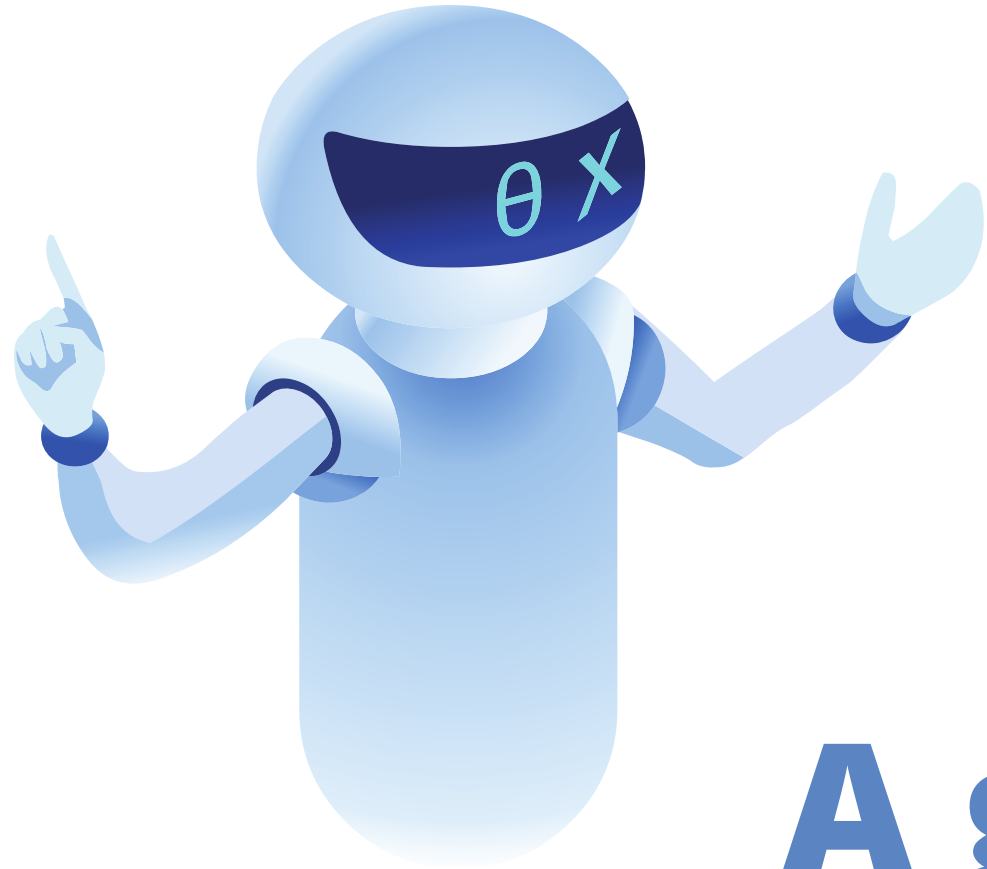




N u k k A I



NuXX

**A generic tool for high-level
explanations**

vventos@nukk.ai
Cofounder, Head of Research at NukkAI

A private AI lab based in Paris



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Co-founded with Jean-Baptiste Fantun in may 2018

We build the next generation of Artificial Intelligence



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PINKY

Gee, Brain, what do you want to do tonight ?

THE BRAIN

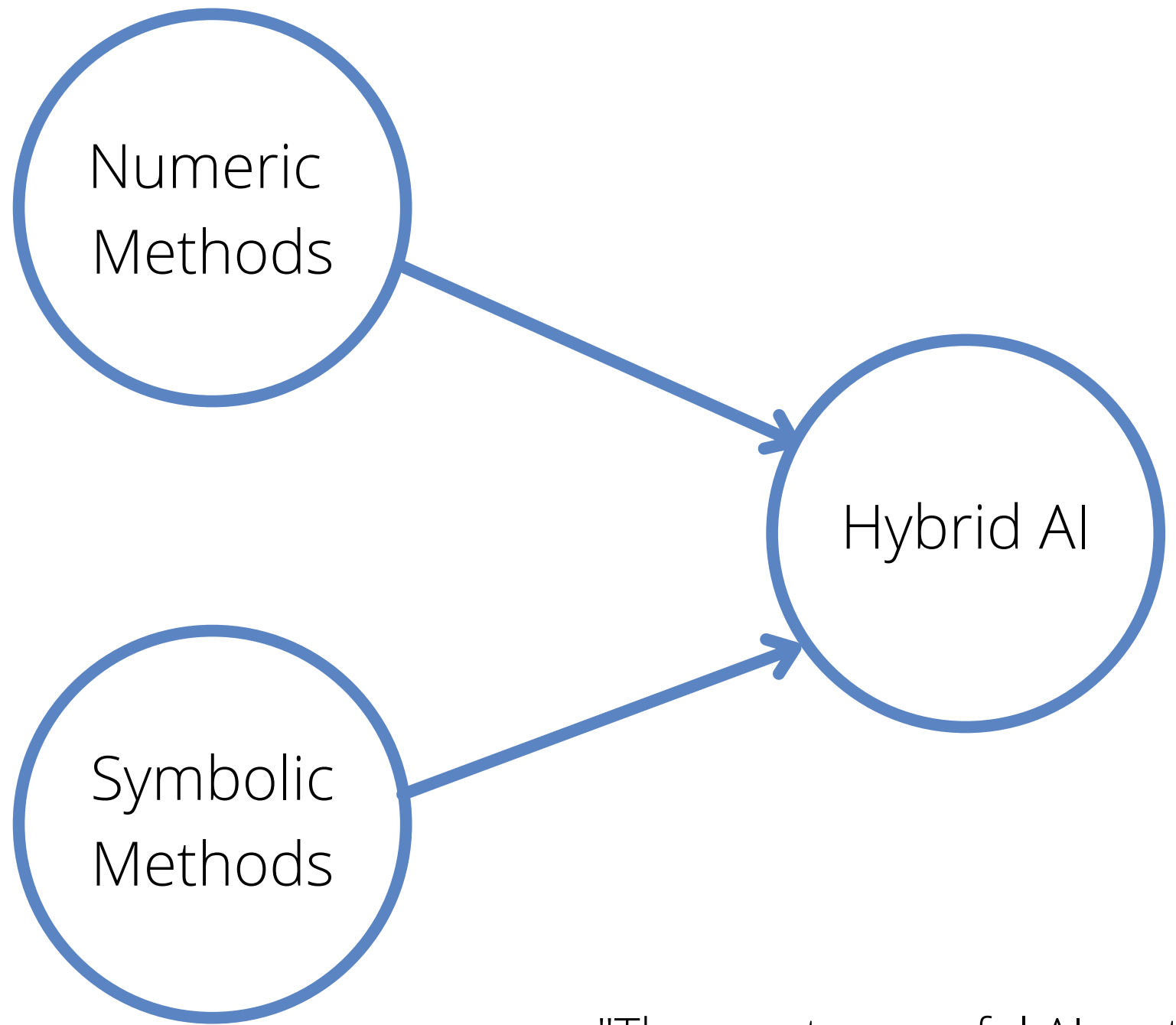
The same thing we do every night, Pinky.
Try to take over the world.

Hybrid AI : mixed paradigms



Powerful
Useful toolboxes

Black Box
Data greedy



Computer time consuming
High cost of entry

Powerful
Providing explanations
Good generalization
Data frugal
Easy human validation

"The most powerful AI systems use Deep Learning as just one element in a very complicated ensemble of techniques"

