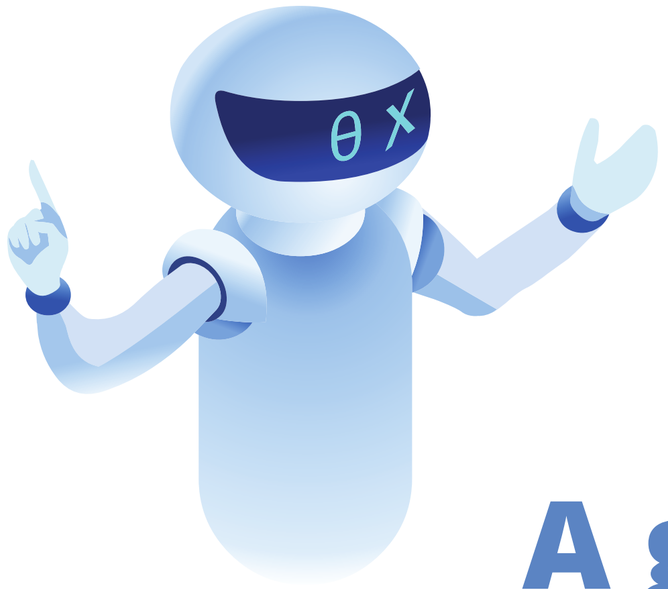


NukkAI

NuX

A generic tool for high-level explanations

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

A private AI lab based in Paris

NukkAI

Co-founded with Jean-Baptiste Fantun in may 2018

We build the next generation of Artificial Intelligence

NukkAI

PINKY

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

THE BRAIN

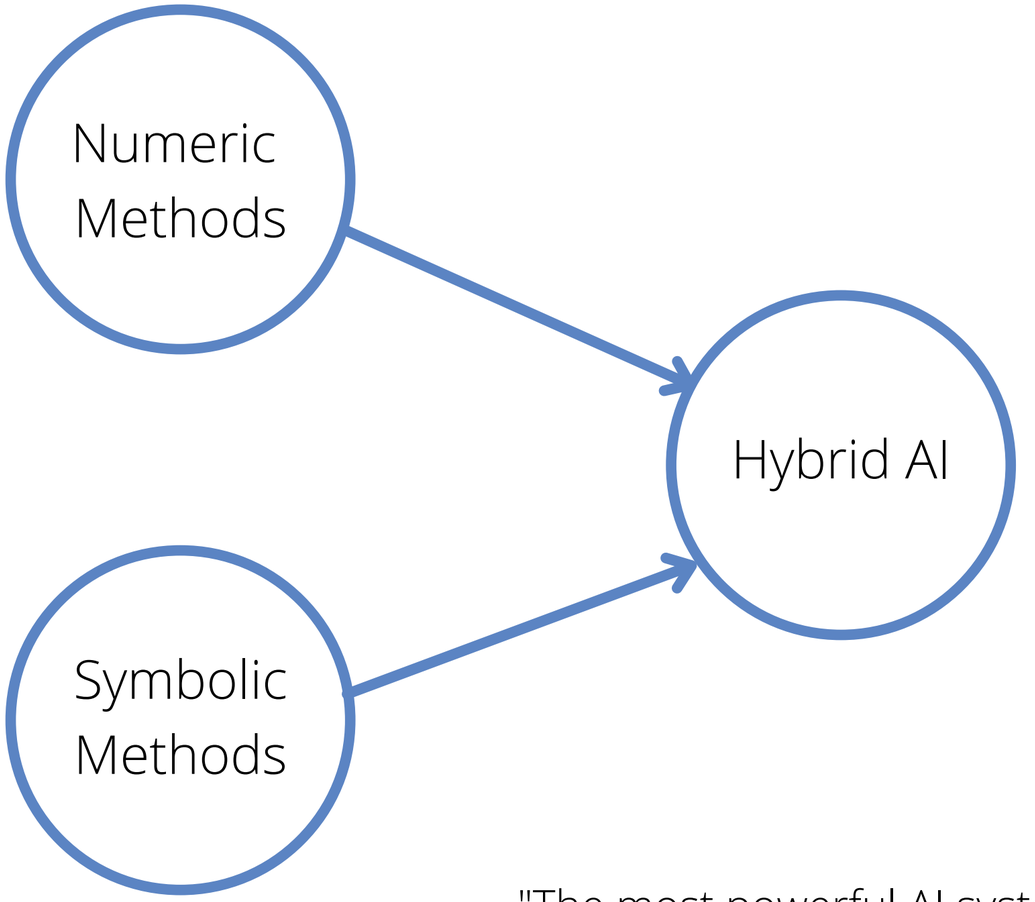
The same thing we do every night, Pinky.

Try to take over the world.

Hybrid AI : mixed paradigms

NukkAI

Powerful
Useful toolboxes
Black Box
Data greedy



Computer time consuming
High cost of entry

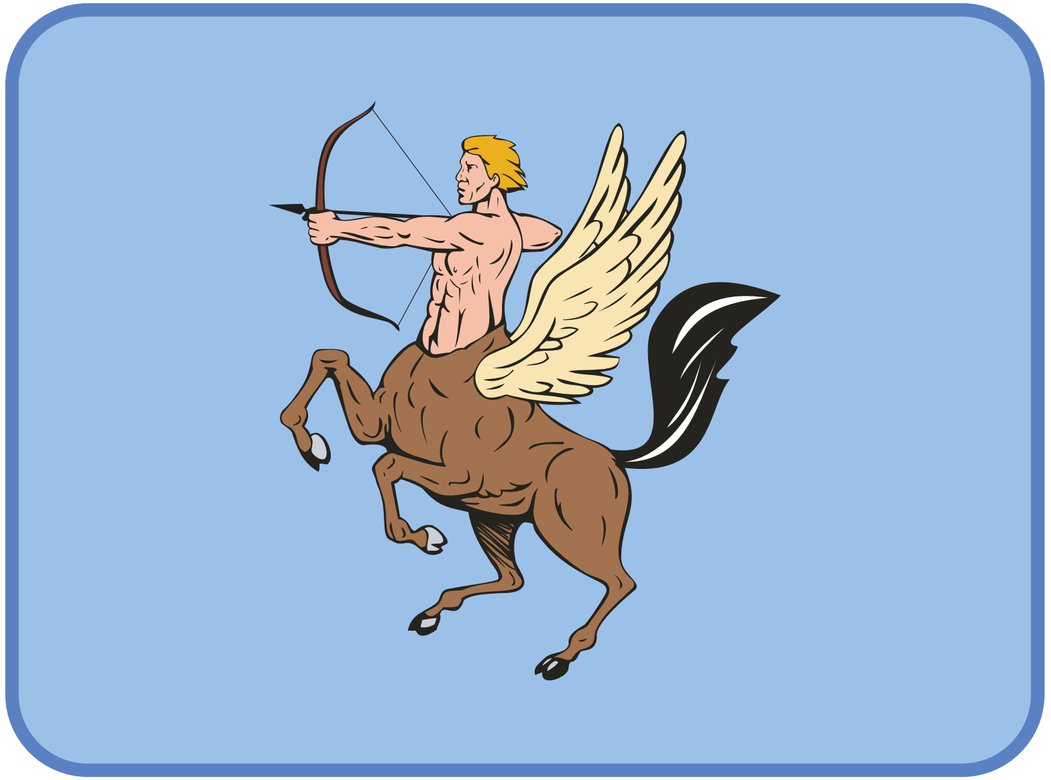
Powerful
Providing explanations
Good generalization
Data frugal
Easy human validation

