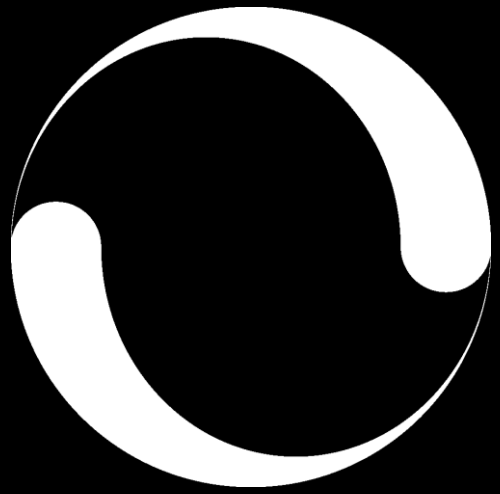
TRICENTIS



Artificial Intelligence

The Best & Worst Uses of AI in Software Testing

Ingo Philipp

The New **Paradigm**

André Mendes

The Next **Digital Frontier**

McKinsey Institute

The Next **Disruptive Force**

Bloomberg

The New **Black**

MIT Technology Review

The New **Electricity**

Andrew Ng

Nothing has moved as fast as **artificial intelligence** is moving right now in the enterprise

We'll be able to fully **backup** our brains. We'll be able to think in the cloud

We're going to put **gateways** to the cloud in our brains

By the late 2030s human thought will be predominantly **non-biological**

We will be uploading our minds to computers & become **immortal** by 2045

:: Raymond **Kurzweil** ‹› Director of Engineering at Google

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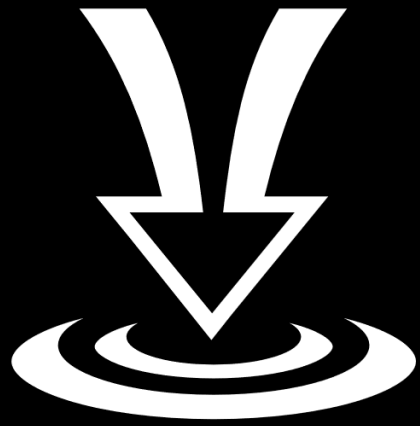

We are just a baby step away from eliminating the need for **human thinking** in software testing

We'll be able to fully **backup** our brains. We'll be able to think in the cloud

We're going to put **gateways** to the cloud in our brains

By the late 2030s human thought will be predominantly **non-biological**

We will be uploading our minds to computers & become **immortal** by 2045

I won't sell you
artificial intelligence in
software testing in the way
miracle weight loss programs
or **anti**-**aging** face creams
(with micro beads!)
are being sold

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or **anti-aging** face creams
(with micro beads!)
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Artificial Intelligence

Viewed narrowly, there seem to be
almost as many **definitions** of intelligence
as the number of experts asked to define it

TRICENTIS

TECHNICAL REPORT IDSIA-07-07

A Collection of Definitions of Intelligence

Shane Legg

IDSIA, Galleria 2, Manno-Lugano CH-6928, Switzerland*
shane@idsia.ch www.idsia.ch/~shane

Marcus Hutter

IDSIA, Galleria 2, Manno-Lugano CH-6928, Switzerland*
RSISE/ANU/NICTA, Canberra, ACT, 0200, Australia
marcus@hutter1.net www.hutter1.net

15 June 2007

Abstract

This paper is a survey of a large number of informal definitions of "intelligence" that the authors have collected over the years. Naturally, compiling a complete list would be impossible as many definitions of intelligence are buried deep inside articles and books. Nevertheless, the 70-odd definitions presented here are, to the authors' knowledge, the largest and most well referenced collection there is.

Artificial Intelligence

Viewed narrowly, there seem to be almost as many **definitions** of intelligence as the number of experts asked to define it

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Emotional Thinking	**Critical** Thinking	**Problem** Solving
Logical Thinking	**Communication** Perception	**Modelling** Planning
Abstraction Learning	**Imagination** Creativity	**Memory** Experience
Understanding Knowledge	**Judgement** Analysis	Environment **Manipulation**
Environment **Adaptation**	Strategic **Goal Setting**	Instinctive **Judgement**

TRICENTIS

> Intelligence is what is measured by **intelligence tests**
>
> Edwin Boring

- The Turing Test
- The Reverse Turing Test
- The Visual Turing Test
- The Lovelace Test
- The Lovelace 2.0 Test
- The Winograd Schema Challenge
- The Ex Machina Test
- The Tokyo Test
- The AIQ Test
- The DeepMind Test
- The Marcus Test
- The IKEA Challenge
- The NCC Test

Emotional Thinking	**Critical** Thinking	**Problem** Solving
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TRICENTIS

> Intelligence is what is measured by **intelligence tests**
>
> Edwin Boring

> Intelligence measures an agent's ability to achieve **goals** in a wide range of **environments**
>
> Shane Legg

> Artificial intelligence is **anything** machines can't yet do
>
> Chris Bishop

Emotional Thinking	**Critical** Thinking	**Problem** Solving
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Abstraction Learning	**Imagination** Creativity	**Memory** Experience
Understanding Knowledge	**Judgement** Analysis	Environment **Manipulation**
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TRICENTIS

General

• Artificial Intelligence •

A machine with the ability to apply intelligence to **any problem**

Emotional Thinking	**Critical** Thinking	**Problem** Solving
Logical Thinking	**Communication** Perception	**Modelling** Planning
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TRICENTIS

General

• Artificial Intelligence •

A machine with the ability to apply intelligence to **any problem**

Narrow

• Artificial Intelligence •

A machine with the ability to apply intelligence to a **specific problem**

TRICENTIS

Software Testing

Narrow

• Artificial Intelligence •

A machine with the ability to apply intelligence to a **specific problem**

© Dominik **Weissböck**

Narrow

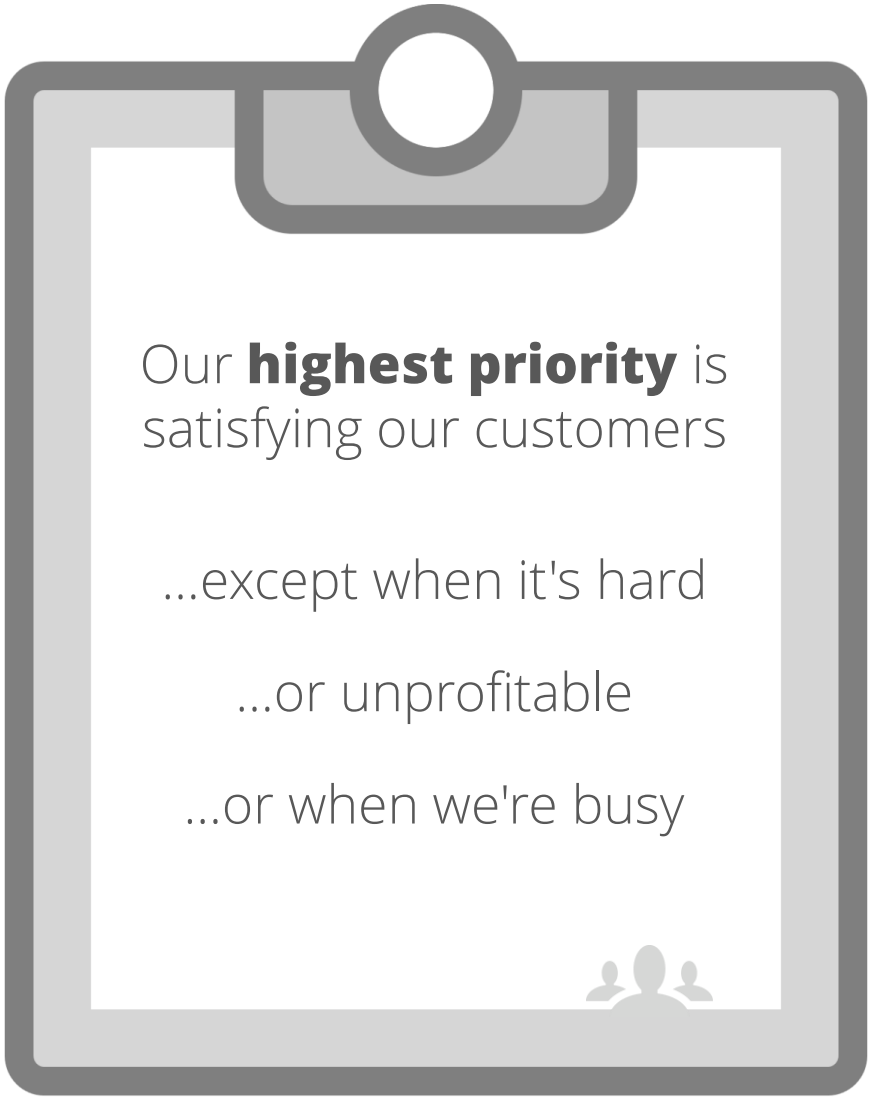
• Artificial Intelligence •

A machine with the ability to apply intelligence to a **specific problem**

Narrow

• Artificial Intelligence •

A machine with the ability to apply
intelligence to a **specific problem**



Narrow

• Artificial Intelligence •

A machine with the ability to apply intelligence to a **specific problem**

TRICENTIS

5400+ Responses; 720+ Customers

Narrow

• Artificial Intelligence •

A machine with the ability to apply intelligence to a **specific problem**

TRICENTIS

	Approach	Research	Use
Test Strategy Optimization	Rule-Based System	No	Worst
Automated Test Design	Learning System	No	Worst
Redundancy Prevention	Rule-Based System	Yes	Best
Risk Coverage Optimization	Rule-Based System	Yes	Best
Automated Exploratory Testing	Learning System	Yes	Worst
Resilient Automation	Learning System	Yes	Best
False-Positive Detection	Rule-Based System	Yes	Best
Automated Defect Diagnosis	Rule-Based System	No	Worst
User Experience Analysis	Learning System	Yes	Worst
Portfolio Inspection	Rule-Based System	Yes	Best

