NEC Advanced Analytics Cloud
~Complete support for Verification~Deploy~Operation of AI adoption~

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NEC
NEC brings together and integrates technology and expertise to create the ICT-enabled society of tomorrow. We collaborate closely with partners and customers around the world, orchestrating each project to ensure all its parts are fine-tuned to local needs. Every day, our innovative solutions for society contribute to greater safety, security, efficiency and equality, and enable people to live brighter lives.
Agenda

- Business infrastructure to accelerate new social value creation
- NEC Advanced Analytics Cloud
Business infrastructure to accelerate new social value creation
Initiatives with customers in the IoT era

Accumulation of vast know-how from experience gained through more than 600 projects

- **Prevention of accidents/crime**, vehicle theft rate reduced by **80%**
  - Urban surveillance system (Tigre, Argentina)

- Landslide/slope collapse risk detected **10 to 60 minutes** in advance
  - Landslide risk calculation

- **Highly accurate demand forecasting** from a variety of data reduces power usage by **20%**
  - Electric power demand forecasting (Construction company B)

- **Optimal guidance based on flexible adaptation to demand** reduces taxi vacancies by **12 to 16%**
  - Fleet management (Freight forwarder C)

- Inventory value of parts subject to demand forecasting reduced by **20%**
  - Predictive Analytics Solution for Demand of Repair Parts (NEC Fielding)

- Discarding of fresh food reduced by **40%**
  - Predictive Analytics Solution for Fresh Food Demand (Retail company A)

- Analysis of operational status improves production efficiency by **20%**
  - Production efficiency improvement (NEC factory)
"The essence of digital business"

### Essence of digital business

1. Incorporation of business outcomes into system requirements as distinct models
   - Hypothesis proposal

2. Make full use of technologies capable of treating things and contexts as data and converting them into knowledge and wisdom
   - Hypothesis verification

3. Quickly launch a demonstration system and lead this to an actual production system
   - Small start

4. Ability to flexibly expand according to business growth and environment changes
   - Business growth

5. Stably perpetuate digital business
   - Consolidation

### Features of required capability and business infrastructure

1. Domain knowledge of various industries
2. Co-creation programs
3. Business consulting
4. Utilization of AI and advanced technologies
5. IoT data collection infrastructure
6. Technical consulting
7. Co-creation program (field demonstration environment)
8. Building blocks
9. Utilization of various clouds
10. Portability
11. Scalability
12. Multi-connectivity
13. Openness
14. Security technologies
15. Utilization of know-how in mission-critical systems
Function enhancement based on 5-layer IoT architecture model

Enable provision of common functions based on 5-layer IoT architecture model announced last year※

* Building blocks: Method of flexibly selecting and combining pre-verified functions into a standard model according to system requirements

5-layer IoT architecture model

Utilization of data
- IoT-related control processing
- Points of contact with the real world

Case 1
- Security
- Device Computing
- Points of contact with the real world

Case 2
- Device Connectivity
- Short distance networks

Case 3
- IoT-related control processing

Case 4
- Utilization of data

Case 5
- Third-party service
- GW

Case 6
- MV
- NO
- Wired
- Less

Case 7
- LTE
- VPN
- Leased
- line

Creation of common functions as building blocks that can be adapted to IoT systems

NEC the WISE IoT Platform, a set of functions for IoT systems

NEC Flexible Business Infrastructure

Consultation services
(Business consultation/Technical consultation)

Co-creation programs
(Social Value Design™/Workshops/Field validation environment, etc.)

NEC the WISE IoT Platform

Security Service

Shared Service

API/App Template

Service Compose

Data Store

Actuation

Data Analytics

Communication

Connectivity

IoT Devices

Operation Service

AI Technologies

Operation
What is NEC the WISE?

NEC the WISE is a portfolio of AI technologies developed by NEC for enriching human intellect and creativity. This portfolio represents our strong determination to harness the wisdom of humans and AI working together to resolve the increasingly complex and intertwined issues society is facing today.

The NEC the WISE Mark

The NEC the WISE mark is a simple, opaque triangular pyramid with a cube in the center. The keen edges and futuristic shape of the pyramid represent our intention to hone our technologies to precision and use them as a cornerstone of future innovations. The cube is the core of wisdom collected as AI technologies. The orientation of the mark expresses our goal of bringing stability to societies that have become unbalanced by social problems and creating a brighter world for everyone by harmonizing people, society, and AI.
NEC Advanced Analytics Cloud
NEC Advanced Analytics Cloud (AA Cloud) with Heterogeneous Mixture Learning (AA Cloud)

### Visualization
- Digitalization
  - Good Quality Data
  - Image Sharpening
  - Self-learning
  - Super Resolution
  - Multimodal Image Fusion
  - Identification Dot

### Analysis
- Understanding
  - Intent and meaning
  - Textual Entailment Recognition
  - Crowd Behavior Analysis
  - Profiling Across Spatio-Temporal Data
  - Customer Profile Estimation
  - Acoustic Situation Awareness

- Analysis with Interpretation
  - Heterogeneous Mixture Learning
  - Invariant Analysis
  - Automated Security Intelligence
  - Predictive Analytics Automation