"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

NukkAI

AI at the service of humans



Centaur

From Bridge to business verticals

NukkAI

The sandbox: **Bridge**

Industry

Healthcare

Cybersecurity

Finance

NuX explainers

NukkAI

Intelligent Dashboard over raw data

Bridge in short

NukkAI

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

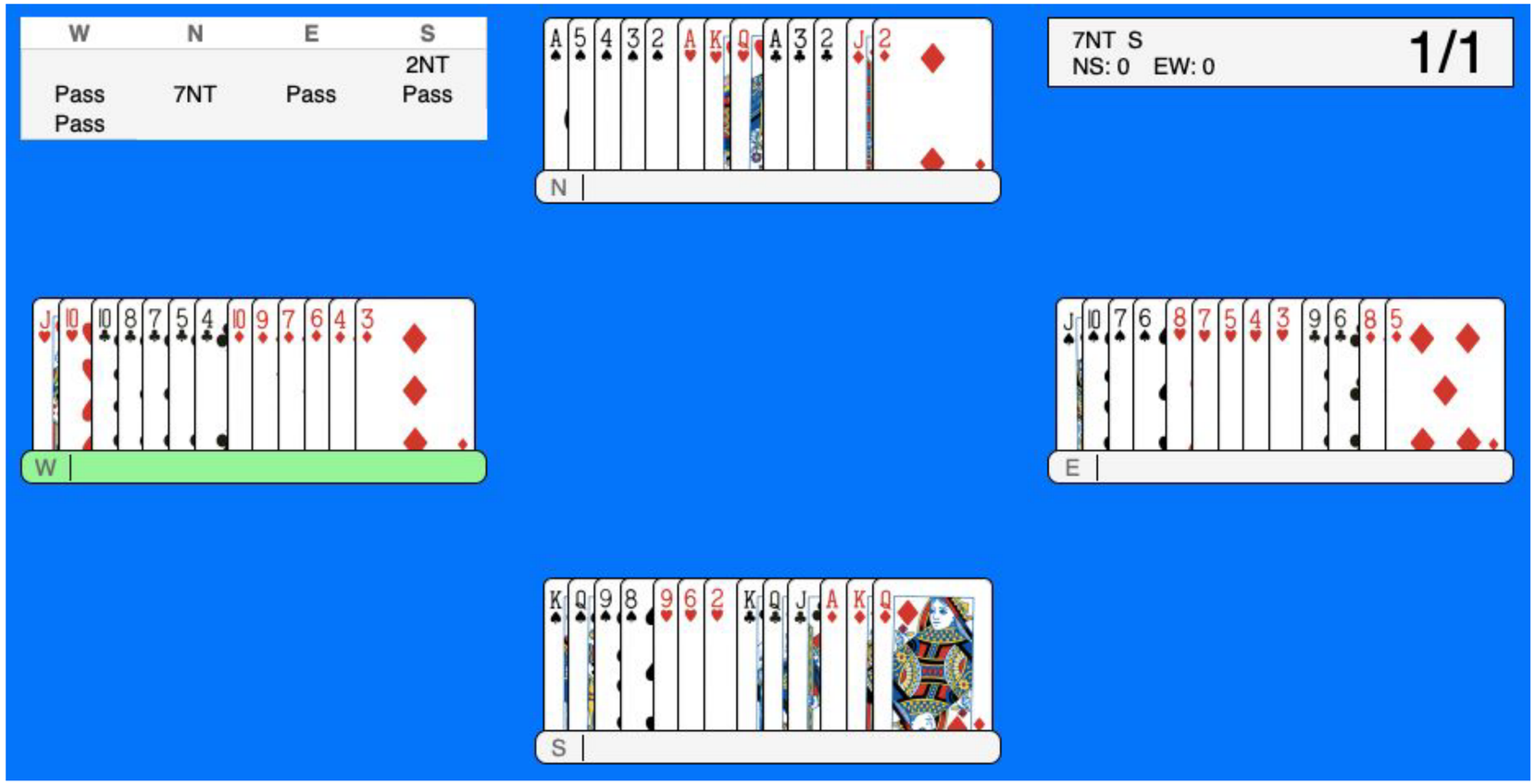
Cards are dealt **randomly** to the four players
Each of them only sees his hand (13 cards)

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

Two game phases:

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

Card Play



Meta-actions

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

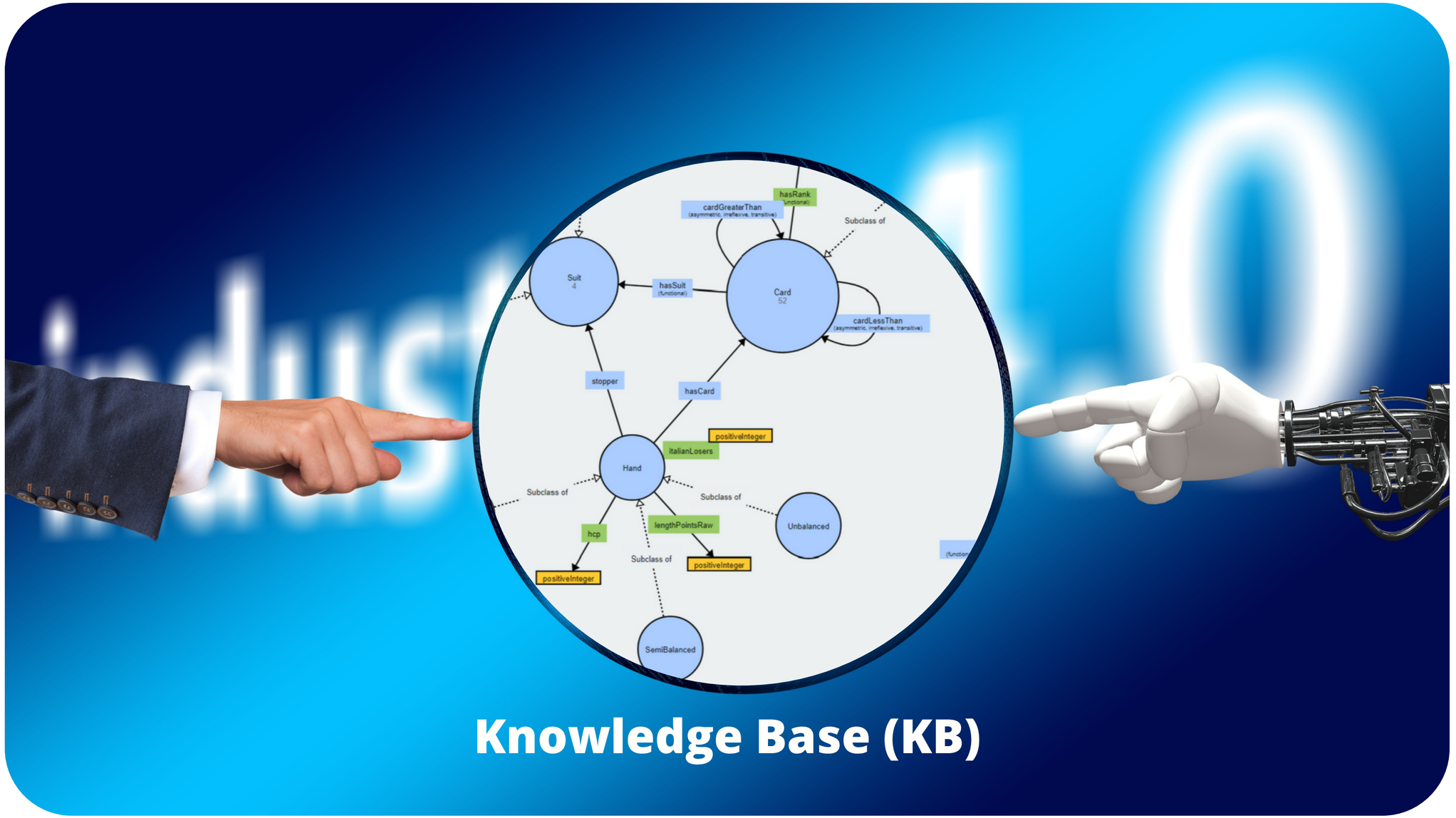
Meta-actions are described using logical formulae (STRIPS approach)

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

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

A common language between humans and machines

NukkAI



NuX-Bridge: Automated board analysis

NukkAI

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

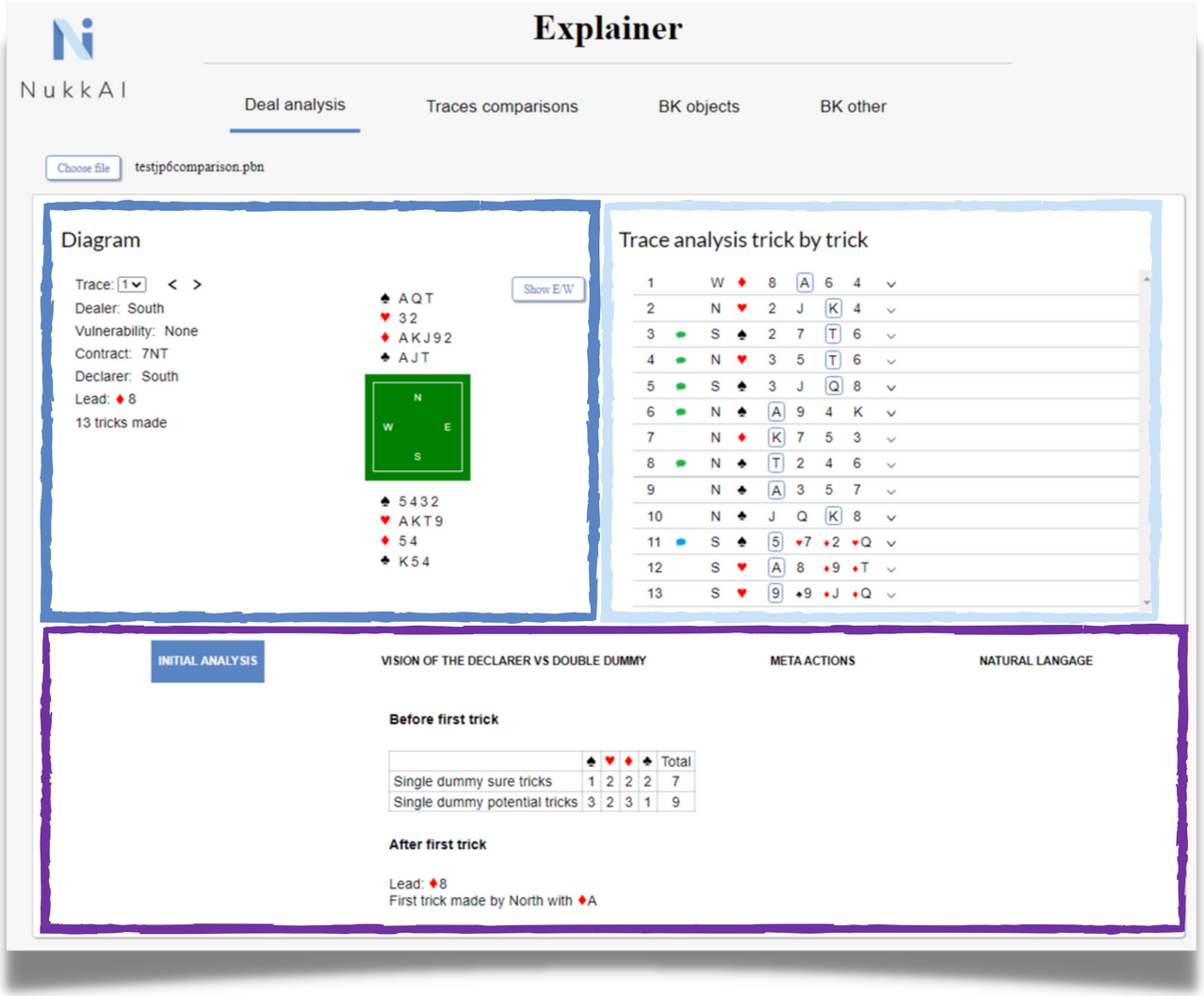
Natural language descriptions provided on different levels of abstraction