Narrow

• Artificial Intelligence •

A machine with the ability to apply intelligence to a **specific problem**

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False-Positive Detection	Rule-Based System	Yes	Best
Automated Defect Diagnosis	Rule-Based System	No	Worst
User Experience Analysis	Learning System	Yes	Worst
Portfolio Inspection	Rule-Based System	Yes	Best

AI uses production data to **prioritize** features, to define what to test, what to automate, and even what to build

- Test Strategy **Optimization**

TRICENTIS

	Approach	Research	Use
Test Strategy Optimization	Rule-Based System	No	Worst
Automated Test Design	Learning System	No	Worst
Redundancy Prevention	Rule-Based System	Yes	Best
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False-Positive Detection	Rule-Based System	Yes	Best
Automated Defect Diagnosis	Rule-Based System	No	Worst
User Experience Analysis	Learning System	Yes	Worst
Portfolio Inspection	Rule-Based System	Yes	Best

AI interprets requirements (e.g. user stories) and generates the minimal number of test cases from the **requirements** to maximize risk coverage

TRICENTIS

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Test Strategy Optimization	Rule-Based System	No	Worst
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False-Positive Detection	Rule-Based System	Yes	Best
Automated Defect Diagnosis	Rule-Based System	No	Worst
User Experience Analysis	Learning System	Yes	Worst
Portfolio Inspection	Rule-Based System	Yes	Best

AI eliminates and prevents **redundancies** in test case portfolios to achieve the same results in terms of business risk coverage but with less effort

- **Redundancy** Prevention

TRICENTIS

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Test Strategy Optimization	Rule-Based System	No	Worst
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False-Positive Detection	Rule-Based System	Yes	Best
Automated Defect Diagnosis	Rule-Based System	No	Worst
User Experience Analysis	Learning System	Yes	Worst
Portfolio Inspection	Rule-Based System	Yes	Best

AI **interacts** with the application, builds a model of it, **discovers** relevant functionality, reveals defects, and extracts test cases to reduce test effort

- Automated **Exploratory Testing**

TRICENTIS

	Approach	Research	Use
Test Strategy Optimization	Rule-Based System	No	Worst
Automated Test Design	Learning System	No	Worst
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Resilient Automation	Learning System	Yes	Best
False-Positive Detection	Rule-Based System	Yes	Best
Automated Defect Diagnosis	Rule-Based System	No	Worst
User Experience Analysis	Learning System	Yes	Worst
Portfolio Inspection	Rule-Based System	Yes	Best

AI reduces the effort required for results analysis by indicating whether a failed test case actually detected a **defect** in the application, or just broke due to **technical issues** with the test case itself

- **False-Positive** Detection

TRICENTIS

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False-Positive Detection	Rule-Based System	Yes	Best
Automated Defect Diagnosis	Rule-Based System	No	Worst
User Experience Analysis	Learning System	Yes	Worst
Portfolio Inspection	Rule-Based System	Yes	Best

AI proposes potential reasons that caused a test case to fail to help development reduce the time it takes to analyze the **root cause** of a defect

- Automated **Defect Diagnosis**

TRICENTIS

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False-Positive Detection	Rule-Based System	Yes	Best
Automated Defect Diagnosis	Rule-Based System	No	Worst
User Experience Analysis	Learning System	Yes	Worst
Portfolio Inspection	Rule-Based System	Yes	Best

AI monitors and interprets **user emotions** during exploratory testing and links its findings back to the related application component to increase the precision of UX analysis

- **User Experience** Analysis

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False-Positive Detection	Rule-Based System	Yes	Best
Automated Defect Diagnosis	Rule-Based System	No	Worst
User Experience Analysis	Learning System	Yes	Worst
Portfolio Inspection	Rule-Based System	Yes	Best

AI tracks flaky test cases, unused test cases, test cases not linked to requirements, untested requirements, etc. to indicate **weak spots** in test portfolios

- Portfolio **Inspection**

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User Experience Analysis	✸ Learning System	Yes	Worst
Portfolio Inspection	Rule-Based System	Yes	Best

TRICENTIS

How to teach a machine doing exploratory testing?

Worst Uses

Best Uses

How to make test automation more robust against changes?

Value

Effort » Uncertainty » Complexity » Risks » Costs

If you can define concrete steps to get to a solution, don't use **machine learning**

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Explicit Design

Explicit programming; fixed knowledge; no learning capabilities; fake and rigid intelligence

TRICENTIS

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We do have **16 hours**.
What's the best possible we can achieve?

TRICENTIS

Test Cases ↓

Coverage ↑

Costs ↓

16 hours

Time •

Resources ↓

Defects ↑

We do have **16 hours**.
What's the best possible we can achieve?

TRICENTIS

Test Cases	#**1576**	↓
Coverage	**67**%	↑
Costs	$**3000**	↓
Time	**16** hours	•
Resources	**4**/**10** testers; **8**/**10** machines	↓
Defects	**6** critical defects (12%)	↑

We do have **16 hours**.
What's the best possible we can achieve?

TRICENTIS

Test Cases	#**180**	↓
Coverage	**35**%	↑
Costs	$**2000**	↓
Time	**6** hours	•
Resources	**5** testers	•
Defects	**8** critical defects (46%)	↑

We do have **6 hours** and **5 testers**. What's the best possible we can achieve?

TRICENTIS

Test Cases	#**3476**
Coverage	**60**%
Costs	$**800**
Time	**3** hours
Resources	**7**/**12** machines
Defects	**2** critical defects (36%)

We want at least
60% **risk coverage**.
What does it cost?

Explicit Design

The science of getting computers to act by being **explicitly** programmed

We want at least 60% **risk coverage**. What does it cost?

Explicit Design

The science of getting computers to act by being **explicitly** programmed

Before we've had **rules** and **data** that led to **answers**, now we have answers and data the lead to rules

Linda Liukas

Explicit Design

The science of getting computers to act by being **explicitly** programmed

Machine Learning

The science of getting computers to act without being **explicitly** programmed

Human Learning

The science of getting people to test without being **explicitly** told to do so

Machine Learning

The science of getting computers to act without being **explicitly** programmed

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Machine Learning

The science of getting computers to act without being **explicitly** programmed

TRICENTIS

Present

Low-Code UI Automation

« Model-Based Test Automation »