Pr Gary Marcus, NY University

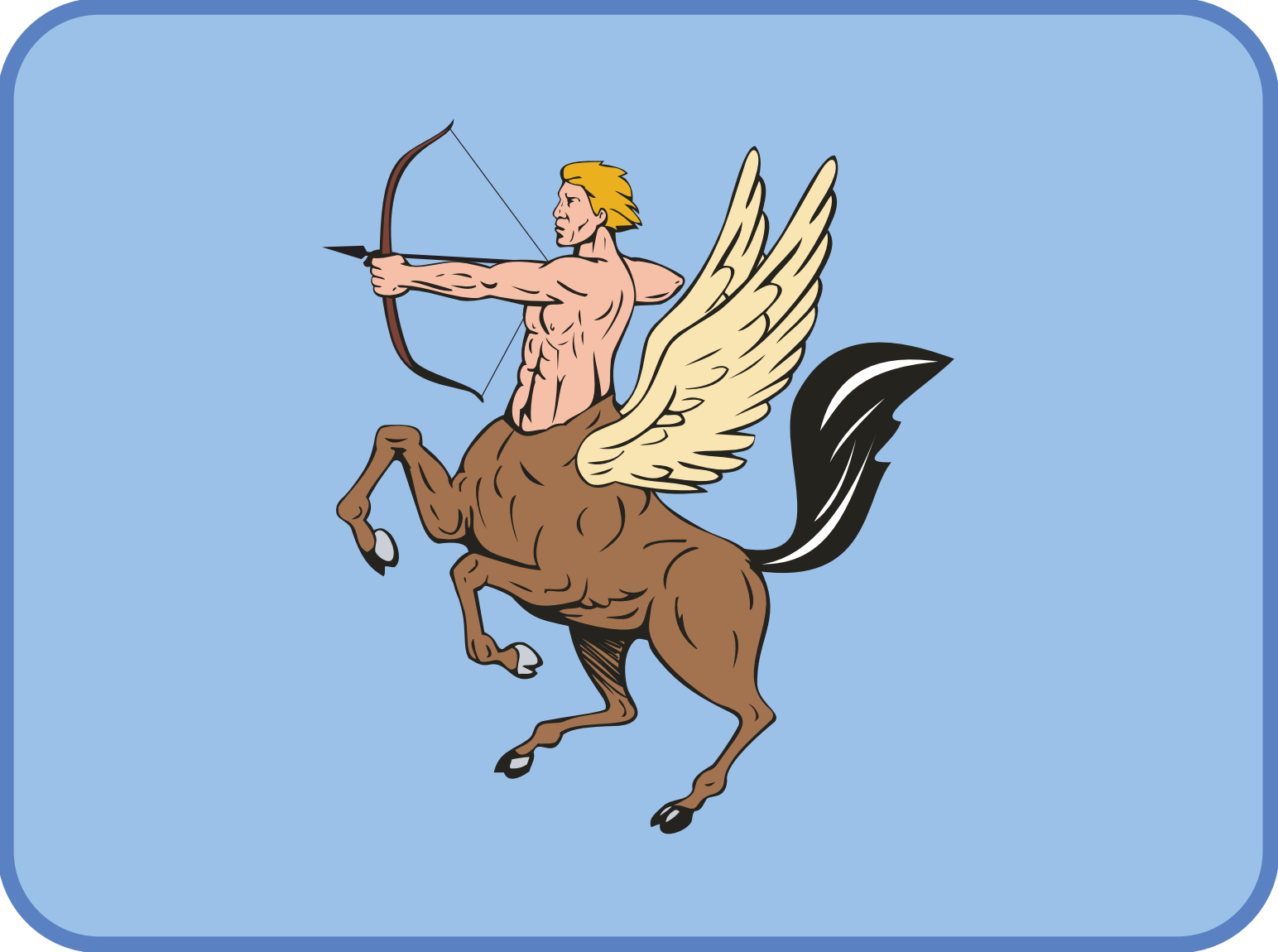
Hybrid AI: Human-AI collaboration



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AI at the service of humans



Centaur

From Bridge to business verticals



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The sandbox: **Bridge**



Industry



Healthcare



Cybersecurity



Finance

NuX explainers



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Intelligent Dashboard over raw data

Bridge in short

Trick-taking game played with 52 standard cards
opposing two pairs of player

Cards are dealt **randomly** to the four players
Each of them only sees his hand (13 cards)

Incomplete information game: players do not have
common knowledge of the game being played

Two game phases:

- **Bidding**
- **Card Play**



Card Play

W	N	E	S
Pass	7NT	Pass	2NT
Pass			Pass

N

7NT S
NS: 0 EW: 0

1/1

W

E

S

Meta-actions

Groupings of elementary actions that allow to win extra trick(s) under specific conditions.

Meta-actions are described using logical formulae (STRIPS approach)

A high-level strategy is a set of meta-actions.

W	♦	8	A	6	4
N	♥	2	J	K	4
S	♠	2	7	T	6
N	♥	3	5	T	6
S	♠	3	J	Q	8
N	♠	A	9	4	K
N	♦	K	7	5	3
N	♣	T	2	4	6
N	♣	A	3	5	7

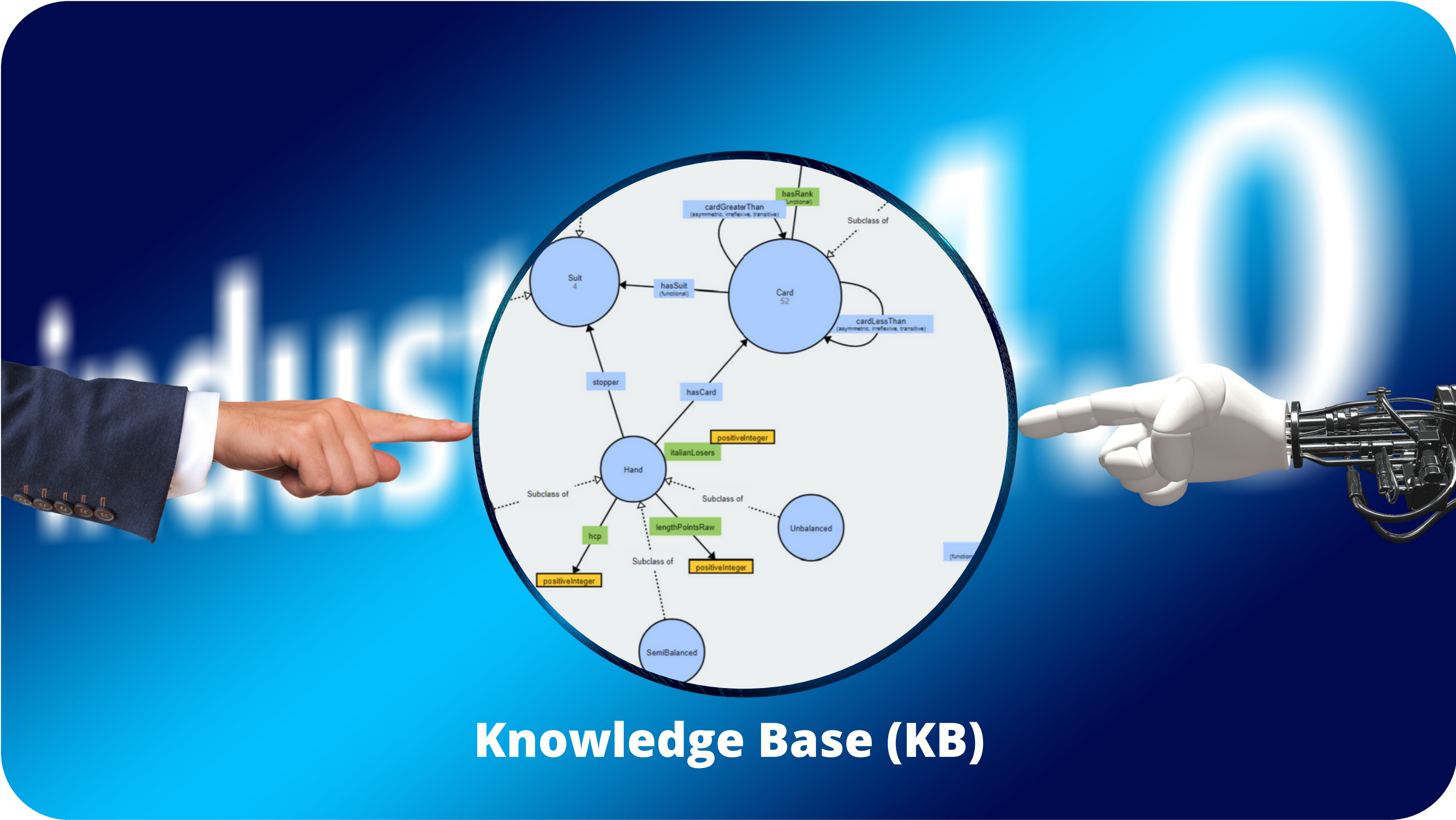


The direct finesse against the ♥Q in E has succeeded. Hence, the declarer gains 1 extra trick.