High level comparison of traces

NuX-Bridge

NukkAI

Visualisation of the initial situation



Trace analysis, annotations

Explanations

Initial analysis

NukkAI

INITIAL ANALYSIS

VISION OF THE DECLARER VS DOUBLE DUMMY

Before first trick

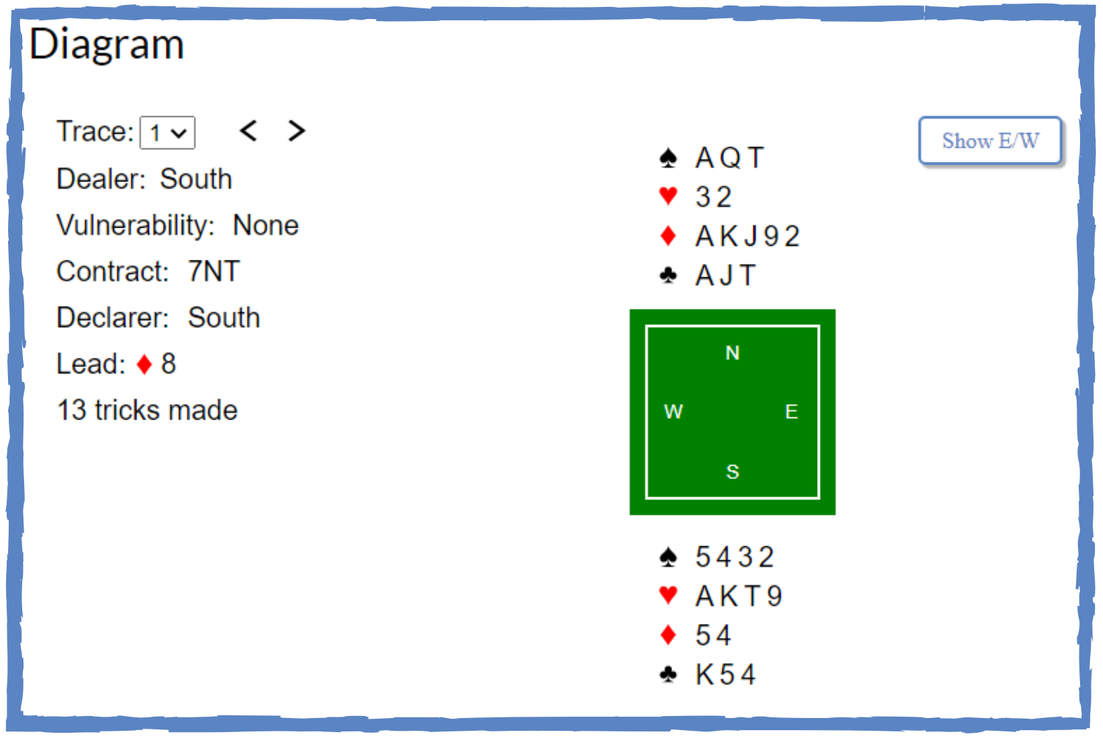
	♠	♥	♦	♣	Total
Single dummy sure tricks	1	2	2	2	7
Single dummy potential tricks	3	2	3	1	9

After first trick

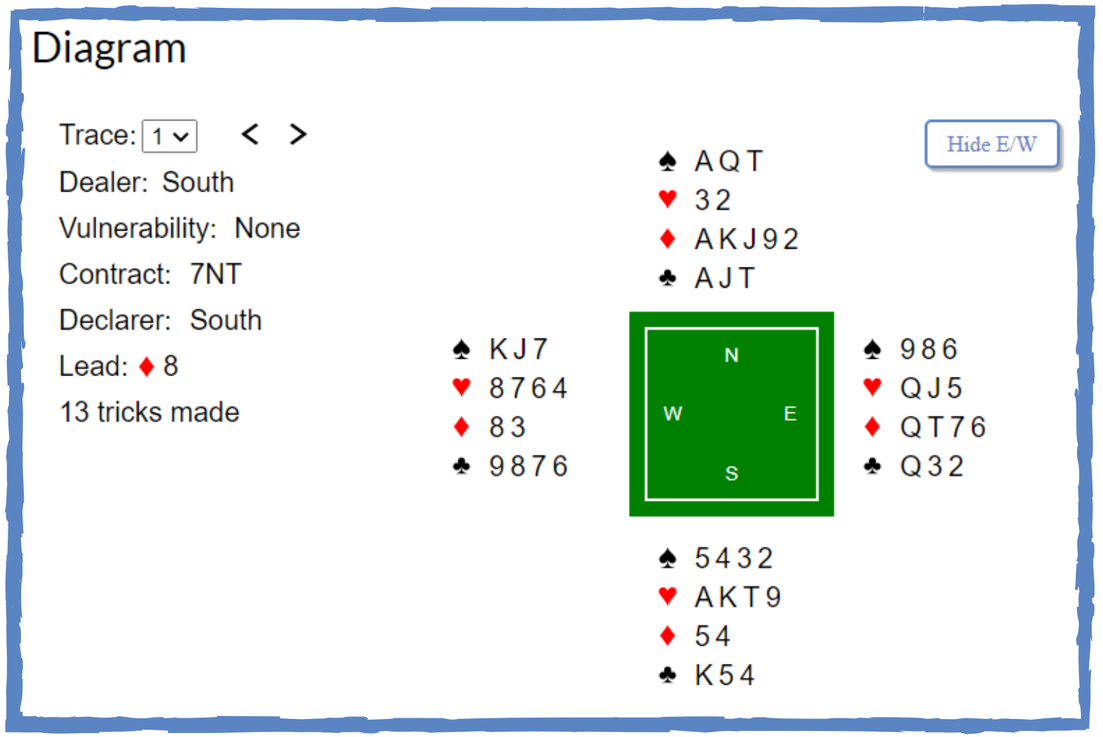
Lead: ♦8
First trick made by North with ♦A