Future

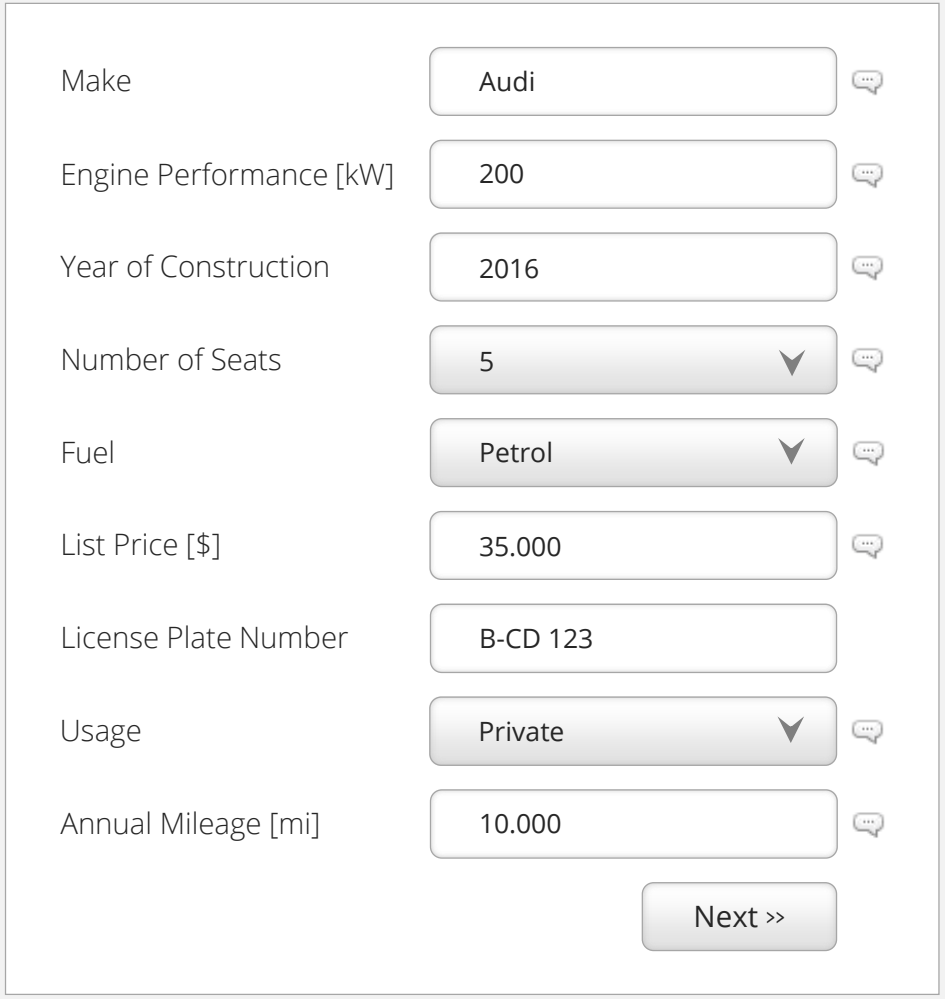
No-Code UI Automation

« Model-Free Test Automation »

Machine Learning

The science of getting computers to act without being **explicitly** programmed

TRICENTIS



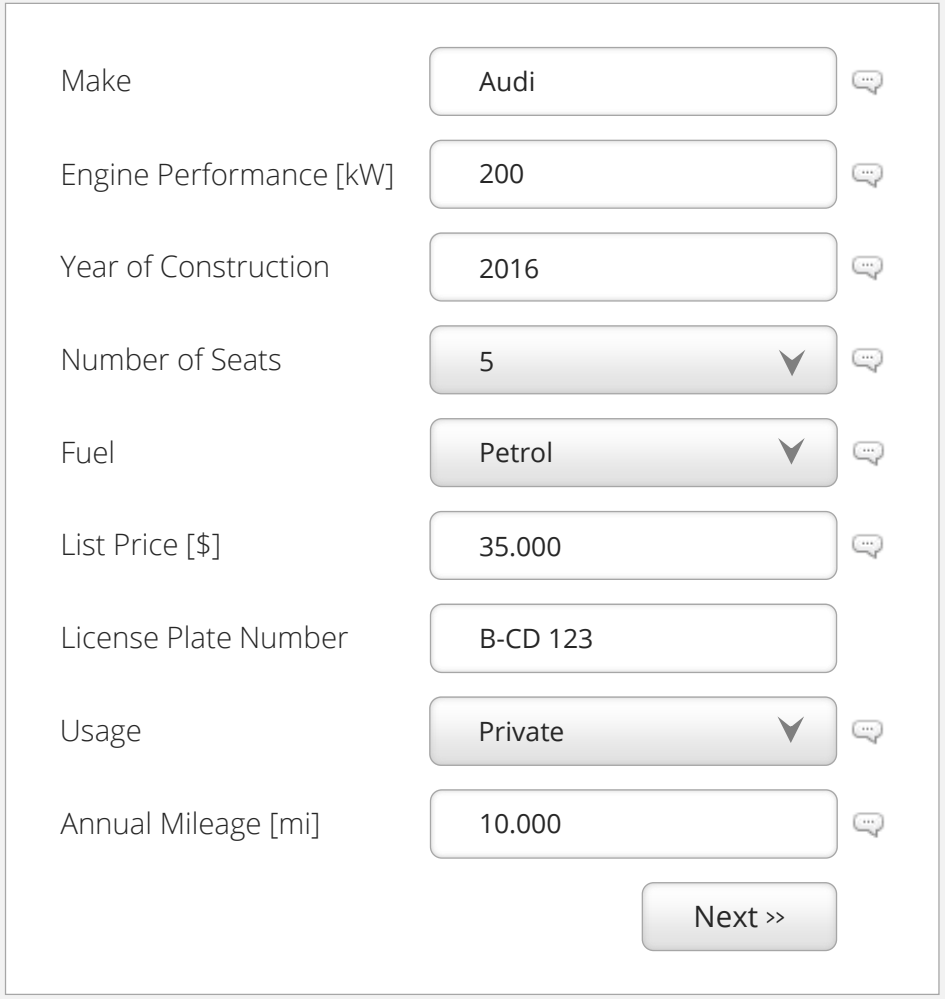
Application

« User's Perspective »

Machine Learning

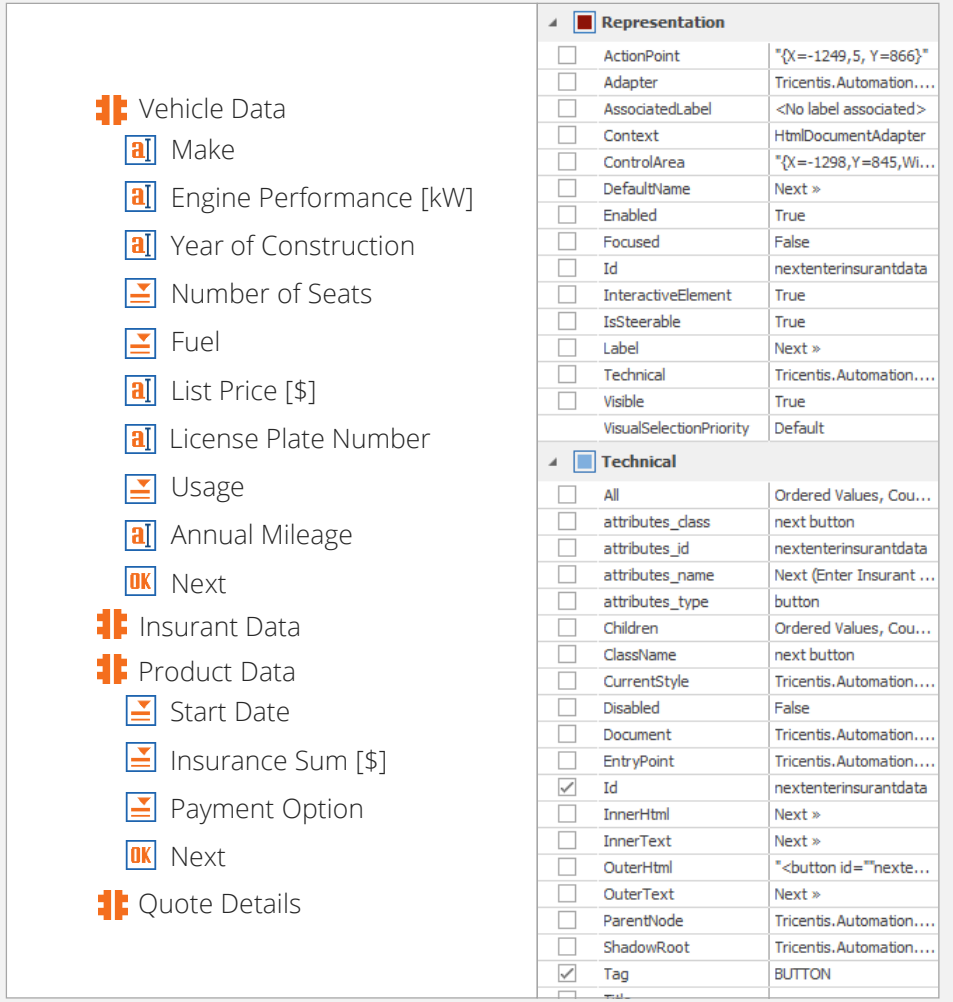
The science of getting computers to act without being **explicitly** programmed