- Control/Guidance
  - Planning/Optimization
    - Autonomous and Adaptive Control
    - Predictive Robust Optimization Framework

### Control/Guidance
- Planning/Optimization
  - Autonomous and Adaptive Control
  - Predictive Robust Optimization Framework

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*1: No.1 consecutively for 4 occasions in evaluation tasks hosted by National Institute of Standards and Technology (NIST).
*2: No.1 for 5 occasions in evaluation tasks hosted by NIST.
*3: No.1 in 2012 for evaluation tasks hosted by NIST.
*4: No.1 in 2016 at international contest DCASE2016 for acoustic detection.
Heterogeneous Mixture Learning Technology

1. Automatic Partitioning

Weekday or Holiday

- Weekday
  - Temperature: 25°C or more
    - Yes
    - No
  - Event
    - Prediction Formula①
    - Prediction Formula②

- Holiday
  - No
  - Event
    - Prediction Formula③
    - Prediction Formula④

2. Automatic creation of predictive formulas

Predictive Formula: \( Y_1 = a_0 x_0 + a_1 x_1 + \cdots + a_{50} x_{50} \)

Predictive Formula: \( Y_n = a_0 x_0 + a_1 x_1 + \cdots + a_{50} x_{50} \)

Achieves high-precision in prediction and interpretability even without any experts.

YY pieces of XX item will be sold tomorrow. These are the basis of calculation.

Historical data
Case Study of Heterogeneous Mixture Learning

Since FY2014, use of Heterogeneous Mixture learning has increased year by year.

Track Record (FY 2014-16)

No. of licenses released for Heterogeneous Mixture Learning Engine

Above 200

Case Study

- Automatic order placement against the forecasted demand for small retailers
- Predictive pricing estimation for used-item dealers
- Predictive demand forecast of maintenance parts in manufacturing industry
- Predictive demand forecast of shipping energy in heavy industry
- Predictive forecast of paper money for banking
- Predictive demand forecast for electricity in construction industry
- Predictive subscriber churn-ratio for telecommunication industry

Case Study Report

- Seven Bank, Ltd.
- Mitsubishi Heavy Industries, Ltd.
- Obayashi Corporation
- NEC Fielding, Ltd.
- RareJob Corporation
(Reference)
Case Study: Daily demand forecasting for small retailers

Keeping “Control of Opportunity Loss” and “Reduction of Disposal Loss” together

Challenges

• Reducing loss of sale opportunities caused due to lack of stock
• Reducing losses due to piling up excess amount of perishables

Value

• Reduction of opportunity losses and disposal losses
• Reducing time taken to place order → Enhancing other operations

Implementation method

• Predict future demand of products with high accuracy using machine learning
• Automatically determine order size from the forecasted demand, stock available at that time, delivery schedule information, etc.

API

UI

Daily Product Demand Forecasting System

Purchase In-charge

Actor

AP Layer

Analysis

PF Layer

Heterogeneous Mixture Learning (Forecast)
Work on reducing both “Maintenance parts stock-out” and “Excess inventory”

Challenge

• Improving efficiency in Production management activities
• Surplus Inventory/Product wastage due to unsold products

Value

• Effort reduction in creating sales plan
• Reduction in stocktaking frequency for products and components

Implementation method

• Demand forecast of maintenance parts derived from number of parts shipped, parts in operation, months since release, etc.
• Automatic calculation of order quantity by taking inventory size into consideration.
End User

- We want to perform analysis by ourselves!!
- We want the analysis environment that NEC the WISE can use!!

(User)

Business Application

- We want a platform that can be used even without having knowledge of analytics!!

(Application Developer)

Analysis PF

- Tool selection and integration are very tough!!
- We do not want to spend much time in building the environment!!

(Data Scientist)

Heterogeneous Mixture Learning (Forecast)
Challenges in deploying AI based solution

Deploying solutions that utilize AI, require collaboration and cooperation among professionals with different skills in three phases of “Verification-Deploy-Operation”

1. Verification (Modeling)
   - Tool selection and environment building are very tough
   - Data Scientist

2. Deploy
   - Difficult to include AI into AP
   - Application Developer

3. Operation
   - No idea about the performance of AI
   - User & Operations Manager
NEC Advanced Analytics Cloud

Seamlessly connect three phases of AI adoption “Verification ~ Deploy ~ Operation” on the same platform. Enable quick value realization through cooperation of professionals with different skill sets.

Verification (Modeling)
- Data Scientist
  - Tool integration on interactive UI (Jupyter)
  - Various engines which include NEC the WISE

Deploy
- Application Developer
  - Quickly build AI-Apps development and operation environment
  - Easily embed AI functions into AP by using API

Operation
- User & Operations Manager
  - Visualization of analysis results by linking to dashboard
  - Automatic relearning and update of Forecasting models (*)

Analysis PF
- Heterogeneous Mixture Learning
- RAPID Machine Learning (*)

AI Development Environment

AI-API
- Decision Tree
- SVM (Discrimination/Regression)
- Random Forest
- Clustering
- Principal Component Analysis

Dashboard

NEC Advanced Analytics Cloud (AACloud)

*Support is scheduled
Three features of NEC Advanced Analytics Cloud + α

1. Provides the necessary tools and environment together
   - Integrated NEC the WISE x world standard OSS
   - Multi-user and scale-out support

2. Facilitates easy AP Development and AI’s API creation
   - Analysis Procedure → API creation framework
   - Support both on-premises and cloud

3. Supports performance visualization
   - Flexible visualization by linking to dashboard

All types of related services and contents
- AI adoption service menu
- AI adoption operation management service
Interactive analysis execution and maintaining result records through Jupyter Notebook. Various algorithms can be written in a single environment with Python (with scikit-learn).