A common language between humans and machines



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Knowledge Base (KB)

Inputs

One or multiple traces

- Initial situation
- Deal evolution

Bridge KB

- Objects KB
- Meta-actions KB

Outputs

A priori analysis of a situation and of applicable meta-actions

- Context:
 - Complete information
 - Incomplete information

A posteriori analysis

- Meta-actions observable in traces
- Their probability of success

The expert's focus, directed on the most important aspects of the trace

Natural language descriptions provided on different levels of abstraction

High level comparison of traces

NuX-Bridge



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Explainer

N u k k A I
Deal analysis
Traces comparisons
BK objects
BK other

testjp6comparison.pbn

Diagram

Trace: 1 < >

Dealer: South
Vulnerability: None
Contract: 7NT
Declarer: South
Lead: ♠ 8
13 tricks made

- ♠ AQT
- ♥ 32
- ♦ AKJ92
- ♣ AJT

N

W E

S

- ♠ 5432
- ♥ AKT9
- ♦ 54
- ♣ K54

Trace analysis trick by trick

1	W	♦	8	A	6	4	▼
2	N	♥	2	J	K	4	▼
3	S	♠	2	7	T	6	▼
4	N	♥	3	5	T	6	▼
5	S	♠	3	J	Q	8	▼
6	N	♠	A	9	4	K	▼
7	N	♦	K	7	5	3	▼
8	N	♣	T	2	4	6	▼
9	N	♠	A	3	5	7	▼
10	N	♣	J	Q	K	8	▼
11	S	♠	5	♥7	♥2	♥Q	▼
12	S	♥	A	8	♥9	♥T	▼
13	S	♥	9	♥9	♥J	♥Q	▼

INITIAL ANALYSIS
VISION OF THE DECLARER VS DOUBLE DUMMY
META ACTIONS
NATURAL LANGUAGE

Before first trick

	♠	♥	♦	♣	Total
Single dummy sure tricks	1	2	2	2	7
Single dummy potential tricks	3	2	3	1	9

After first trick

Lead: ♥8
First trick made by North with ♥A

Visualisation of the initial situation

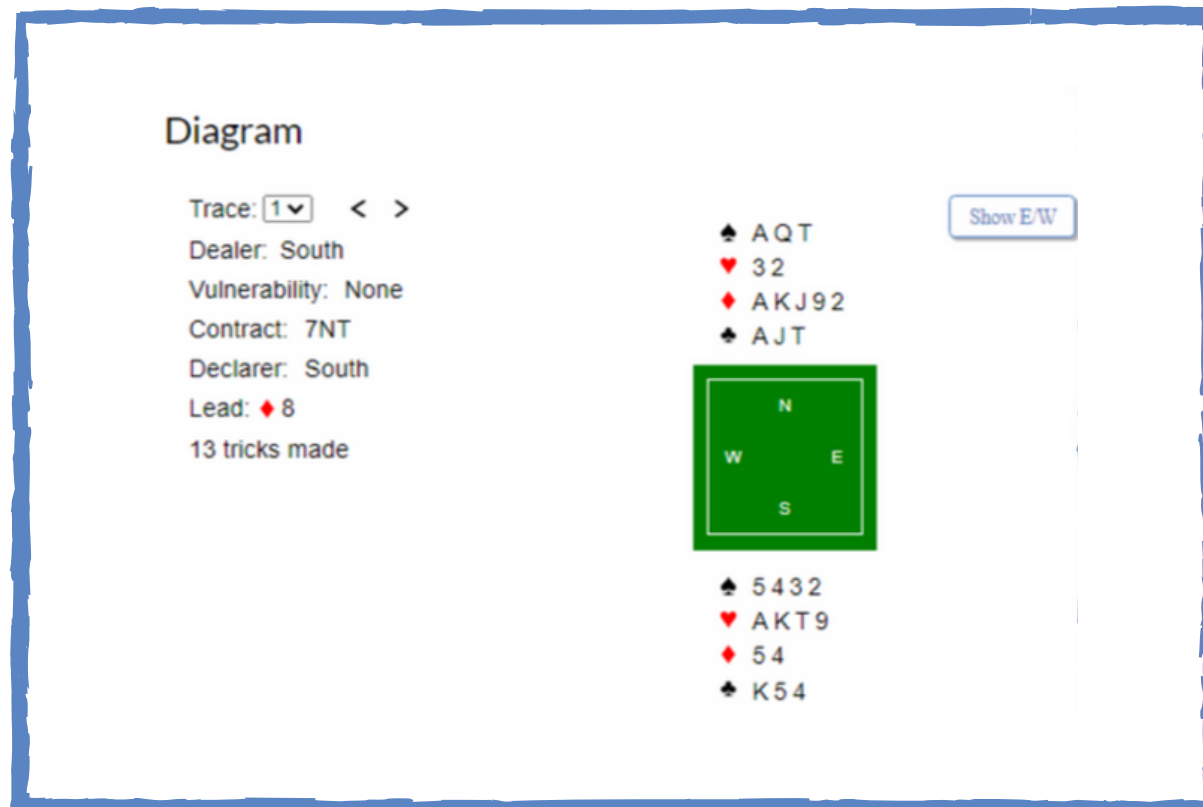
Trace analysis, annotations

Explanations

Initial analysis



Nukki AI



INITIAL ANALYSIS

VISION OF THE DECLARER VS DOUBLE DUMMY

Before first trick

	♠	♥	♦	♣	Total
Single dummy sure tricks	1	2	2	2	7
Single dummy potential tricks	3	2	3	1	9