TRICENTIS



Application

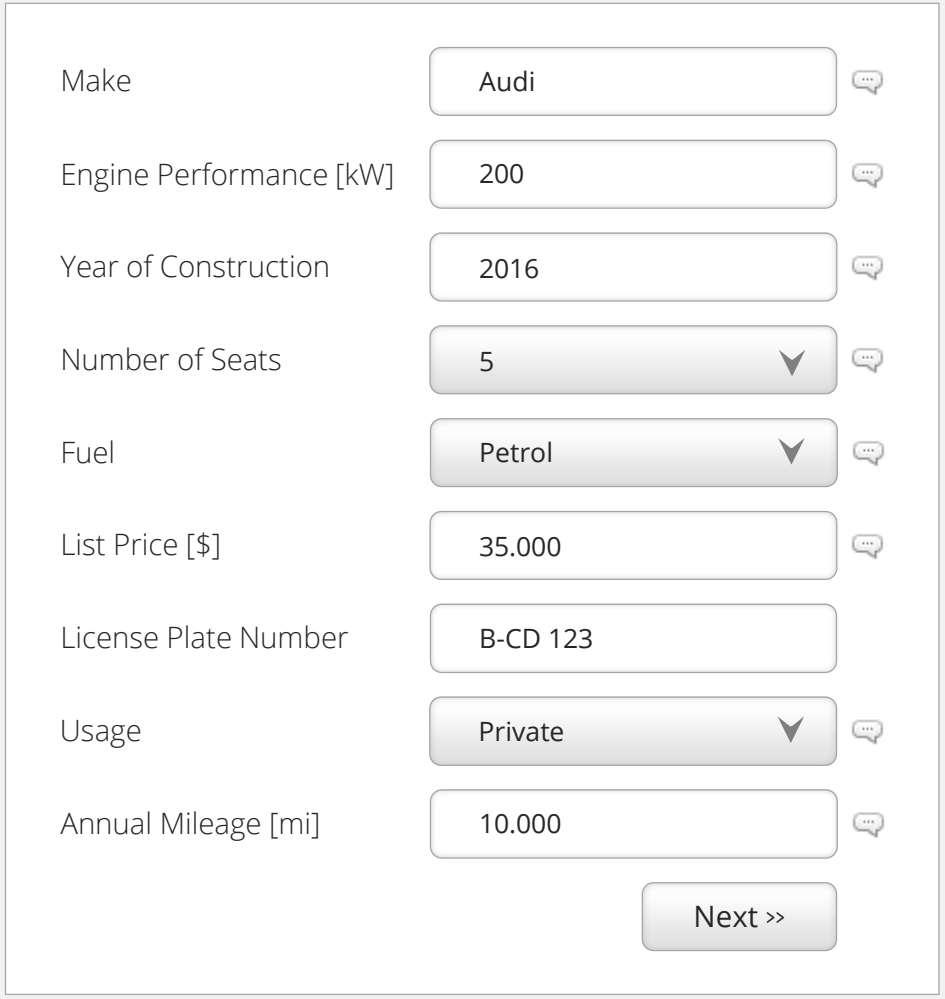
« User's Perspective »



Model

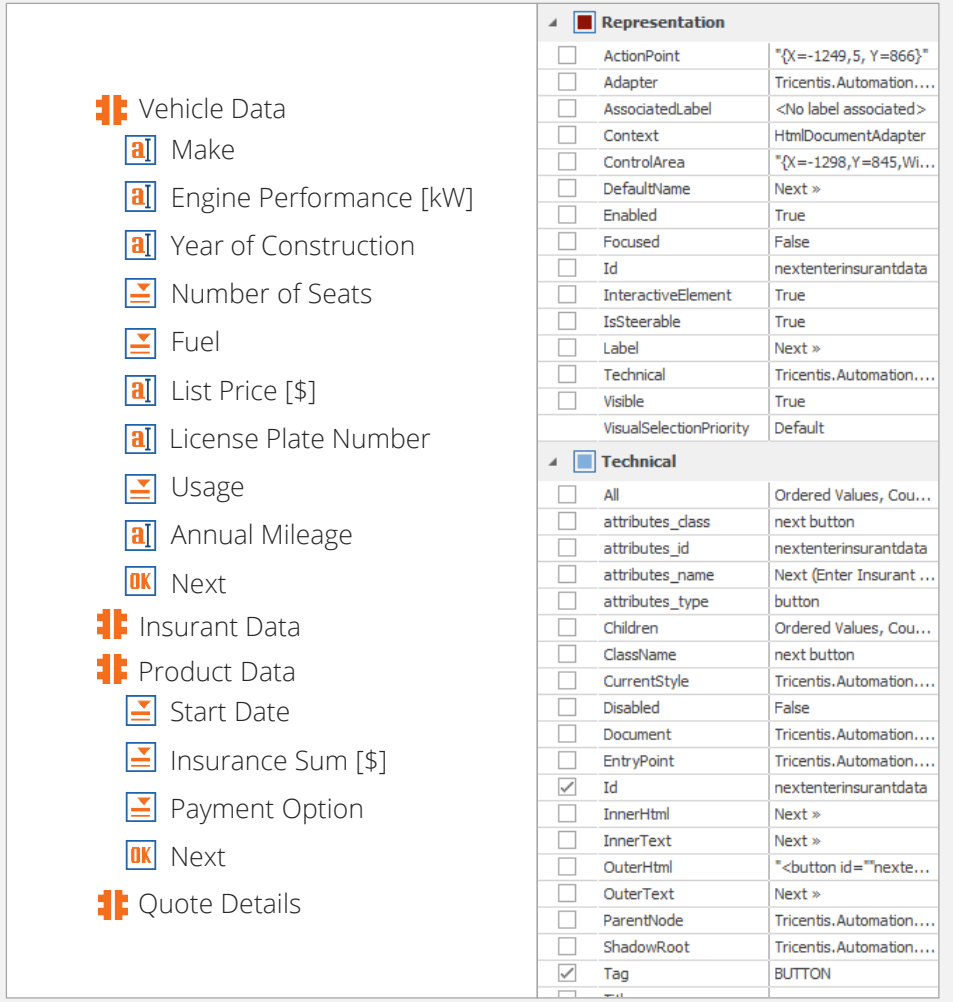
« Machine's Perspective »

TRICENTIS



Application

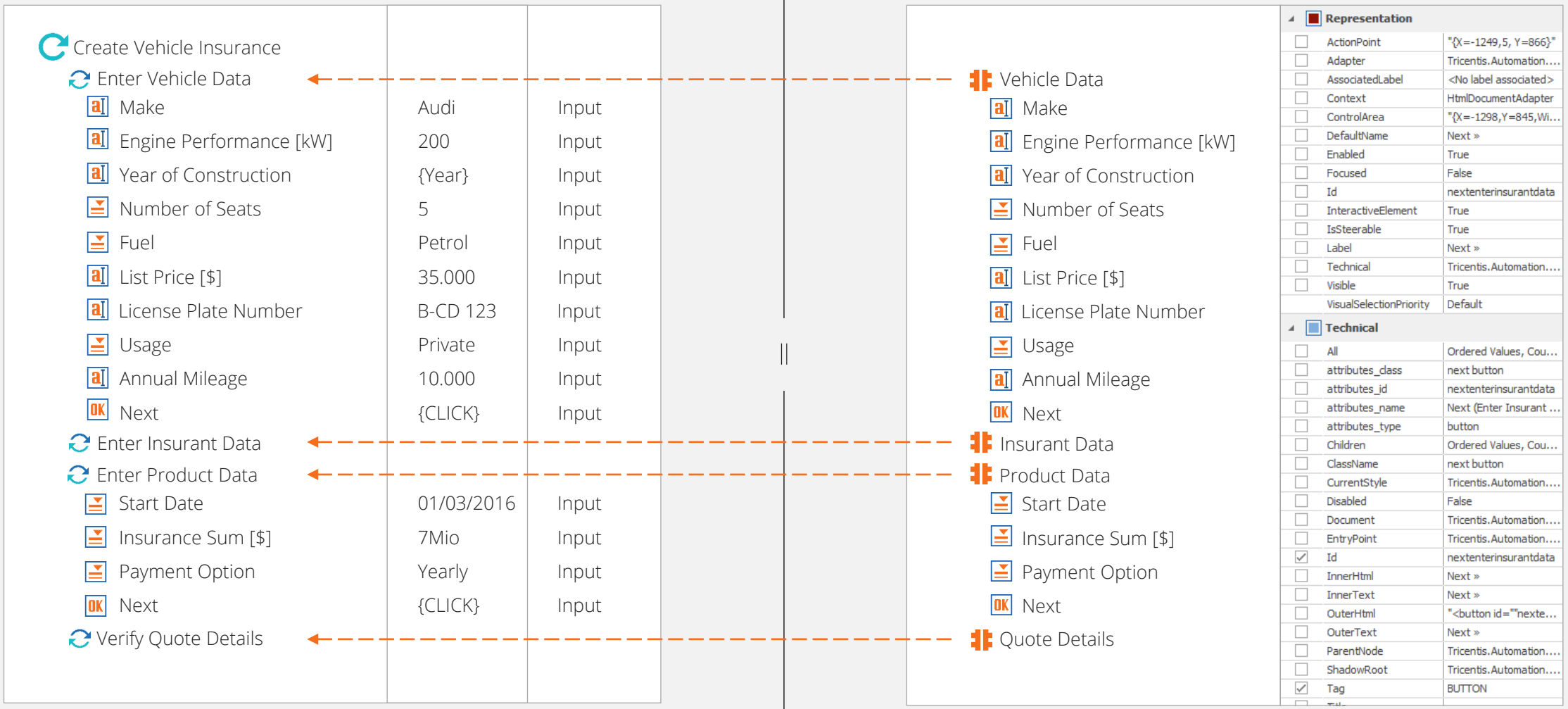
« User's Perspective »



