Solution Exercises Step by Step

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**Abstract**

This document is an English explanation on how to solve the Learning Factory. Each of the exercises has a chapter where answers are provided step by step. Solutions are provided in the following format: On the left-hand side figures show illustrate the steps. On the right-hand side the reader can find instructions.

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# Glossary

|  |  |
| --- | --- |
| German | English |
| Lern | Learn |
| Fabrik | Factory |
| Lernfabrik | Learning factory |
| Aktuell | Current |
| Künstliche Intelligenz / KI | Artificial Intelligence / AI |
| Modul | Module |
| Modell | Model |

# Exercise 1

|  |  |
| --- | --- |
| [hivemqserver.feste-ip.net:9443/nifi/](https://learn.ki-campus.org/go/link?url=https%3A%2F%2Fhivemqserver.feste-ip.net%3A9443%2Fnifi%2F&checksum=66f7638&tracking_type=rich_text_item_link&tracking_id=2054f950-1cac-49a9-9da3-46d916ab54d0&tracking_course_id=bc88ac00-0c8c-4019-bacc-bf7bac0abbdf) | Open link to nifi page |
|  | Insert the following credentials:  user: lernfabrik  pw: L5nf1br|k  Now you can take a look |
| [hivemqserver.feste-ip.net:9001](https://learn.ki-campus.org/go/link?url=https%3A%2F%2Fhivemqserver.feste-ip.net%3A9001%2Fhub%2Flogin&checksum=43e3f83&tracking_type=rich_text_item_link&tracking_id=2054f950-1cac-49a9-9da3-46d916ab54d0&tracking_course_id=bc88ac00-0c8c-4019-bacc-bf7bac0abbdf) | Open the link to access Jupyter |
|  | Insert the following credentials:  user: lernfabrik  pw: L5nf1br|k  From here you can open new terminals and view the used notebooks |
| [hivemqserver.feste-ip.net:1880](https://learn.ki-campus.org/go/link?url=https%3A%2F%2Fhivemqserver.feste-ip.net%3A1880&checksum=615a39d&tracking_type=rich_text_item_link&tracking_id=2054f950-1cac-49a9-9da3-46d916ab54d0&tracking_course_id=bc88ac00-0c8c-4019-bacc-bf7bac0abbdf) | Open the link to access Node-RED online tool |
|  | Insert the following credentials:  user: lernfabrik  pw: L5nf1br|k  This tool establishes the communication to the factory |

# Exercise 2

a)

|  |  |
| --- | --- |
|  | Double Click |
|  | Click |
|  | 1. Click 2. Read |

b)

|  |  |
| --- | --- |
|  | 1. Right Tap on Consume MQTT 2. Tap View data provenance |
|  | 1. Click the info symbol of the message you are interested 2. Tap Content 3. Tap View |
|  | Complete MQTT-Message |

# Exercise 3

a)

|  |  |
| --- | --- |
|  | 1. Click new 2. Click terminal |
|  | Type into terminal   1. Go to directory 2. Execute order |
| A workpiece with color “BLUE” has been ordered.  Connected to broker via TCP.  Process was successful. | Answer of terminal |

b)

|  |  |
| --- | --- |
|  | Type |
| Current factory state: ORDERED | Response of terminal |

# Exercise 4

|  |  |
| --- | --- |
| Ein Bild, das Text, Screenshot, Schrift, Zahl enthält.  Automatisch generierte Beschreibung | 1. Open JupyterHub 2. Double click ki-campus folder |
| Ein Bild, das Text, Screenshot, Schrift, Reihe enthält.  Automatisch generierte Beschreibung | Double click modul\_4 folder |
| Ein Bild, das Text, Screenshot, Schrift enthält.  Automatisch generierte Beschreibung | Open notebook by double click |
| Ein Bild, das Text, Schrift, Zahl, Software enthält.  Automatisch generierte Beschreibung | Execute the notebook by clicking Restart & Run All |
| Ein Bild, das Reihe, Text, Handschrift, Diagramm enthält.  Automatisch generierte Beschreibung | Brightness in % is sinkings |
| Ein Bild, das Reihe, Diagramm, Handschrift, Text enthält.  Automatisch generierte Beschreibung | Brightness sensor value is increasing |
|  | Temperature in °C is increasing in the beginning, then falling and increasing rapidly and changing slightly in the end |
| Ein Bild, das Reihe, Diagramm enthält.  Automatisch generierte Beschreibung | Humidity is falling in the beginning, then rising and falling over the time |
|  | Air quality value is decreasing in the beginning, then rising softly towards an asymptote |

# Exercise 5

a)

|  |  |
| --- | --- |
| Open Node RED, sign in |  |
|  | Click on Flow order to reach the flow, that is used to control the factory |
|  |  |
|  | OPC UA Client node should show “value written” |

b)

|  |  |
| --- | --- |
| Trigger order like shown in a) |  |
|  | In the upper right corner, click on the bug to open the debug feed |
|  | Wait for confirmation that a order has been placed  Read the time the order has been placed: 5:18,36AM |
|  | Wait during messages that show “IN\_PROCESS” and “SHIPPED” |
|  | Read the time in the message showing “WAITING\_FOR\_ORDER”: 5:22,36AM |
| 5:22,36AM - 5:18,36AM = 4min | Calculate the duration |

c)

|  |  |
| --- | --- |
| -Trigger the same process like in b)  -Goal of this task is to understand the messages issued in the  debug window |  |
| Ein Bild, das Text, Screenshot, Schrift, Zahl enthält.  Automatisch generierte Beschreibung | Order triggered for red piece |
| Ein Bild, das Text, Schrift enthält.  Automatisch generierte Beschreibung | Confirmation that red piece is ordered |
|  | * This section shows the current stock * Every container has the following attributes: RFID, state if raw or already worked on and colour * Courser shows an empty space, the space is empty because of the placed order |
|  | * This section shows the states of each production step * The second column show the name of each station * The courser is pointing on the column indicating the state of each station   1: Ready  2: Currently working   * The last column is indicating the station where the workpiece is at |
| Ein Bild, das Text, Schrift, weiß, Algebra enthält.  Automatisch generierte Beschreibung | Indicates that production is finished |
|  | High rack storage has no empty slots anymore |

Ein Bild, das Text, Screenshot, Schrift, Farbigkeit enthält.