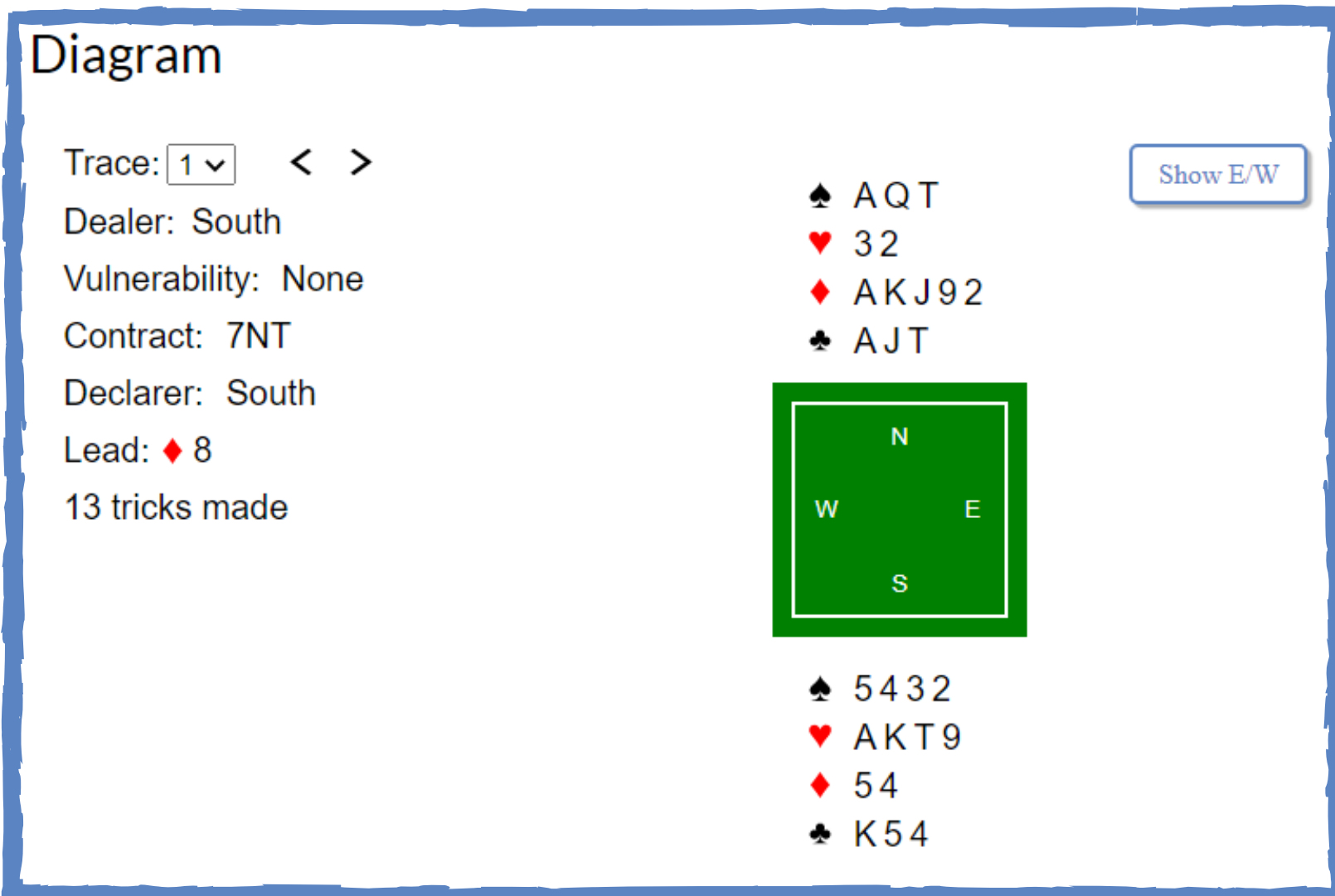
After first trick

Lead: ♦8
 First trick made by North with ♦A

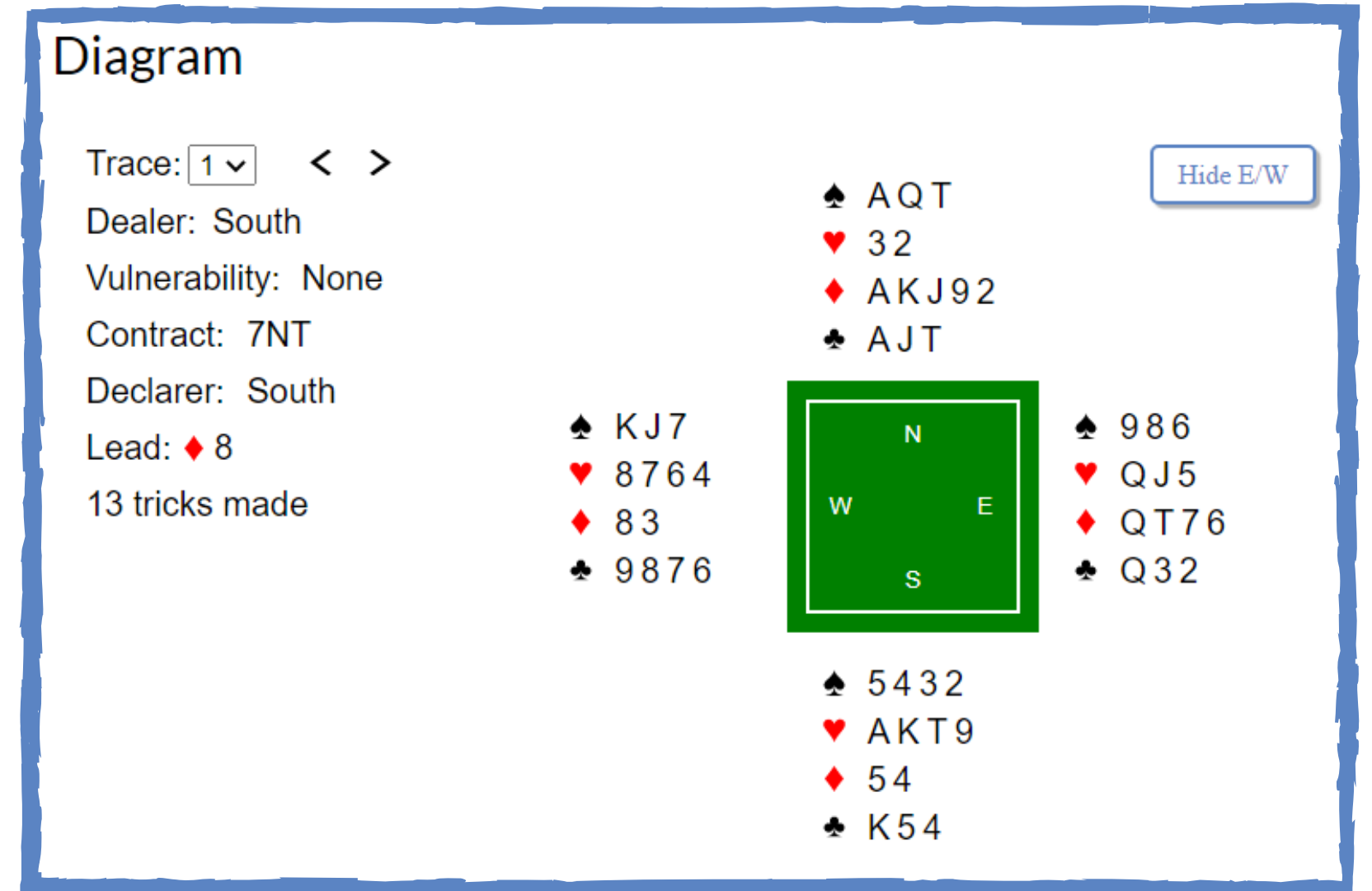
Vision declarer vs dd



Nukki AI



Incomplete information



Complete information

Probabilistic analysis of MetaActions



VISION OF THE DECLARER

Valid meta-actions	Single dummy probabilities
Cash by rank in ♠	2%
Cash by rank in ♥	1%
Cash by rank in ♦	12%
Cash by rank in ♣	10%
Direct finesse against ♠K in W	50%
Direct finesse against ♠KJ in W	24%
Direct finesse against ♥QJ in E	24%
Direct finesse against ♦Q in W	50%
Direct finesse against ♦QT in W	24%
Direct finesse against ♣Q in W	50%
Forcing finesse against ♣Q in E	50%

Incomplete information

VISION OF THE DECLARER

Valid meta-actions	Single dummy probabilities	Double dummy check	Warning
Cash by rank in ♠	2%	✗	
Cash by rank in ♥	1%	✗	
Cash by rank in ♦	12%	✗	
Cash by rank in ♣	10%	✗	
Direct finesse against ♠K in W	50%	✓	
Direct finesse against ♠KJ in W	24%	✓	⚠
Direct finesse against ♥QJ in E	24%	✓	⚠
Direct finesse against ♦Q in W	50%	✗	
Direct finesse against ♦QT in W	24%	✗	
Direct finesse against ♣Q in W	50%	✗	
Forcing finesse against ♣Q in E	50%	✓	

Complete information

Trace analysis & annotations

Trace analysis trick by trick

	W	♦	8	A	6	4	∨
2	N	♥	2	J	K	4	∨
3	S	♠	2	7	T	6	∨
4	N	♥	3	5	T	6	∨
5	S	♠	3	J	Q	8	∨
6	N	♠	A	9	4	K	∨
7	N	♦	K	7	5	3	∨
8	N	♣	T	2	4	6	∨
9	N	♣	A	3	5	7	∨
10	N	♣	J	Q	K	8	∨
11	S	♠	5	♥7	♦2	♥Q	∨
12	S	♥	A	8	♦9	♦T	∨
13	S	♥	9	♣9	♦J	♦Q	∨

Raw data

Annotations

Trace analysis trick by trick

2	N	♥	2	J	K	4	∨
3	S	♠	2	7	T	6	∨
4	N	♥	3	5	T	6	^

The direct finesse against the ♥Q in E has succeeded. Hence, the declarer gains 1 extra trick.

Analysis after the trick

Situation	♠	♥	♦	♣	Total
Tricks made	1	2	1	0	4 / 4

Future tricks	♠	♥	♦	♣	Total
Sure	1	1	1	2	5
Potential	2	1	3	1	7
Double dummy	3	2	1	3	9

DDS : 9 remaining tricks in N/S

Annotation analysis and explanation

High-level trace analysis



N u k k A I

META ACTIONS

Trick	Meta-action	Status	Single dummy probabilities
2	Cash by rank attempt in ♥ Direct finesse against ♥QJ in E	Promising SuccessMaybe	1% 24%
3	Direct finesse against ♠KJ in W	Success	24%
4	Direct finesse against ♥Q in E	Success	50%
5	Direct finesse against ♠K in W	Success	50%
6	Cash by length attempt in ♠	Success	53%
7	Cash by rank attempt in ♦	Failed	12%
8	Forcing finesse against ♣Q in E	Success	50%

Different levels of explanation



N u k k i A I

NATURAL LANGUAGE

High level

Medium level

Low level

After the lead, the declarer only has 7 tricks: 1 trick of ♠, 2 tricks of ♥, 2 tricks of ♦, and 2 tricks of ♣. He still needs 6 more tricks for the contract. The declarer won by establishing 3 tricks of ♠, 2 tricks of ♥, 1 trick of ♣. The defenders could not defeat the contract.

NATURAL LANGUAGE

High level

Medium level

Low level

Trick 1 : After the lead, the declarer only has 7 tricks. He still needs 6 more tricks for the contract.
Trick 3 : The direct finesse against the ♠K and the ♠J in W has succeeded. Hence, the declarer gains 1 extra trick.
Trick 4 : The direct finesse against the ♥Q in E has succeeded. Hence, the declarer gains 1 extra trick.
Trick 5 : The direct finesse against the ♠K in W has succeeded. Hence, the declarer gains 1 extra trick.
Trick 6 : The declarer has established his spades by a cash by length. Hence, the declarer gains 1 extra trick.
Trick 7 : The declarer fails to drop the high cards of the opponents in diamonds.
Trick 8 : The forcing finesse against the ♣Q in E has succeeded. Hence, the declarer gains 1 extra trick.
Trick 11 : Due to an opponent's discard in hearts, the declarer realises that he has established 1 extra trick in this suit. Now the declarer has enough tricks for the contract.