Model

« Machine's Perspective »

TRICENTIS



Test Case

« Tester's Perspective »

Model

« Machine's Perspective »

TRICENTIS

Create Vehicle Insurance		
Enter Vehicle Data		
Make	Audi	Input
Engine Performance [kW]	200	Input
Year of Construction	{Year}	Input
Number of Seats	5	Input
Fuel	Petrol	Input
List Price [$]	35.000	Input
License Plate Number	B-CD 123	Input
Usage	Private	Input
Annual Mileage	10.000	Input
Next	{CLICK}	Input
Enter Insurant Data		
Enter Product Data		
Start Date	01/03/2016	Input
Insurance Sum [$]	7Mio	Input
Payment Option	Yearly	Input
Next	{CLICK}	Input
Verify Quote Details		

- Vehicle Data
  - Make
  - Engine Performance [kW]
  - Year of Construction
  - Number of Seats
  - Fuel
  - List Price [$]
  - License Plate Number
  - Usage
  - Annual Mileage
  - Next
- Insurant Data
- Product Data
  - Start Date
  - Insurance Sum [$]
  - Payment Option
  - Next
- Quote Details

Representation	
ActionPoint	"{X=-1249,5, Y=866}"
Adapter	Tricentis.Automation....
AssociatedLabel	<No label associated>
Context	HtmlDocumentAdapter
ControlArea	"{X=-1298,Y=845,Wi...
DefaultName	Next »
Enabled	True
Focused	False
Id	nextenterinsurantdata
InteractiveElement	True
IsSteerable	True
Label	Next »
Technical	Tricentis.Automation....
Visible	True
VisualSelectionPriority	Default
Technical	
All	Ordered Values, Cou...
attributes_class	next button
attributes_id	nextenterinsurantdata
attributes_name	Next (Enter Insurant ...
attributes_type	button
Children	Ordered Values, Cou...
ClassName	next button
CurrentStyle	Tricentis.Automation....
Disabled	False
Document	Tricentis.Automation....
EntryPoint	Tricentis.Automation....
Id	nextenterinsurantdata
InnerHtml	Next »
InnerText	Next »
OuterHtml	"<button id=""nexte...
OuterText	Next »
ParentNode	Tricentis.Automation....
ShadowRoot	Tricentis.Automation....
Tag	BUTTON

Business

« Test & Test Data Logic »

Technical

« Automation Logic »

TRICENTIS

Business

« Test & Test Data Logic »

Technical

« Automation Logic »

TRICENTIS

Create Vehicle Insurance		
Enter Vehicle Data		
Make	Audi	Input
Engine Performance [kW]	200	Input
Year of Construction	{Year}	Input
Number of Seats	5	Input
Fuel	Petrol	Input
List Price [$]	35.000	Input
License Plate Number	B-CD 123	Input
Usage	Private	Input
Annual Mileage	10.000	Input
Next	{CLICK}	Input
Enter Insurant Data		
Enter Product Data		
Start Date	01/03/2016	Input
Insurance Sum [$]	7Mio	Input
Payment Option	Yearly	Input
Next	{CLICK}	Input
Verify Quote Details		

Business

« Test & Test Data Logic »

Technical **Changes**

- Vehicle Data
  - Make
  - Engine Performance [kW]
  - Year of Construction
  - Number of Seats
  - Fuel
  - List Price [$]
  - License Plate Number
  - Usage
  - Annual Mileage
  - Next
- Insurant Data
- Product Data
  - Start Date
  - Insurance Sum [$]
  - Payment Option
  - Next
- Quote Details

Identify By **Properties**

Identify By **Image**

Identify By **Anchor**

Identify By **Index**

Technical

« Automation Logic »

TRICENTIS

Human Territory

Create Vehicle Insurance		
Enter Vehicle Data		
Make	Audi	Input
Engine Performance [kW]	200	Input
Year of Construction	{Year}	Input
Number of Seats	5	Input
Fuel	Petrol	Input
List Price [$]	35.000	Input
License Plate Number	B-CD 123	Input
Usage	Private	Input
Annual Mileage	10.000	Input
Next	{CLICK}	Input
Enter Insurant Data		
Enter Product Data		
Start Date	01/03/2016	Input
Insurance Sum [$]	7Mio	Input
Payment Option	Yearly	Input
Next	{CLICK}	Input
Verify Quote Details		

Business

« Human Territory »

Human Territory

- Vehicle Data
  - Make
  - Engine Performance [kW]
  - Year of Construction
  - Number of Seats
  - Fuel
  - List Price [$]
  - License Plate Number
  - Usage
  - Annual Mileage
  - Next
- Insurant Data
- Product Data
  - Start Date
  - Insurance Sum [$]
  - Payment Option
  - Next
- Quote Details

Identify By
Properties

Identify By
Image

Identify By
Anchor

Identify By
Index

Technical

« Human Territory »

TRICENTIS

Human Territory

Create Vehicle Insurance		
Enter Vehicle Data		
Make	Audi	Input
Engine Performance [kW]	200	Input
Year of Construction	{Year}	Input
Number of Seats	5	Input
Fuel	Petrol	Input
List Price [$]	35.000	Input
License Plate Number	B-CD 123	Input
Usage	Private	Input
Annual Mileage	10.000	Input
Next	{CLICK}	Input
Enter Insurant Data		
Enter Product Data		
Start Date	01/03/2016	Input
Insurance Sum [$]	7Mio	Input
Payment Option	Yearly	Input
Next	{CLICK}	Input
Verify Quote Details		

Business

« Human Territory »

Machine Territory

- Vehicle Data
  - Make
  - Engine Performance [kW]
  - Year of Construction
  - Number of Seats
  - Fuel
  - List Price [$]
  - License Plate Number
  - Usage
  - Annual Mileage
  - Next
- Insurant Data
- Product Data
  - Start Date
  - Insurance Sum [$]
  - Payment Option
  - Next
- Quote Details

Identify By **Properties**

Identify By **Image**

Identify By **Anchor**

Identify By **Index**

Technical

« Machine Territory »

TRICENTIS

‹› From Static to **Dynamic Identification** ‹›

Human Territory

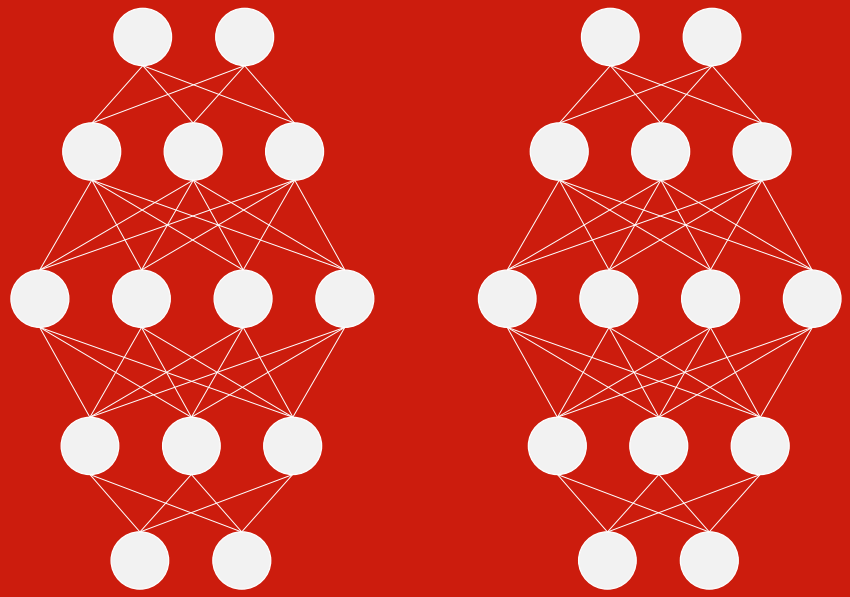
Create Vehicle Insurance		
Enter Vehicle Data		
Make	Audi	Input
Engine Performance [kW]	200	Input
Year of Construction	{Year}	Input
Number of Seats	5	Input
Fuel	Petrol	Input
List Price [$]	35.000	Input
License Plate Number	B-CD 123	Input
Usage	Private	Input
Annual Mileage	10.000	Input
Next	{CLICK}	Input
Enter Insurant Data		
Enter Product Data		
Start Date	01/03/2016	Input
Insurance Sum [$]	7Mio	Input
Payment Option	Yearly	Input
Next	{CLICK}	Input
Verify Quote Details		

Business

« Human Territory »

Visual Recognition

Technical Recognition



Deep Convolutional Neural Network

Deep Recurrent Neural Network

TRICENTIS **Vehicle Insurance Application**
This is a sample application, Version 1.0.1