Vision declarer vs dd

NukkAI



Incomplete information



Complete information

Probabilistic analysis of MetaActions

NukkAI

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

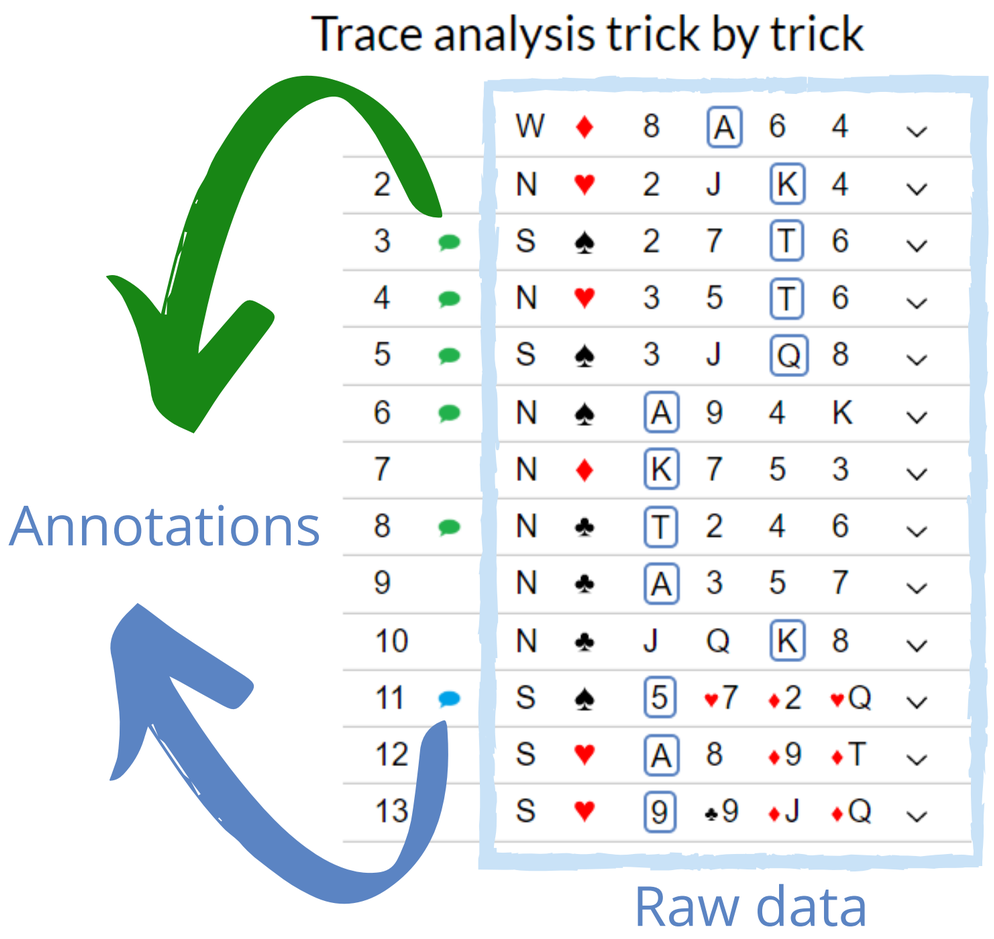
VISION OF THE DECLARER

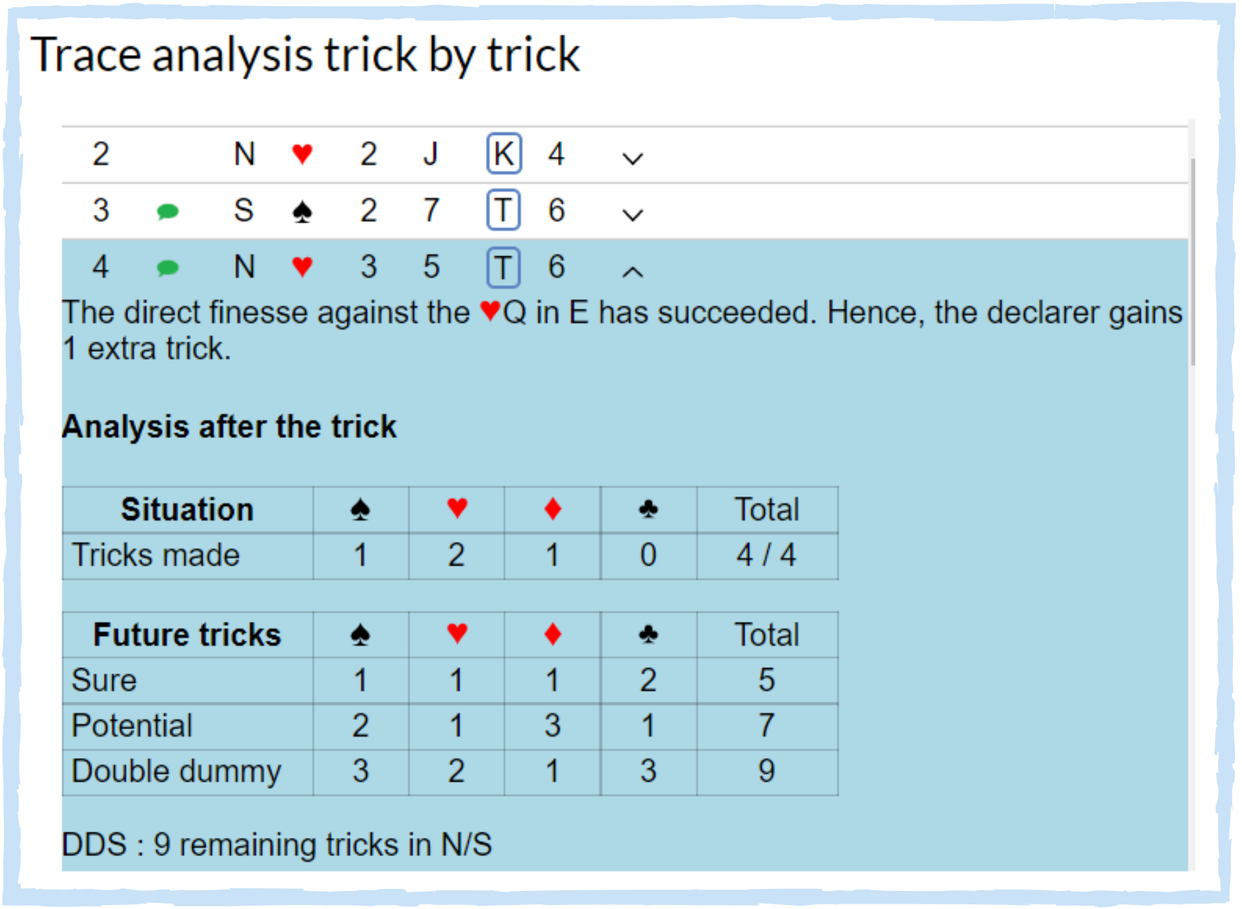
Valid meta-actions	Single dummy probabilities	Double dummy check	Warning
Cash by rank in ♠	2%	✗	
Cash by rank in ♥	1%	✗	
Cash by rank in ♦	12%	✗	
Cash by rank in ♣	10%	✗	
Direct finesse against ♠K in W	50%	✓	
Direct finesse against ♠KJ in W	24%	✓	⚠
Direct finesse against ♥QJ in E	24%	✓	⚠
Direct finesse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