NATURAL LANGUAGE

High level

Medium level

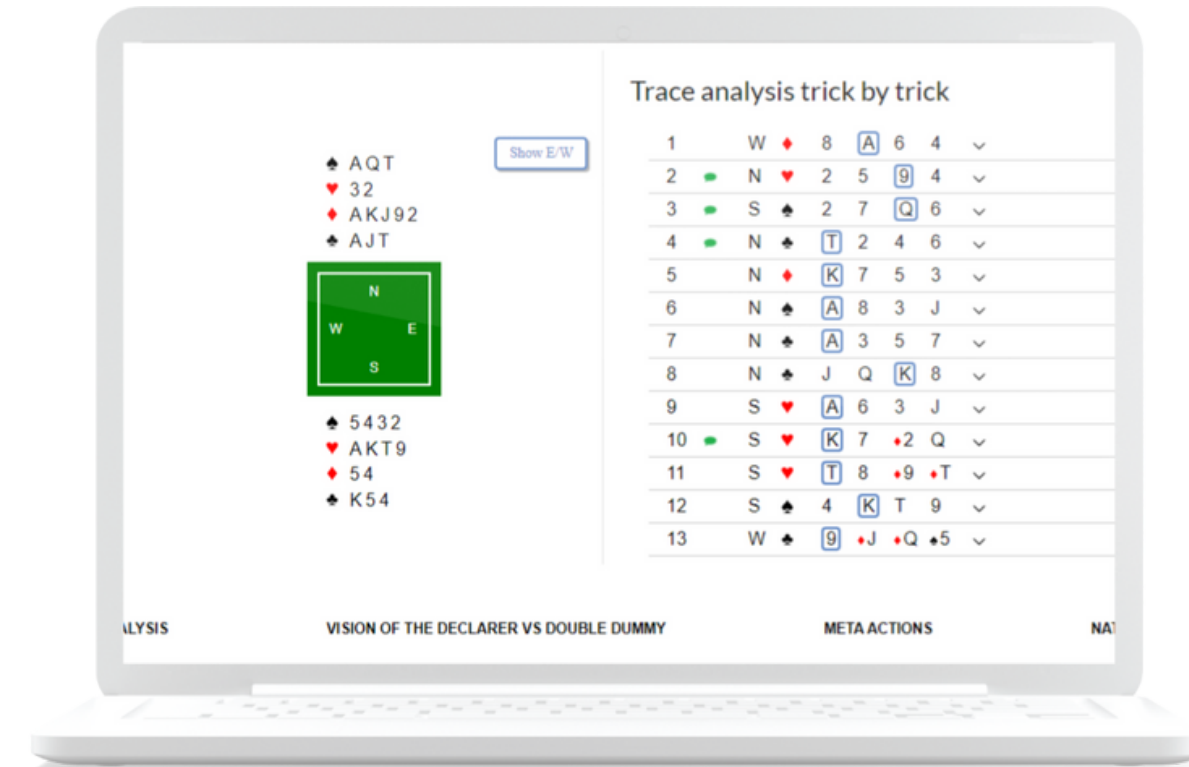
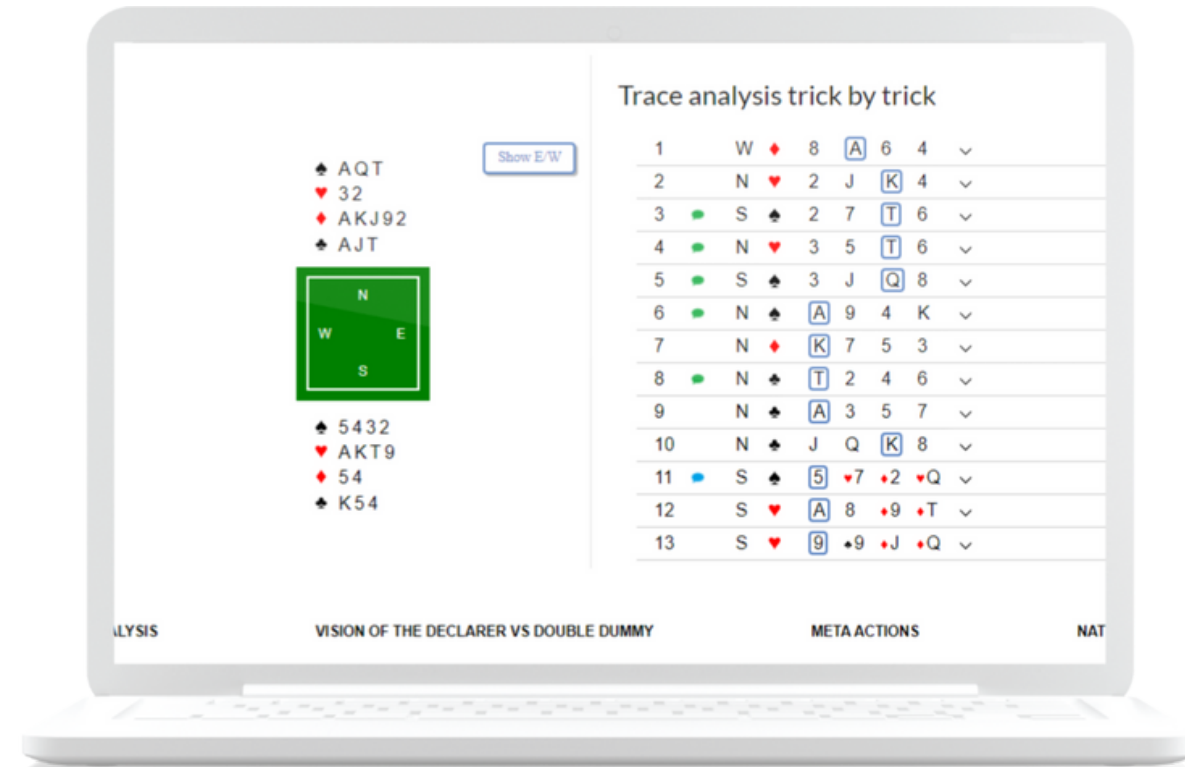
Low level

The declarer started with 7 top tricks.
They took the lead with the ♦A in dummy.
They played the ♥2, East rose the Jack and South's King took the trick.
They played the ♠2 to dummy's Ten, successfully finessing against the ♠K, ♠J, giving them 8 total top tricks.
They played the ♥3 to South's Ten, successfully finessing against the ♥Q, giving them 9 total top tricks.
They played the ♠3 to dummy's Queen, successfully finessing against the ♠K, giving them 10 total top tricks.
They cashed the ♠A and both defenders followed suit, establishing the ♠5, giving them 11 total top tricks.
They cashed the ♦K.
They ran the ♣T, holding the trick, giving them 12 total top tricks.
Declarer cashed the ♠A, ♠K.
They cashed the ♠5, West discarding the ♥7, North discarding the ♦2, East discarding the ♥Q, giving them 13 total top tricks.
Declarer cashed the ♥A, ♥9, North discarding the ♦9, ♦J, West discarding the ♣9, East discarding the ♦T, ♦Q.

Trace comparison



Nukki AI



Trace #1

Trace #2

Name	♠	♥	♦	♣	Result
Trace 1	4	4	2	3	Won
Trace 2	2	4	2	3	Lost

Player 1 won his contract but Player 2 went down.
From a DDS point of view, no trick was given at the first trick.

Both declarer attempted successfully a direct finesse against ♠K in West, a forcing finesse against ♣Q in East and unsuccessfully a cash by rank in ♦.

Player 1 attempted successfully a direct finesse against ♠KJ in West with 24% chances of success when he did it, at trick 3.

Player 1 attempted successfully a direct finesse against ♥Q in East with 50% chances of success when he did it, at trick 4.

Player 1 attempted successfully a cash by length in ♠ with 53% chances of success when he did it, at trick 6.

Player 2 attempted successfully a direct finesse against ♥QJ in East with 24% chances of success when he did it, at trick 2.

Player 2 attempted successfully a cash by rank in ♥ with 0% chances of success when he did it, at trick 10.