Visit

Automobile | Truck | Motorcycle | Camper

Home → Automobile Insurance

Enter Vehicle Data 0 | Enter Insurant Data | Enter Product Data | Select Price Opt

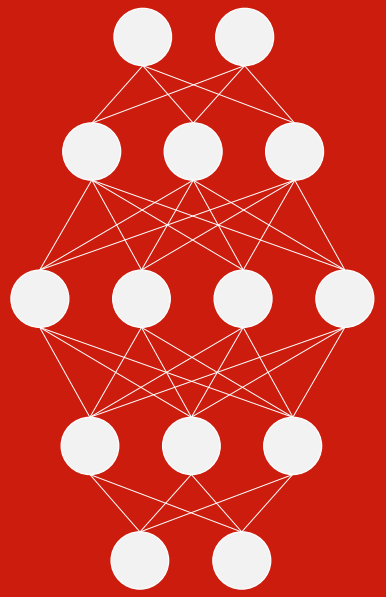
Make	Volkswagen
Engine Performance [kW]	200
Date of Manufacture	10/10/2007
Number of Seats	4
Fuel Type	Petrol
List Price [$]	18000
License Plate Number	W857463
Annual Mileage [mi]	24500

Next »

About | Products | Events & Webinars | Resources | Services

‹› From Static to **Dynamic Identification** ‹›

Visual Recognition



Deep Convolutional Neural Network

Technical Recognition

Deep Recurrent Neural Network

TRICENTIS Vehicle Insurance Application
This is a sample application, Version 1.0.1

Automobile | Truck | Motorcycle | Camper

Home → Automobile Insurance

Enter Vehicle Data 0 | Enter Insurant Data | Enter Product Data | Select Price Opt

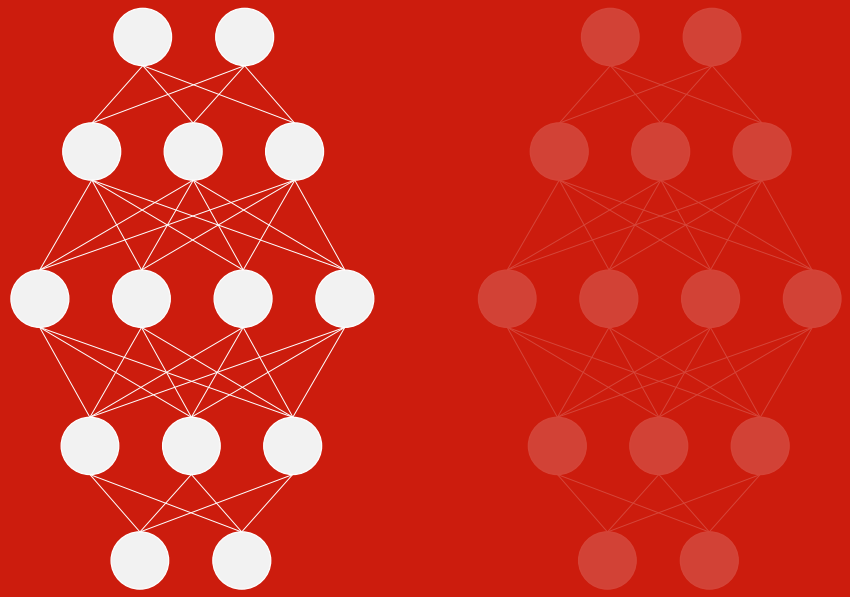
Make	Volkswagen	
Engine Performance [kW]	200	
Date of Manufacture	10/10/2007	
Number of Seats	4	
Fuel Type	Petrol	
List Price [$]	18000	
License Plate Number	W857463	
Annual Mileage [mi]	24500	

Next »

About | Products | Events & Webinars | Resources | Services

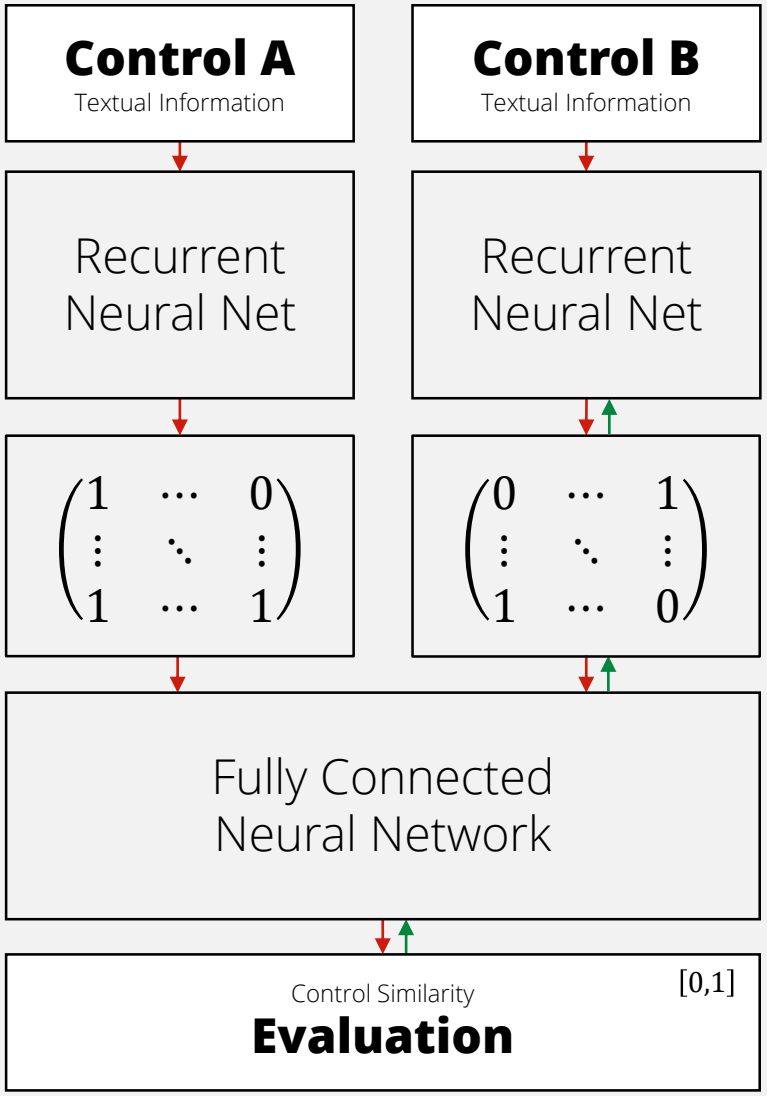
Visual Recognition

Technical Recognition



Deep Convolutional Neural Network

Deep Recurrent Neural Network



:: One neural network per **technology**.

Visual Recognition

Technical Recognition

Deep Convolutional Neural Network

Deep Recurrent Neural Network

PROJECT | HOME | VIEW | TOOLS | EXECUTION LISTS | API TESTING

Paste | Cut | Copy | Duplicate | Clipboard
Delete | Modify | Attach File | Edit
Search... | Project | Scratchbook | Object | My Area | Section | Go to
Update all | Checkin all | Checkout | Checkout Tree | Team
Import Subset | Export Subset | Subset

Automated Test Cases | Requirements | Test Case Design

Technical Definition | Semantic Definition

- Automated Test Cases
  - Create Truck Quote
  - Create Motorcycle Quote
  - Create Automobile Quote
  - Create Trailer Quote

Test Case. Create Automobile Quote

Step. Enter Vehicle Data
- Enter **Audi** into the edit-box **Make**
- Enter **200** into the edit-box **Engine Performance**
- Enter **01/03/2015** into the edit-box **Year of Construction**
- Select **5** in the combo-box **Number of Seats**
- Select **Petrol** in the combo-box **Fuel**
- Enter **$35000** in the edit-box **List Price**
- Enter **W975633** in the edit-box **License Plate Number**
- Select **Private** in the combo-box **Usage**
- Enter **10.000 i**n the edit-box **Annual Mileage**
- Click the button **Next**

Step. Enter Insurant Data

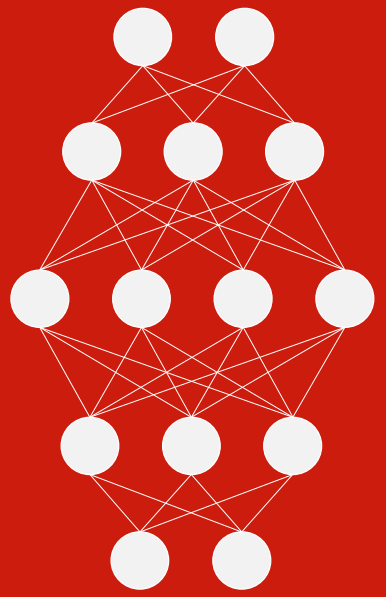
Step. Enter Product Data
- Select **09/10/2018** in the date-picker **Start Date**
- Enter **7000000** in the combo-box **Insurance Sum**
- Select **Yearly** in the combo-box **Payment Option**
- Click the button **Next**