NukkAI





High-level trace analysis

NukkAI

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

NukkAI

NATURAL LANGAGE

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 LANGAGE

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 LANGAGE

High level

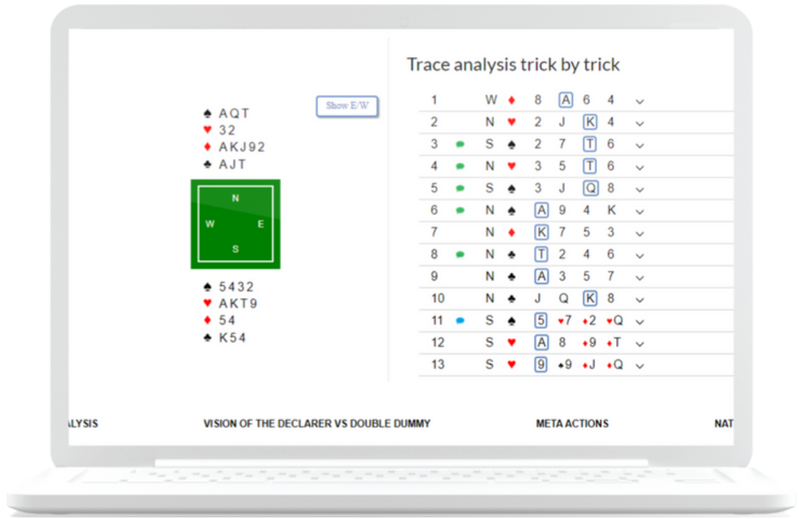
Medium level

Low level

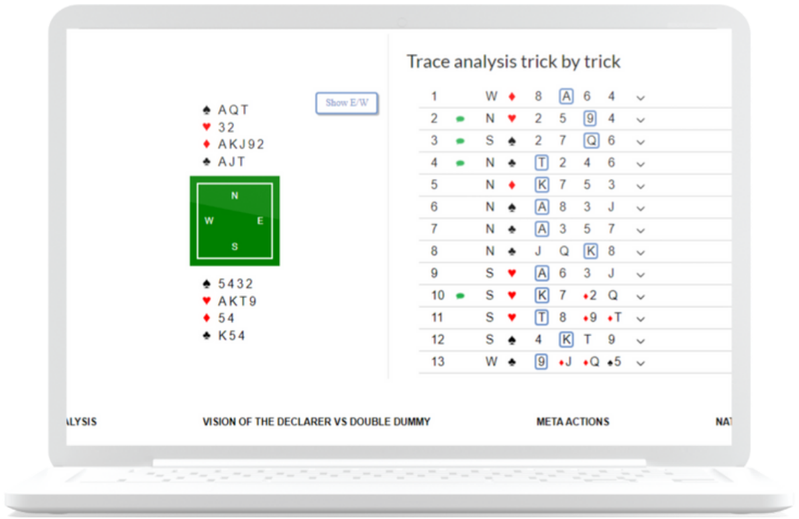
The declarer started with 7 top tricks.
They took the lead with the ♦A in dummy.
They played the ♥2, East rose the Jack and South's King took the trick.
They played the ♠2 to dummy's Ten, successfully finessing against the ♠K, ♠J, giving them 8 total top tricks.
They played the ♥3 to South's Ten, successfully 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