High level analysis (differences and similarities)

NuX explainers



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Intelligent Dashboard over raw data

Inputs

Heterogeneous financial data

- Credit related data
- Black box AI systems

Financial KB

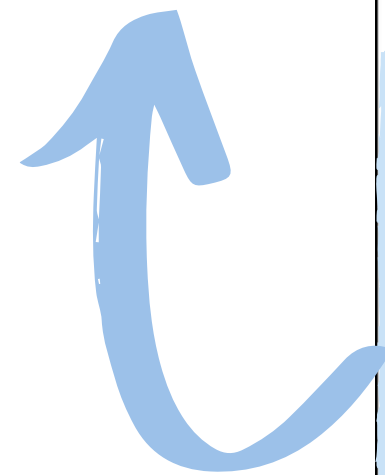
Outputs

Post-hoc explanations

Bias exploration

Abstraction of data

Heterogeneous
data sources



DATA SOURCES
Input file: AI system to investigate:

DATA

ClientID	Age	Name	Amount	SavingsOperations6M	PostalCode	Risk	Output
001	28	Antonelli	12000	10	75	0.01	Yes
002	19	Jung	5000	5	92	0.15	Yes
003	55	Dehouille	50000	1	92	0.60	No
005	42	Sanchez	5000	5	93	0.30	No
006	22	Brun	25000	5	92	0.40	Yes
007	33	Razimi	75000	6	91	0.10	Yes
008	18	Hoch	2500	0	75	0.61	Yes

HUMAN KNOWLEDGE EXPLORER
Human Knowledge:

KNOWLEDGE **BIAS DEFINITION**

- Clients asking for a lower amount than 1/3 x Ressources + Expenses are asking for a safe amount (indebtness)
- Risk is considered low under 0.4
- Risk is considered high over 0.6
- Client who have at least one transfert into saving per month have good saving management
- Clients how have less than 5% defaults on their history and no Banque de France tags are good payers.

Outputs

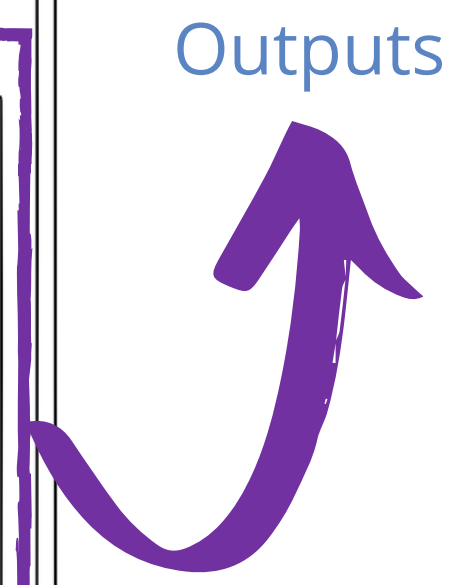
LOW LEVEL TECH VISION | HIGH LEVEL GENERAL | HIGH LEVEL CLIENT

Select a client:

ClientID	Age	Name	Amount	SavingsOperations6M	PostalCode	Risk	Answer
001	28	Antonelli	12000	10	75	0.01	Yes

Risk is very low.
Good saving management and amount asked is within good indebtedness ratio.

Confidence:



Human Knowledge
Explorer / Editor

General method



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Load heterogeneous data and initial KB

DATA FACTORY

Dataview name: Credit_1

File: credit.csv

Options:
 ignore missing data rows
 ignore missing data columns

ALL

Load

Preview

Client ID	Name	Age	Income	Operat	Postal	Risk	Out
001	28	Antoine	12000	10	75	0.01	Yes
002	19	Jung	5000	5	42	0.15	Yes
003	55	Dehou	50000	1	42	0.60	No
005	42	Sanch	5000	5	43	0.30	No

Dataview has 10 923 rows, 8 columns

Create Dataview

HUMAN KNOWLEDGE EXPLORER

Human Knowledge: credit_risk.bk

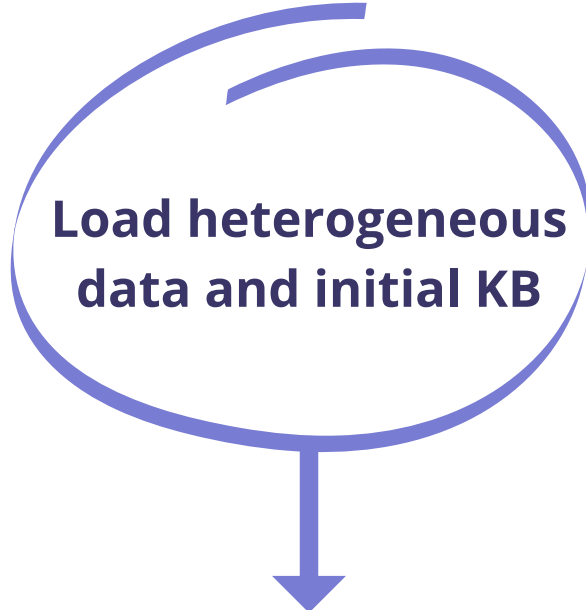
KNOWLEDGE BIAS DEFINITION

- Clients asking for a lower amount than 1/3 x Ressources + Expenses are asking for a safe amount (indebtness)
- Risk is considered low under 0.4
- Risk is considered high over 0.6
- Client who have at least one transfert into saving per month have good saving management
- Clients how have less than 5% defaults on their history and no Banque de France tags are good payers.

General method



N u k k A I



DATA FACTORY

Dataview name: Credit_1

File: credit.csv

Options:
 ignore missing data rows
 ignore missing data columns

ALL

Load

Preview

Client #	A. #	Name	Amo. \$	Savings	Operat. #	PostalC	Ri. #	Out. #
001	28	Antone	12000	10	75	0.01	Yes	
002	19	Jung	5000	5	42	0.15	Yes	
003	55	Dehoui	50000	1	42	0.60	No	
005	42	Sanoh	5000	5	43	0.30	No	

Dataview has 10 923 rows, 8 columns

Create Dataview

HUMAN KNOWLEDGE EXPLORER

Human Knowledge: credit_risk.bk

KNOWLEDGE BIAS DEFINITION

- Clients asking for a lower amount than 1/3 x Ressources + Expenses are asking for a safe amount (indebtness)
- Risk is considered low under 0.4
- Risk is considered high over 0.6
- Client who have at least one transfert into saving per month have good saving management
- Clients how have less than 5% defaults on their history and no Banque de France tags are good payers.

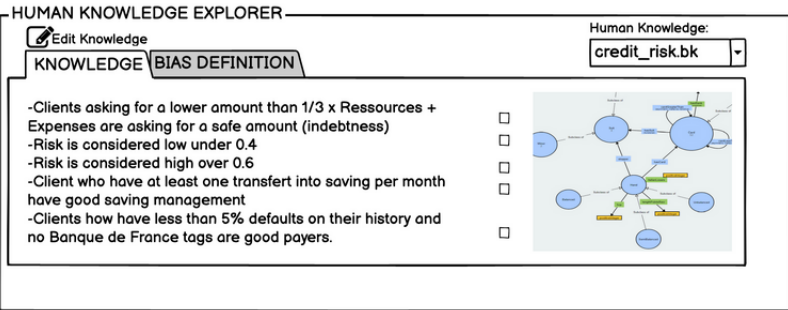
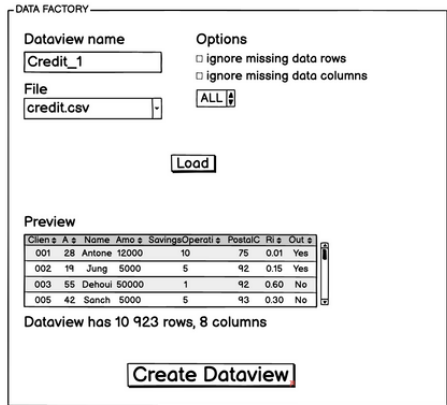
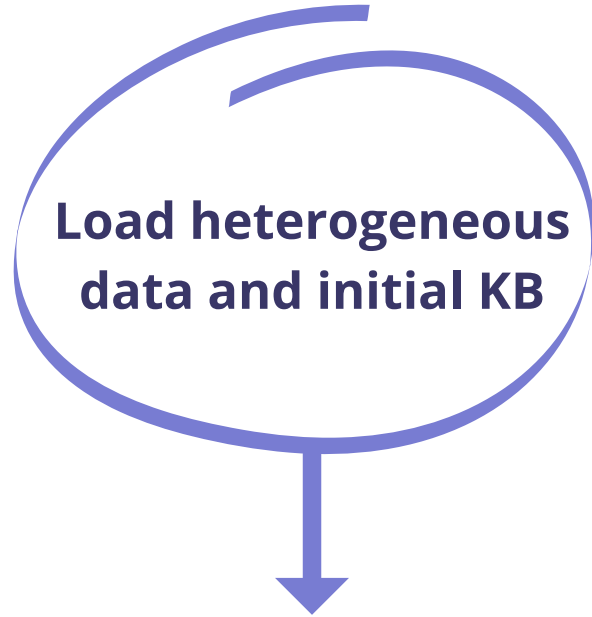
Define a task:

- Data Mining and exploratory analysis
- Machine Learning
- Post-hoc explanation
- Bias analysis
- Data Cleaning

General method

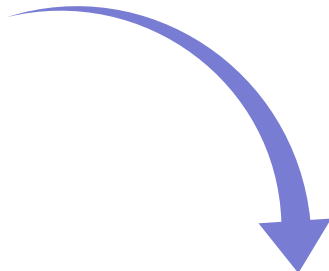


Nukki AI

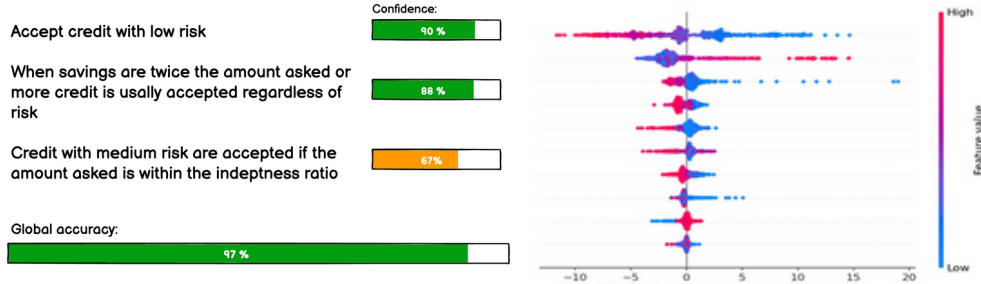


Define a task:

- Data Mining and exploratory analysis
- Machine Learning
- Post-hoc explanation
- Bias analysis
- Data Cleaning



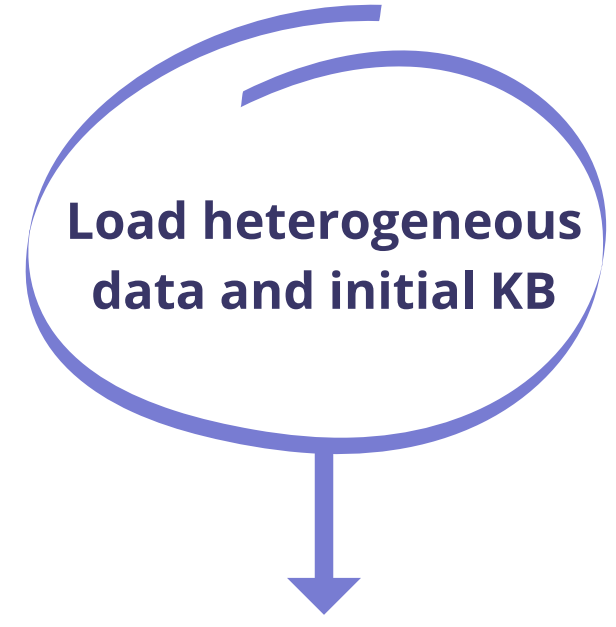
Natural Language Output & Visualisations



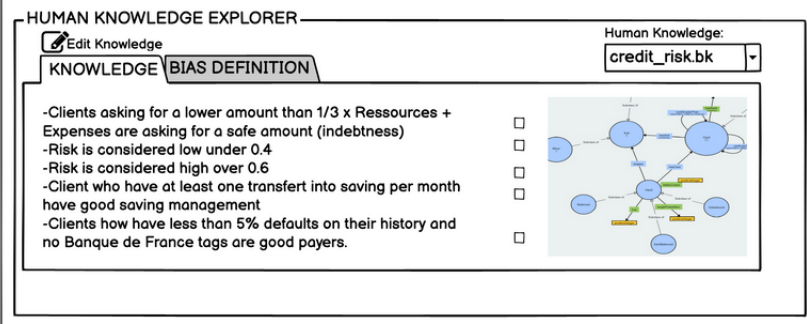
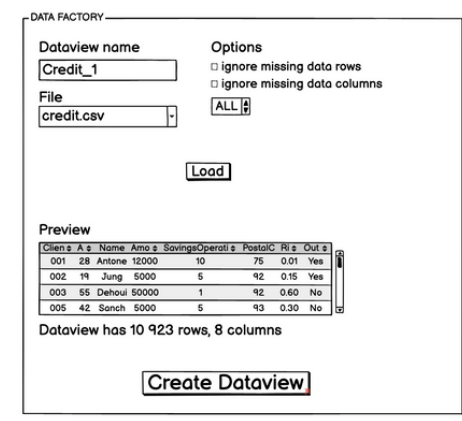
General method



Nukki AI

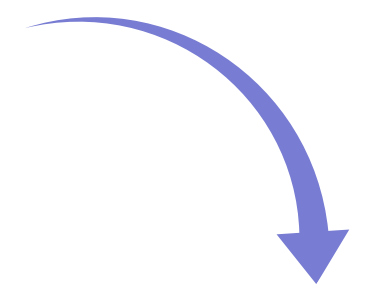


Load heterogeneous data and initial KB

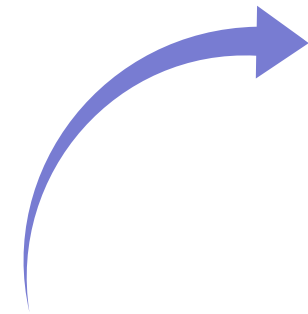
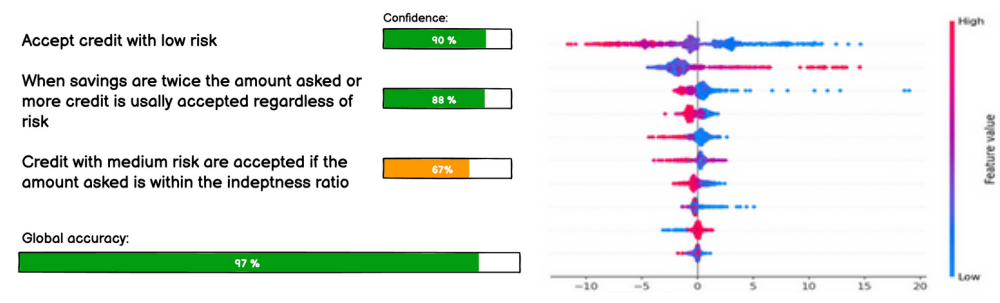


Define a task:

- Data Mining and exploratory analysis
- Machine Learning
- Post-hoc explanation
- Bias analysis
- Data Cleaning



Natural Language Output & Visualisations



Human expert intervention:

Knowledge and data update



Client ID	Age	Name	Amount	SavingsOperations6M	PostalCode	Risk	Output
001	28	Antonelli	12000	10	75	0.01	Yes
002	19	Jung	5000	5	92	0.15	Yes
003	55	Dehouille	50000	1	92	0.60	No
005	42	Sanchez	5000	5	93	0.30	No
006	22	Brun	25000	5	92	0.40	Yes
007	33	Rozimi	75000	6	91	0.10	Yes
008	18	Hoch	2500	0	75	0.61	Yes



Post-hoc explanations



Nukki AI

ClientID	Age	Name	Amount	SavingsOperations6M	PostalCode	Risk	Output
001	28	Antonelli	12000	10	75	0.01	Yes
002	19	Jung	5000	5	92	0.15	Yes
003	55	Dehouille	50000	1	92	0.60	No
005	42	Sanchez	5000	5	93	0.30	No
006	22	Brun	25000	5	92	0.40	Yes
007	33	Razimi	75000	6	91	0.10	Yes
008	18	Hoch	2500	0	75	0.61	Yes

Input Data

LOW LEVEL TECH VISION | HIGH LEVEL GENERAL | HIGH LEVEL CLIENT

Confidence:

Accept credit with low risk 90 %

When savings are twice the amount asked or more credit is usually accepted regardless of risk 88 %

Credit with medium risk are accepted if the amount asked is within the indeptness ratio 67 %

Global accuracy: 97 %

Global

LOW LEVEL TECH VISION | HIGH LEVEL GENERAL | HIGH LEVEL CLIENT

Select a client: ClientID: 003

ClientID	Age	Name	Amount	SavingsOperations6M	PostalCode	Risk	Output
003	55	Dehouille	50000	1	92	0.60	No

EXPLANATION:
Risk is considered high because of the amount asked is too high. Confidence: 98 %
Also, poor saving management (SavingsOperations6M < 3).

ADVICE:
Consider monthly automatic saving transfert or decrease the amount asked to be under twice the indebtedness threshold (from 50 000 to 22 000).