Step. Verify Quote Details
- In the table **Price List** verify **$792** in the column **Gross Premium** and in the row **Premium Tax**

Semantic Test Case Definition

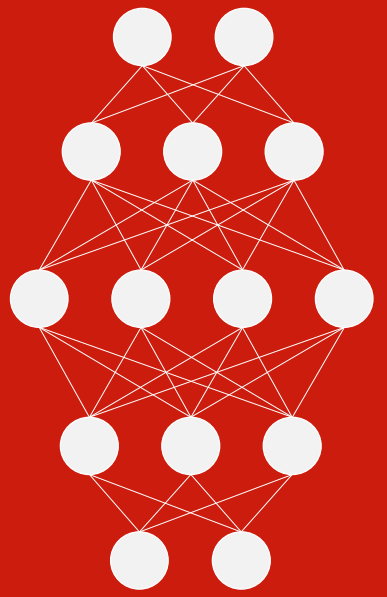
‹› From Static to **Dynamic Identification** ‹›

Visual Recognition

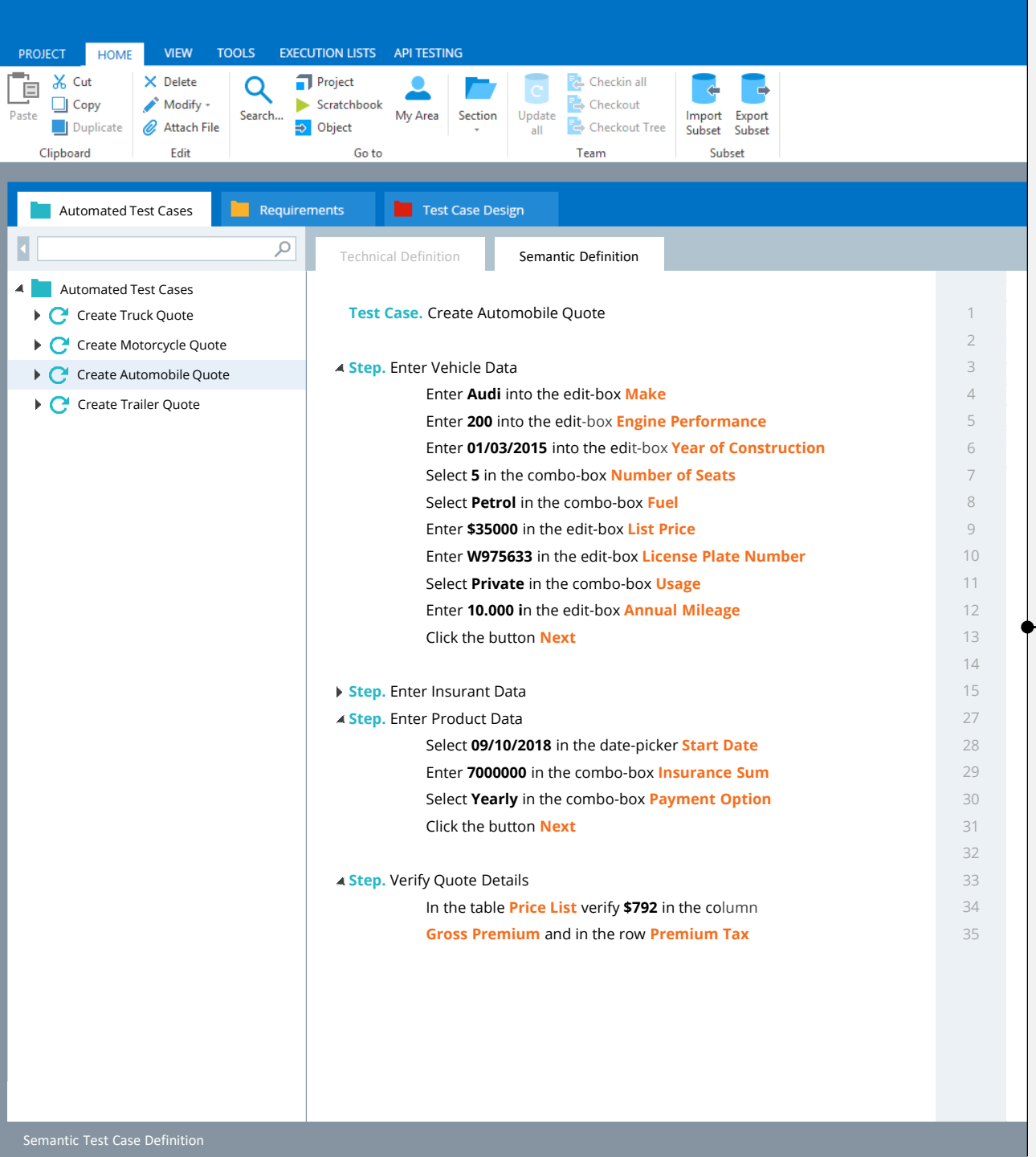


Deep Convolutional Neural Network

Technical Recognition



Deep Recurrent Neural Network



‹› It's like BDD without writing automation.