NukkAI



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

NukkAI

Intelligent Dashboard over raw data

NuX-Finance: Analysis of financial data

NukkAI

Inputs

Heterogeneous financial data

- Credit related data
- Black box AI systems

Financial KB

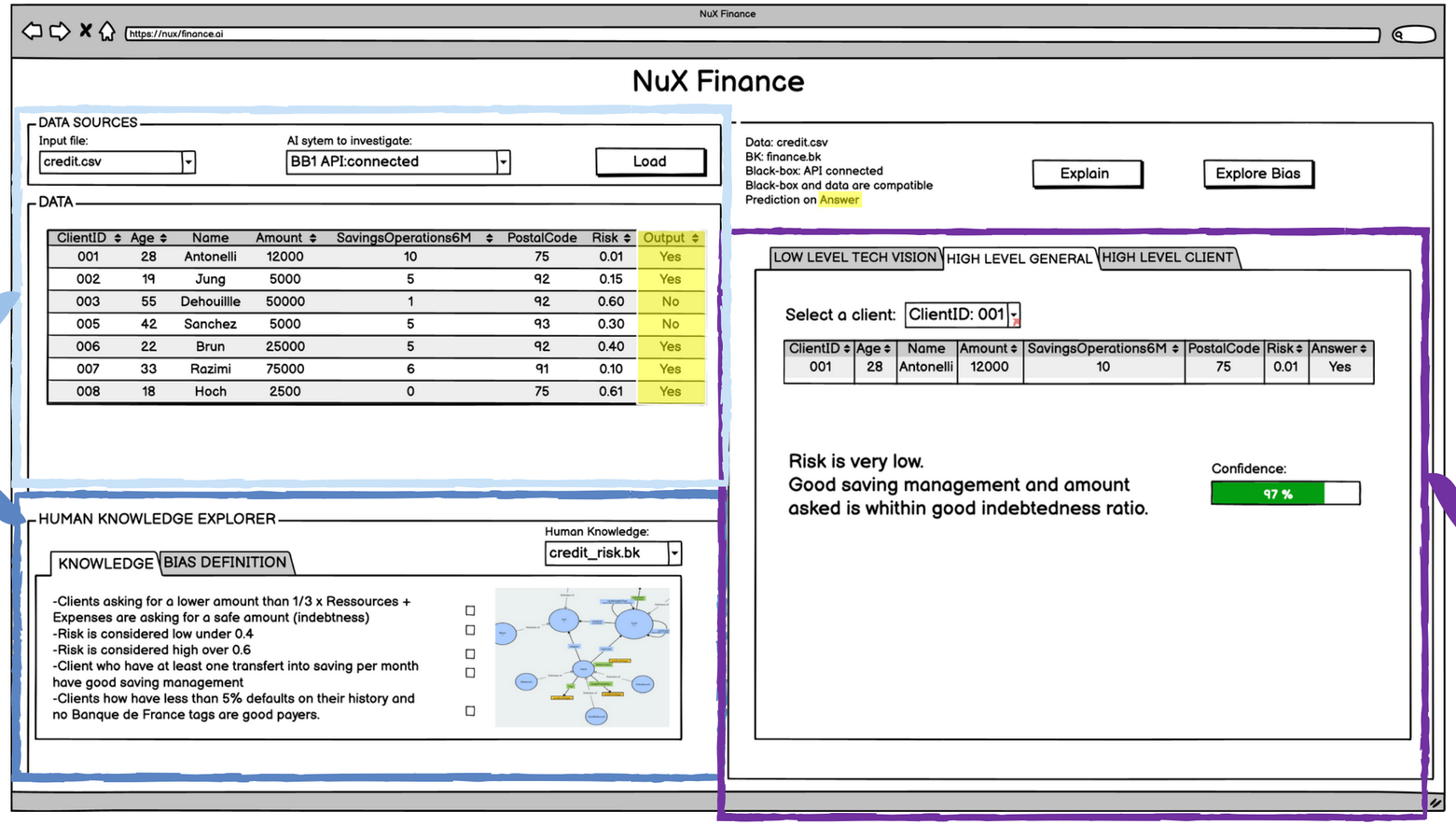
Outputs

- Post-hoc explanations
- Bias exploration
- Abstraction of data

NuX-Finance

NukkAI

Heterogeneous data sources



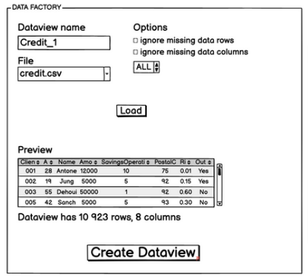
Outputs

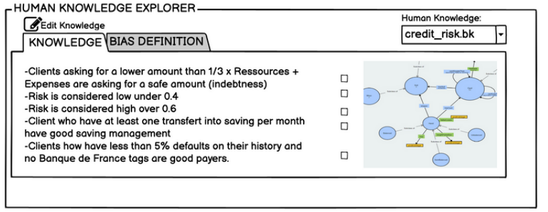
Human Knowledge Explorer / Editor

General method

NukkAI

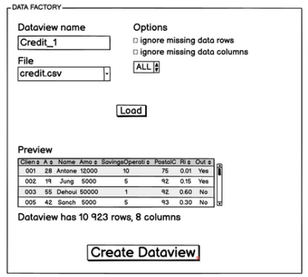
Load heterogeneous data and initial KB

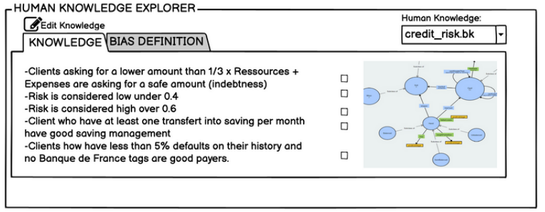




General method

Load heterogeneous data and initial KB





Define a task:

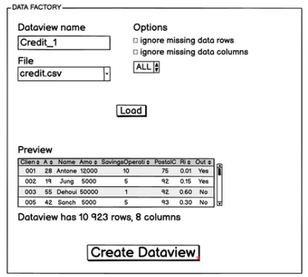
- Data Mining and exploratory analysis
- Machine Learning
- Post-hoc explanation
- Bias analysis
- Data Cleaning

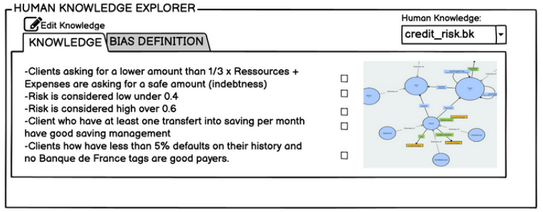
NukkAI

General method

NukkAI

Load heterogeneous data and initial KB

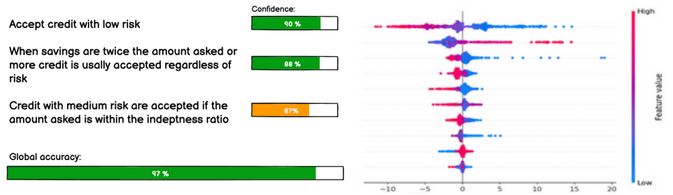




Define a task:

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

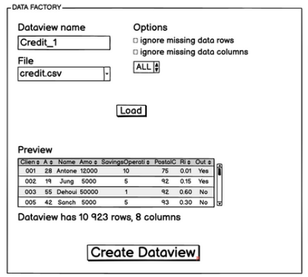
Natural Language Output & Visualisations

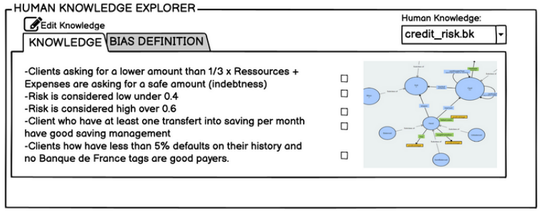


General method

NukkAI

Load heterogeneous data and initial KB





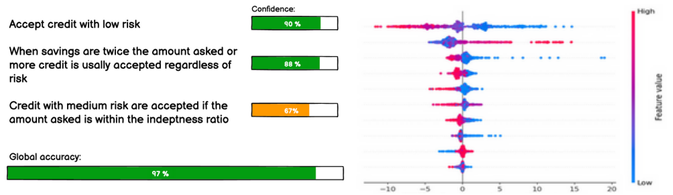
Define a task:

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

Human expert intervention:
Knowledge and data update

ntID	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	Dehouillie	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