COUNTERFACTUALS:

ClientID	Age	Name	Amount	SavingsOperations6M	PostalCode	Risk	Output
003	55	Dehouille	22000	1	92	0.41	Yes
003	55	Dehouille	50000	6	92	0.31	Yes

Local (Client Level)

Bias exploration

ClientID	Age	Name	Amount	SavingsOperations6M	PostalCode	Risk	Output
001	28	Antonelli	12000	10	75	0.01	Yes
002	19	Jung	5000	5	92	0.15	Yes
003	55	Dehouille	50000	1	92	0.60	No
005	42	Sanchez	5000	5	93	0.30	No
006	22	Brun	25000	5	92	0.40	Yes
007	33	Razimi	75000	6	91	0.10	Yes
008	18	Hoch	2500	0	75	0.61	Yes

Input Data

1 potential bias detected:

Distribution on accepted credit (answer = 'Yes'):

PostalCode=75 Investigate

Mean Mark as normal

PostalCode=93 Mark as normal

Hypothesis



1 potential bias detected:

Distribution on accepted credit (answer = 'Yes'):

PostalCode=75 Investigate

Mean Mark as normal

PostalCode=93 Mark as normal

Bias confirmed on PostalCode effect on Risk:
Risk has not the same relation to Answer based on PostalCode

1 Synthetic Counter Example:

ClientID	Age	Name	Amount	SavingsOperations6M	PostalCode	Risk	Answer
042	28	XXXX	82000	3	75	0.61	Yes
043	28	XXXX	82000	3	93	0.61	No

Synthetic examples

Abstraction of data: risky client

ClientID	Age	CreditIncidents	AmountAsked	SavingsOp6M	PostalCode	Employed	SelfEmployed	MeanIncome6M	MeanExpenses6M	DurationEmploymentM	FamilySize	ExpertNote	Delay	Default
001	24	0	12500	8	75	Yes	Yes	1550	250	2	0	9	0	No
002	31	1	1000	2	92	Yes	No	1250	150	120	3	5	6	Yes
003	67	0	10000	6	78	No	No	2800	1000	0	0	7	15	Yes

HUMAN KNOWLEDGE EXPLORER

KNOWLEDGE **BIAS DEFINITION**

Human Knowledge:

decent_saving_management: poor: SavingsOp6M > 0, **decent:** SavingsOp6M > 4, **good:** SavingsOp6M > 5

young_entrepreneur: Age < 26, SelfEmployed

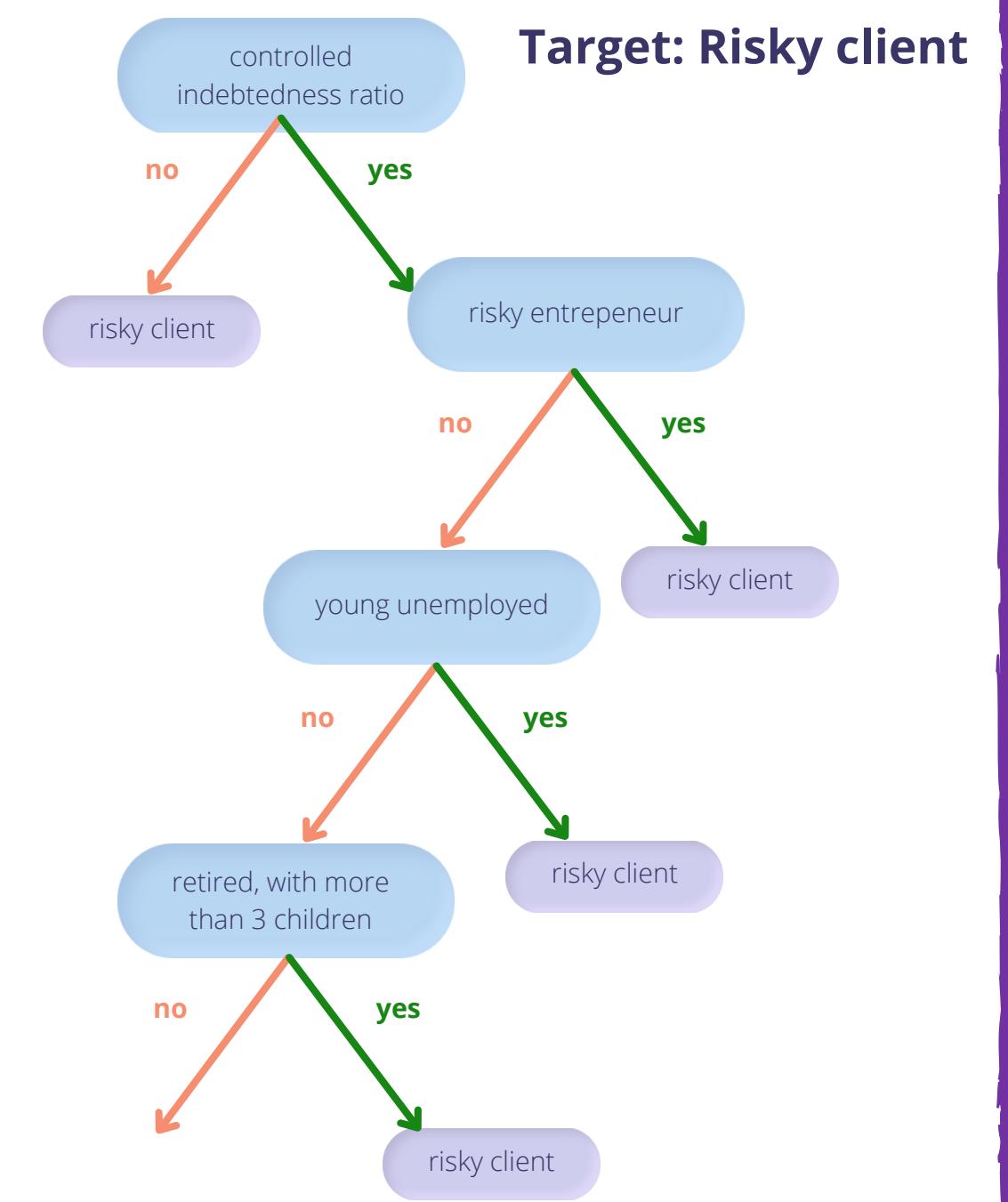
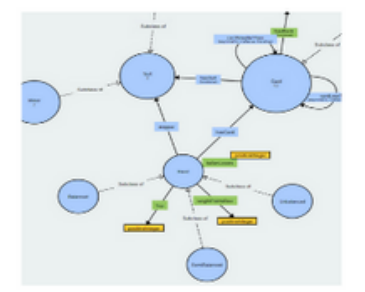
eligible_state_stand_security: young_entrepreneur, DurationEmploymentM < 25

indebtedness_ratio: MeanExpenses6M / MeanIncome6M
controlled, high, very_high

retired: age > 64, Unemployed

risky_entrepreneur:
SelfEmployed, **poor_saving_management**, VarIncome6M <= 0, DurationEmployment > 36

dynamic_entrepreneur:
SelfEmployed, > **decent_saving_management**, VarIncome6M > 3%,



Abstraction of data: reliable client

ClientID	Age	CreditIncidents	AmountAsked	SavingsOp6M	PostalCode	Employed	SelfEmployed	MeanIncome6M	MeanExpenses6M	DurationEmploymentM	FamilySize	ExpertNote	Delay	Default
001	24	0	12500	8	75	Yes	Yes	1550	250	2	0	9	0	No
002	31	1	1000	2	92	Yes	No	1250	150	120	3	5	6	Yes
003	67	0	10000	6	78	No	No	2800	1000	0	0	7	15	Yes

HUMAN KNOWLEDGE EXPLORER

Human Knowledge:

KNOWLEDGE BIAS DEFINITION

risky_client:
 uncontrolled_indeptedness
 risky_entrepreneur
 young_unemployed
 retired, FamilySize > 2

decent_saving_management: poor: SavingsOp6M > 0, **decent:** SavingsOp6M > 4, **good:** SavingsOp6M > 5

young_entrepreneur: Age < 26, SelfEmployed

eligible_state_stand_security: young_entrepreneur,
 DurationEmploymentM < 25

indebtedness_ratio: MeanExpenses6M / MeanIncome6M

retired: age > 64, Unemployed

risky_entrepreneur:
 SelfEmployed, **poor_saving_management**, VarIncome6M <= 0,
 DurationEmployment > 36



Target: Reliable client

R1: dynamic entrepreneur and
 duration of employment > 3 years

-
-
-

R4: risky client with at least decent
savings management

Conclusion



N u k k A I



Conclusion



N u k k a I

Thank you for
your time