Discovery Phase

Find Scenarios

Yes

Definition Phase

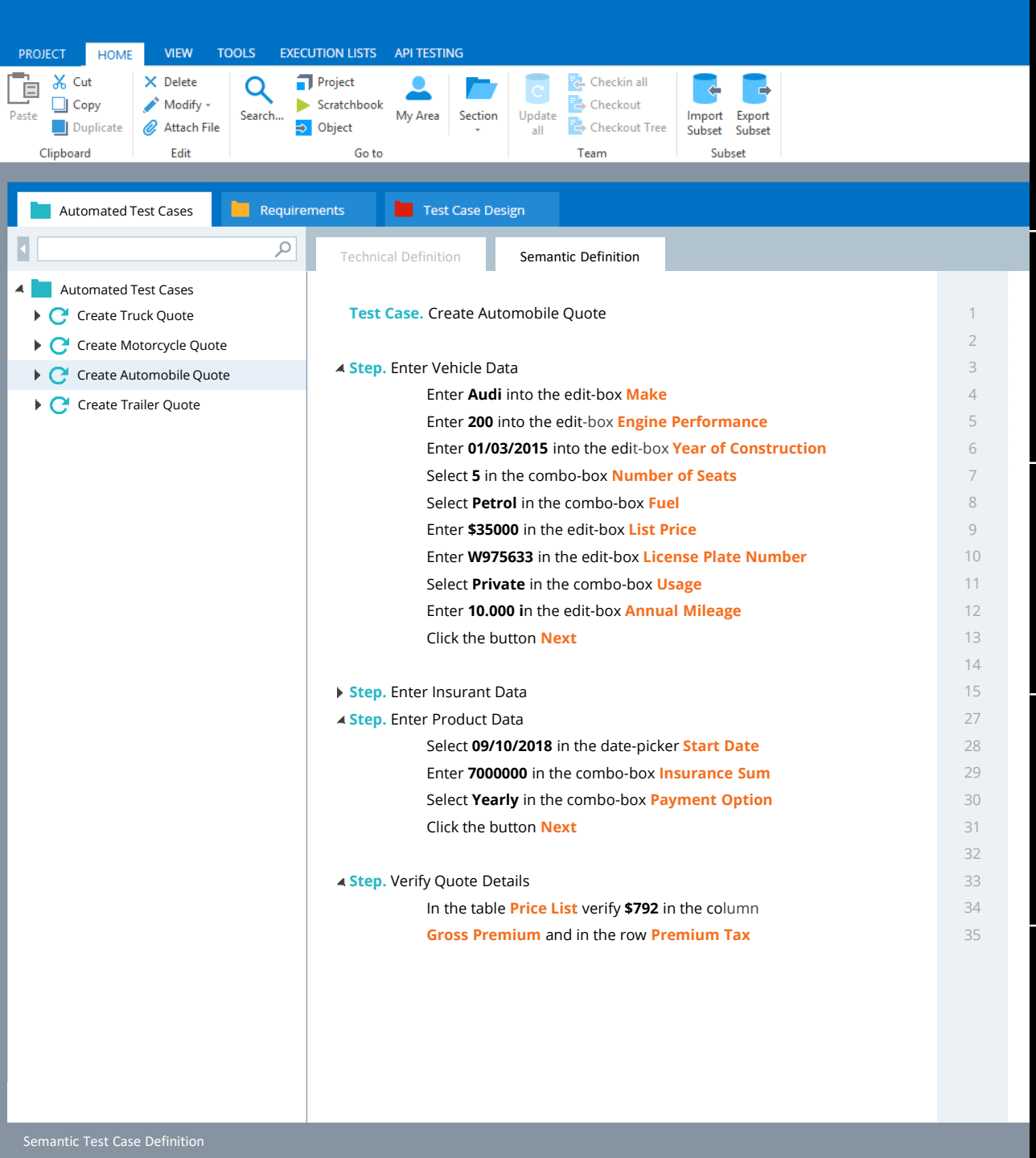
Design Scenarios

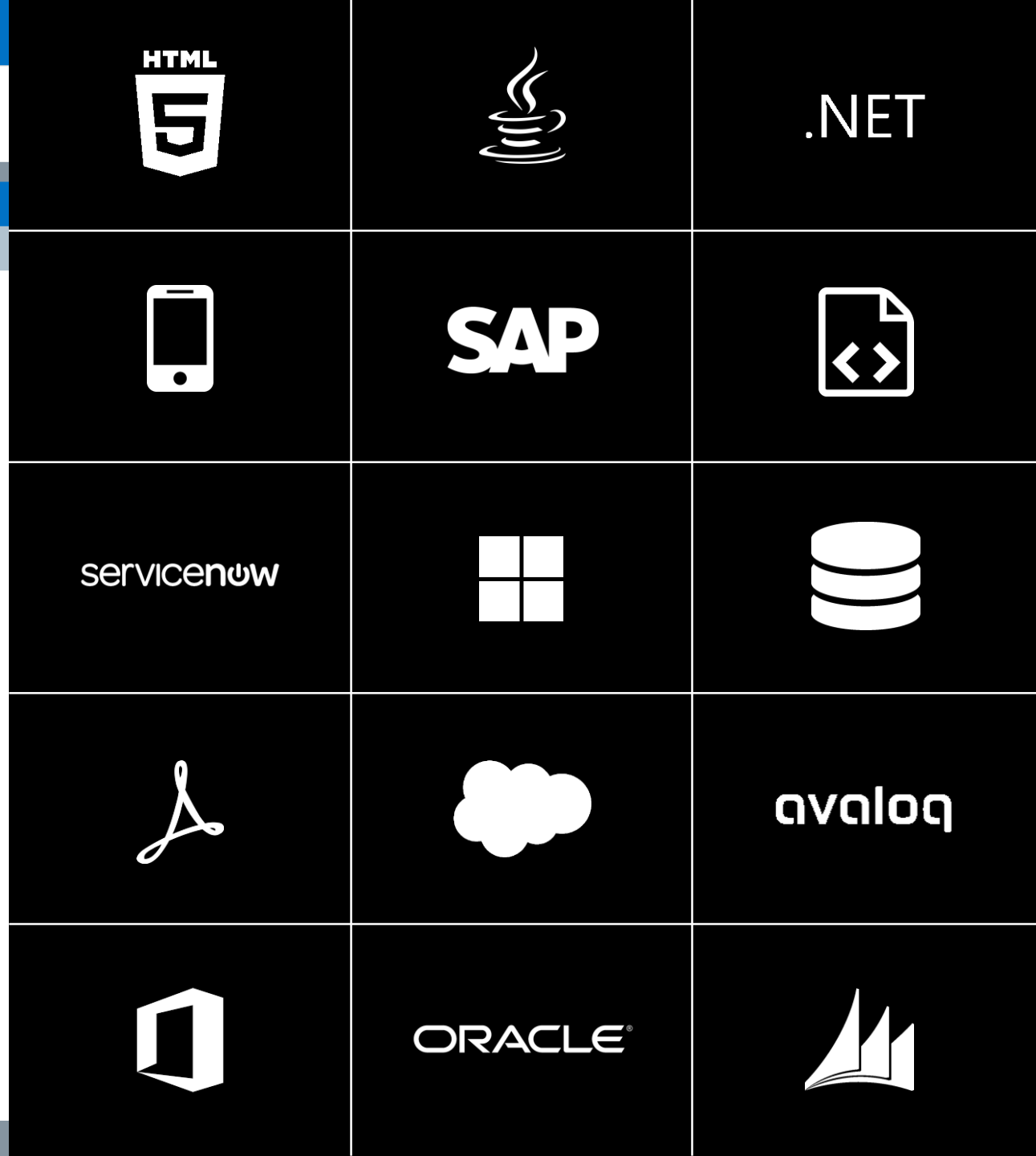
Yes

Automation Phase

Automate Scenarios

No


PROJECT
HOME
VIEW
TOOLS
EXECUTION LISTS
API TESTING
Paste
Cut
Copy
Duplicate
Clipboard
Delete
Modify
Attach File
Edit
Search...
Project
Scratchbook
Object
My Area
Section
Go to
Update all
Checkin all
Checkout
Checkout Tree
Team
Import Subset
Export Subset
Subset
Automated Test Cases
Requirements
Test Case Design
Technical Definition
Semantic Definition
Automated Test Cases
Create Truck Quote
Create Motorcycle Quote
Create Automobile Quote
Create Trailer Quote
Test Case. Create Automobile Quote
Step. Enter Vehicle Data
Enter Audi into the edit-box Make
Enter 200 into the edit-box Engine Performance
Enter 01/03/2015 into the edit-box Year of Construction
Select 5 in the combo-box Number of Seats
Select Petrol in the combo-box Fuel
Enter $35000 in the edit-box List Price
Enter W975633 in the edit-box License Plate Number
Select Private in the combo-box Usage
Enter 10.000 in the edit-box Annual Mileage
Click the button Next
Step. Enter Insurant Data
Step. Enter Product Data
Select 09/10/2018 in the date-picker Start Date
Enter 7000000 in the combo-box Insurance Sum
Select Yearly in the combo-box Payment Option
Click the button Next
Step. Verify Quote Details
In the table Price List verify $792 in the column
Gross Premium and in the row Premium Tax
Semantic Test Case Definition


HTML
.NET
SAP
servicenow
avaloq
ORACLE

TRICENTIS

Intelligent computer systems aren't made of **magic**, they are made of logic

Linda Liukas

The number one testing tool is not
the computer, it is still the **human brain**

Jerry Weinberg

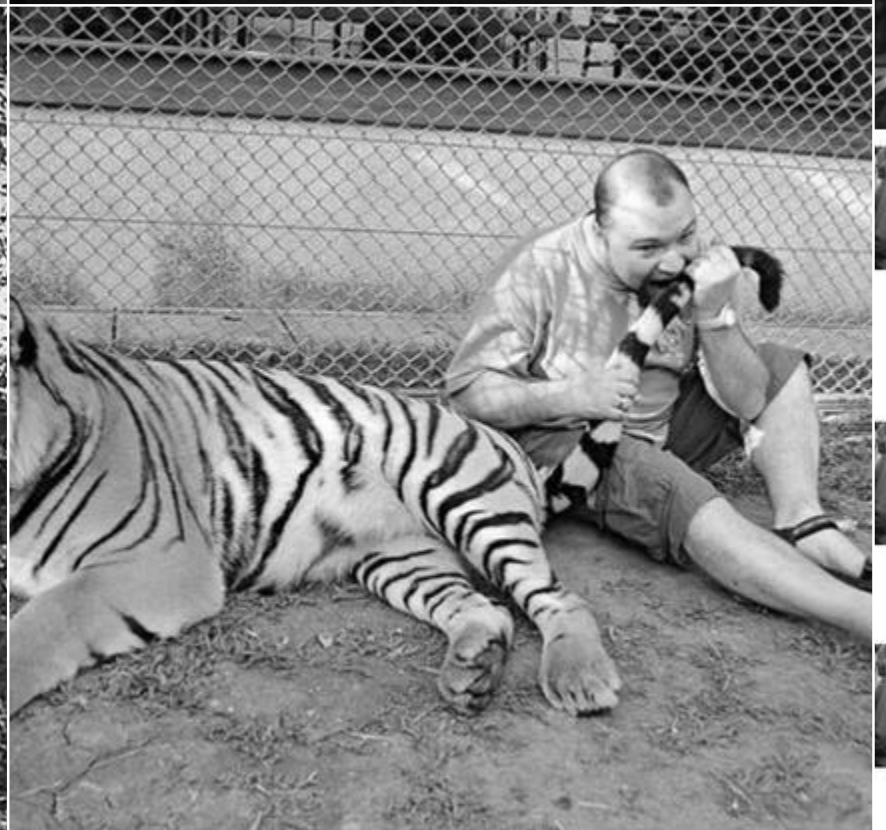
Don't expect AI to solve all your problems soon, do something about **natural stupidity** in testing now

Ingo Philipp

:: Inspired by **Steve Polyak**


Which of the following is the largest?
A: A Peanut
B: An Elephant
C: The Moon
D: A Kettle


REMEMBER THAT TIME
YOU FORGOT TO THINK?




Jesse
Why do you have a framed picture of your ceiling fan?
December 2 at 6:01 PM · Like · 3
Jesse
...
December 2 at 6:01 PM · Like
Jesse
I realize that is a mirror.
December 2 at 6:01 PM · Like

Questions

The show is **over**. It's your turn.