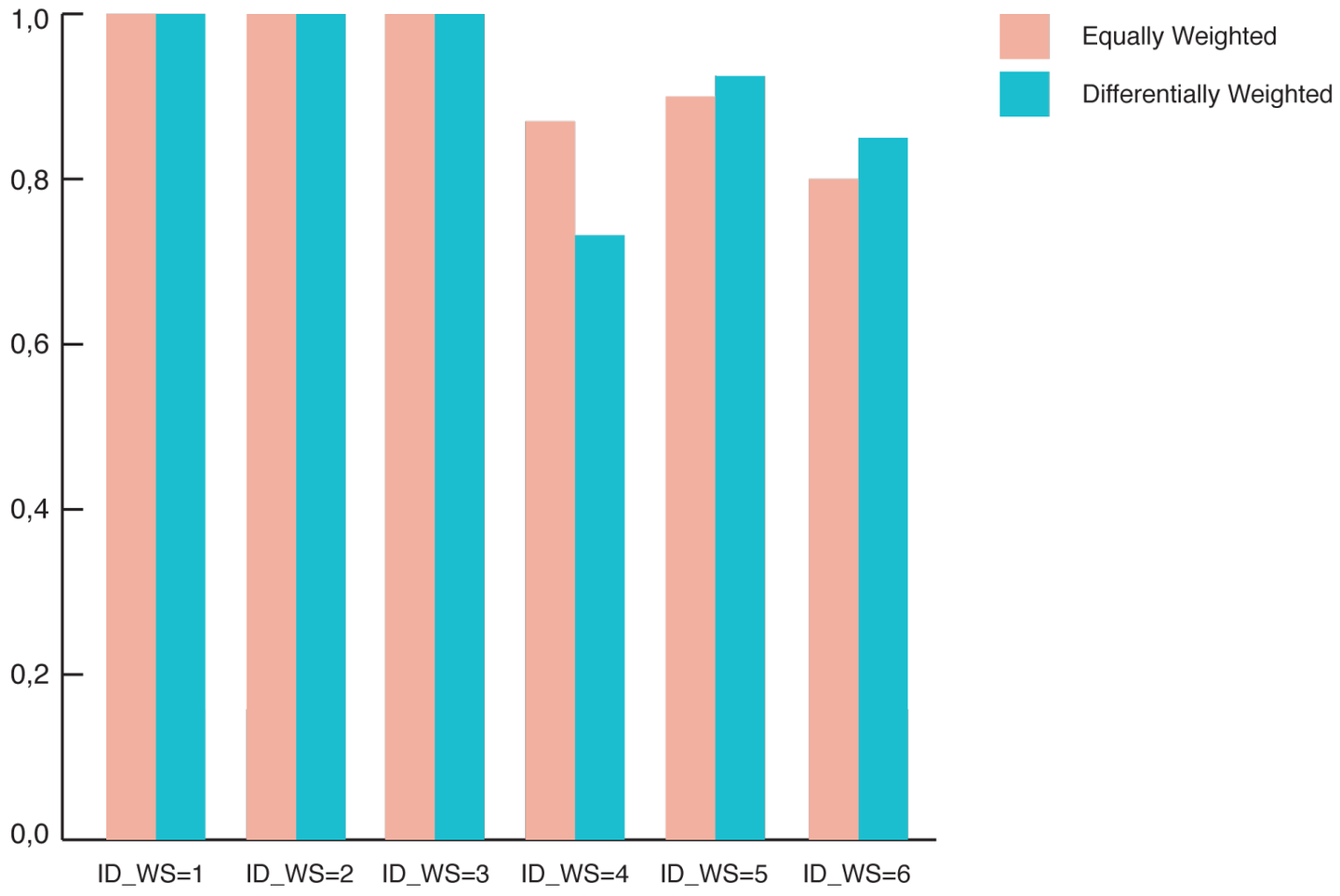
B

KNOWLEDGE REPRESENTATION

Scenarios I Weighting Approaches

EQUALLY WEIGHTED

DIFFERENTIALLY WEIGHTED



CONCLUSIONS

END.