Natural Language Output & Visualisations

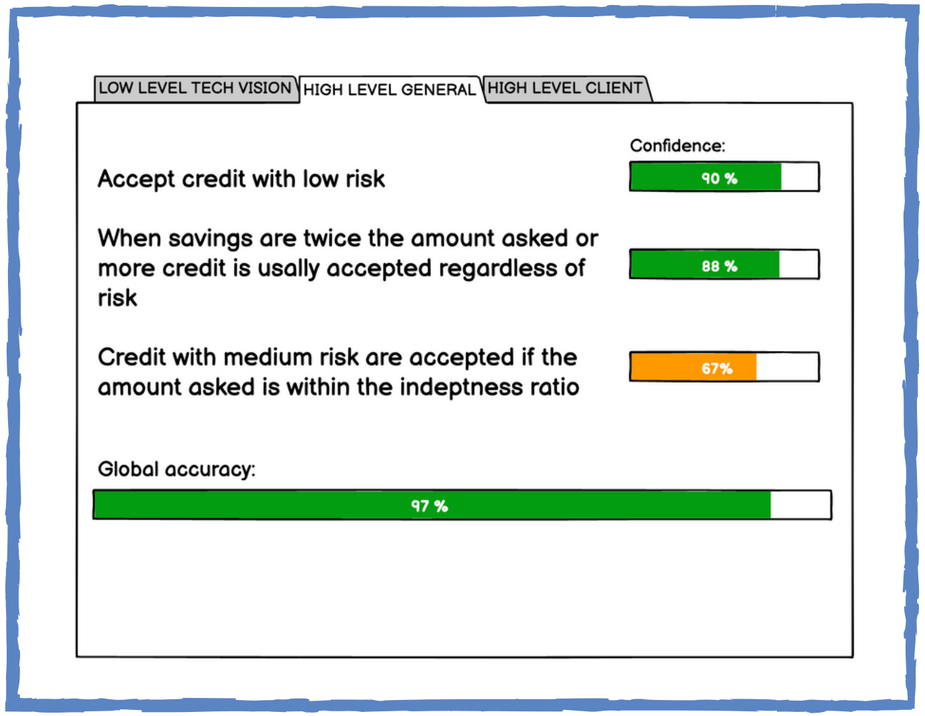


Post-hoc explanations

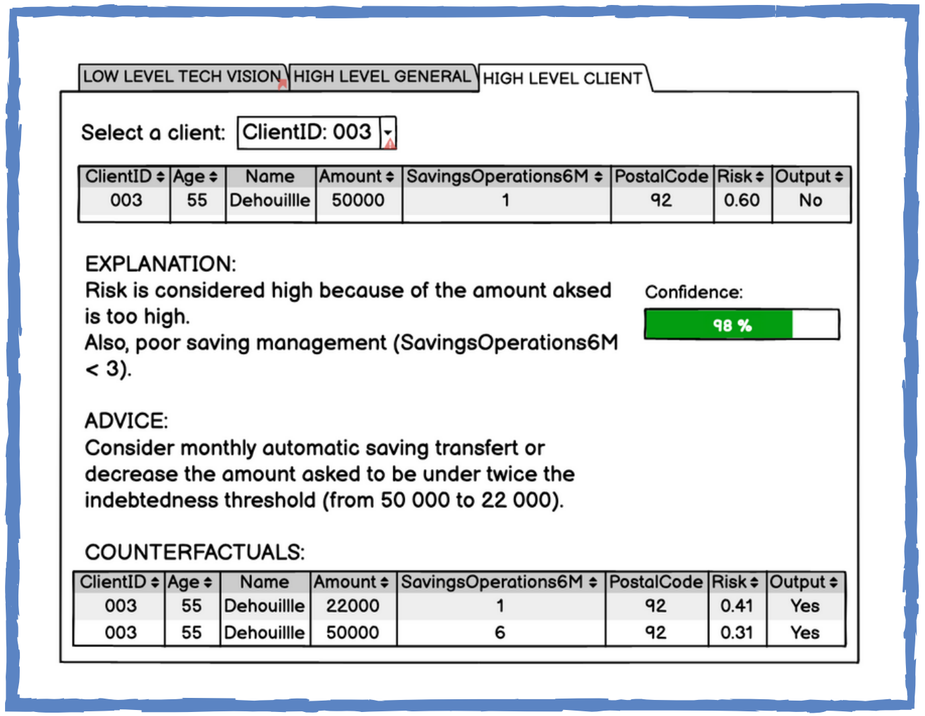
NukkAI

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	Dehouillle	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



Global



Local (Client Level)

Bias exploration

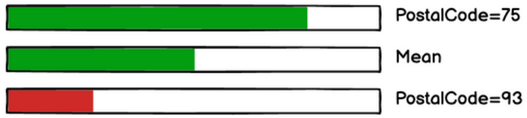
NukkAI

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	Dehouillle	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'):



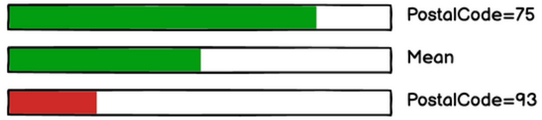
Investigate

Mark as normal

Hypothesis

1 potential bias detected:

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



Investigate

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	DurationEmployementM	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: fincredit1

KNOWLEDGE | BIAS DEFINITION

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

young_entrepreneur: Age <26, SelfEmployed

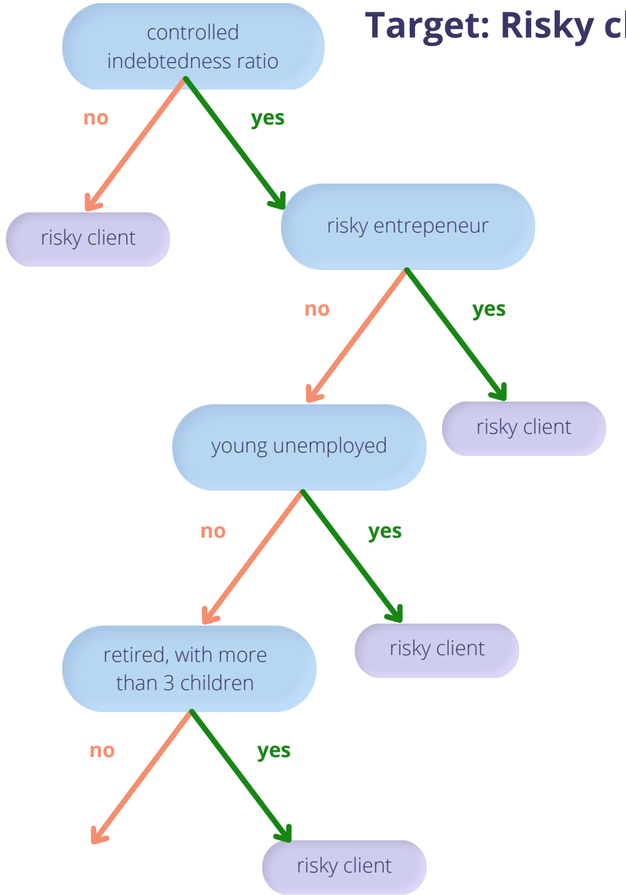
eligible_state_stand_security: **young_entrepreneur**, DurationEmployementM < 25

indebtedness_ratio: MeanExpenses6M / MeanIncome6M
controlled, high, very_high

retired: age > 64, **Unemployed**

risky_entrepreuneur:
SelfEmployed, **poor_saving_management**, VarIncome6M <= 0, DurationEmployement > 36

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



Abstraction of data: reliable client

ClientID	Age	CreditIncidents	AmountAsked	SavingsOp6M	PostalCode	Employed	SelfEmployed	MeanIncome6M	MeanExpenses6M	DurationEmployementM	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: fincredit1

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**, DurationEmployementM < 25

indebtedness_ratio: MeanExpenses6M / MeanIncome6M

retired: age > 64, **Unemployed**

risky_entrepreuneur:
SelfEmployed, **poor_saving_management**, VarIncome6M <= 0, DurationEmployement > 36

Target: Reliable client

R1: **dynamic entrepreneur** and duration of employement > 3 years

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.

R4: **risky client** with at least decent **savings management**

Conclusion

NukkAI

Conclusion

NukkAI