Various analysis engines are available:

- Heterogeneous Mixture Learning (Regression)
- Heterogeneous Mixture Learning (Discrimination)
- RAPID Machine Learning (Note 1)
- Linear Discriminant Analysis
- Quadratic Discrimination Analysis
- L2 Regularization Regression (Ridge Regression)
- L1 Regularization Regression (Lasso)
- Logistic Regression
- Principal Component Analysis
- Support Vector Machine (Discrimination)
- Support Vector Machine (Regression)
- Decision Tree
- Regression Tree
- Random Forest
- K-means
- Gaussian Mixture Model
- Spectral clustering

... and more.

*Although engines are available for use but support and maintenance may not be provided

Note 1: How to handle is under consideration
Jupyter Notebook is widely used from academic applications to practitioners as a de facto standard OSS of machine learning execution environment.

## Dialogue Execution and Abundant Expressions
- In Jupyter Notebook, domain for development activity known as “Notebook” can be concluded on single screen. In Notebook, you can write and execute programs, make notes, draw graphs etc. on browser.

## Various analysis engines can be used
- You can use various classification, regression and clustering algorithms such as Support Vector Machine, Random Forest, Gradient Boosting, k-nearest neighbor algorithm and DBSCAN.

## Notebook sharing
- You can save the created notebook in various file formats. If you share it, anyone who has a notebook environment can reproduce the same programs in one’s own environment.

http://jupyter.org/
① Provides the necessary tools and environment together
Multi-user and Scale-out support

Boot the User analysis environment in container, add a node in case load increases.

Allocation of analysis environment in container for each user

Scale out with node addition

Support even for large-scale data processing
Facilitates easy AP development and AI’s API creation framework

You can easily build an API server just by keeping the Notebook (analysis procedure) at a specified location.

Request
URI: http://.../execute/api/Notebook1.ipynb
Method: GET

Response
[
  "Item": "Salmon Onigiri"
  "Estimated date": "01/09/2017"
  "Estimated result": "23"
]

Planned after April, 2018 (under discussion)
Facilitates easy AP development and AI’s API creation
Support both on-premises and cloud

You can use on-premises and cloud on same platform

- AI Analysis PF (Software)
- Cloud IaaS
- AI Analysis PF (Software)
- On-premises specific
- On-premises infrastructure
Support performance visualization
Flexible visualization by linking to dashboard

You can connect with Kibana + Elasticsearch to achieve flexible and beautiful visualization.

Time series transitive graph of actual and predicted results

Gate Function (Predictive Model)

Coefficient comparison of predictive formula
We wish to use our vast experience and technology to create “Realistic” AI Adoption vision.

<table>
<thead>
<tr>
<th>AI Adoption Life cycle</th>
<th>Investigation</th>
<th>Plan</th>
<th>Verification</th>
<th>Deploy</th>
<th>Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AI Adoption Assessment</strong></td>
<td>Value search</td>
<td>AI Adoption support consultation</td>
<td>AI Adoption Hypothesis verification</td>
<td>Value realization</td>
<td></td>
</tr>
<tr>
<td>We will investigate customer trends within and outside NEC and enhance the understanding of current situation.</td>
<td></td>
<td>We will provide support in investigating AI Adoption scenarios and creating action plans.</td>
<td>We will check the efficiency of AI adoption deployment by using actual data</td>
<td>Consultation for AI implementation: We will support the adoption of AI by aligning the target state with the customer</td>
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<tr>
<td><strong>AI Adoption service Overview</strong></td>
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<td>Al work outsourcing: We will outsource appropriate AI tasks and share analysis results</td>
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<td>Al based system Deploy: We will install AI based systems and support the operations</td>
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</table>

NEC the WISE

We will support in AI adoption that focusses on creating continuous value for the customer in line with their business activities and challenges.

Al/Big Data utilization platform

“NEC Analytics Platform”
**Related Services and Contents**

**AA Cloud Operation Management Service**

Performing Operation management activities of AA Cloud as managed services (Extra Charges)

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**Value**

**Focus on data analysis tasks**

- Data Scientist
  - Wants us to teach how to connect and thereby add users.

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**Operations Management**

- Understanding of AAPF operations is not required
  - Feel free to contact in case of any issues

- Discussed with user about generating log data and improving the processing performance.

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**Service Content**

- **Build Initial Cloud Environment**
- **Build DB (Online)**
- **User Management**
- **Start/Stop/Settings change**
- **Contact us by E-mail**
- **Failure Investigation**
Orchestrating a brighter world

NEC