Automatisch generierte BeschreibungAbbreviation table for stations

# Exercise 7

|  |  |
| --- | --- |
|  | 1. Navigate to modul\_7 folder in jupyter 2. Open the marked notebook |
|  | Execute the notebook by clicking Restart & Run All |
| Neue Message mit Topic: f/s/state/hbw  1/1 [==============================] - 0s 58ms/step  aktualisierte Datenreihe [0 1 0 1 0 0 1 0 1 0 1 0 1] ergibt den Zustand: Ruhend  New Message with topic: f/s/state/hbw  1/1 [==============================] - 0s 58ms/step  Actualized series of data [0 1 0 1 0 0 1 0 1 0 1 0 1] results in state: Neutral | * Scroll down to the end of the script until the message on the left * It says that the factory is currently resting |
|  | Open a new terminal and navigate to cli-client folder |
| python3 lernfabrik.py -o BLUE | Insert the text on the left, this will trigger the order of a blue piece |
| Neue Message mit Topic: f/s/state/hbw  current threads = 9  1/1 [==============================] - 0s 56ms/step  aktualisierte Datenreihe [0 2 0 1 0 0 1 0 1 0 1 0 1] ergibt den Zustand: Ein-/Auslagerung  New Message with topic: f/s/state/hbw  current threads = 9  1/1 [==============================] - 0s 56ms/step  Actualized series of data [0 2 0 1 0 0 1 0 1 0 1 0 1] results in state: to (take out of) warehouse | * Go back to the notebook * Wait for new messages to show up * “Ein-/Auslagerung” means that the production process has begun as a workpieces is taken out of the warehouse |
| Comment: A series of messages will pop up, as a data query is send periodically. It is possible that single messages show a wrong state which can be ignored. | |
| Neue Message mit Topic: f/s/state/hbw  1/1 [==============================] - 0s 72ms/step  aktualisierte Datenreihe [1 1 0 2 0 0 1 0 1 0 1 0 1] ergibt den Zustand: Transport  New Message with topic: f/s/state/hbw  1/1 [==============================] - 0s 72ms/step  Actualized series of data [1 1 0 2 0 0 1 0 1 0 1 0 1] results in state: Transport | Next message will indicate that the gripper station is now running |
| Neue Message mit Topic: f/s/state/hbw  1/1 [==============================] - 0s 76ms/step  aktualisierte Datenreihe [0 2 0 2 0 0 2 0 1 0 1 0 1] ergibt den Zustand: Bearbeitung  New Message with topic: f/s/state/hbw  1/1 [==============================] - 0s 76ms/step  Actualized series of data [0 2 0 2 0 0 2 0 1 0 1 0 1] results in state: Workmanship | This message indicates that the workpiece is worked on |
| Neue Message mit Topic: f/s/state/hbw  1/1 [==============================] - 0s 59ms/step  aktualisierte Datenreihe [0 1 0 1 0 0 1 1 2 0 1 0 1] ergibt den Zustand: Sortierung  New Message with topic: f/s/state/hbw  1/1 [==============================] - 0s 59ms/step  Actualized series of data [0 1 0 1 0 0 1 1 2 0 1 0 1] results in state: Sorting | This message indicates that the colour sorting process is running |
| Neue Message mit Topic: f/s/state/hbw  1/1 [==============================] - 0s 55ms/step  aktualisierte Datenreihe [0 1 1 2 3 0 1 0 1 0 1 0 1] ergibt den Zustand: TransportToDSO  New Message with topic: f/s/state/hbw  1/1 [==============================] - 0s 55ms/step  Actualized series of data [0 1 1 2 3 0 1 0 1 0 1 0 1] results in state: TransportToDSO | This message indicates that the workpiece is transferred to the output station |
| Neue Message mit Topic: f/s/state/hbw  1/1 [==============================] - 0s 67ms/step  aktualisierte Datenreihe [0 2 1 2 2 0 1 0 1 1 0 0 1] ergibt den Zustand: TransportToHBW  New Message with topic: f/s/state/hbw  1/1 [==============================] - 0s 67ms/step  Actualized series of data [0 2 1 2 2 0 1 0 1 1 0 0 1] results in state: TransportToHBW | This message indicates that the workpiece is transported back to the warehouse |
| Neue Message mit Topic: f/s/state/hbw  1/1 [==============================] - 0s 59ms/step  aktualisierte Datenreihe [1 2 0 2 0 0 1 0 1 0 1 0 1] ergibt den Zustand: Ein-/Auslagerung  New Message with topic: f/s/state/hbw  1/1 [==============================] - 0s 59ms/step  Actualized series of data [1 2 0 2 0 0 1 0 1 0 1 0 1] results in state: to (take out of) warehouse | This message indicates that the piece is stored |
| Neue Message mit Topic: f/s/state/hbw  1/1 [==============================] - 0s 33ms/step  aktualisierte Datenreihe [0 1 0 1 0 0 1 0 1 0 1 0 1] ergibt den Zustand: Ruhend  New Message with topic: f/s/state/hbw  1/1 [==============================] - 0s 33ms/step  Actualized series of data [0 1 0 1 0 0 1 0 1 0 1 0 1] results in state: Neutral | After the process has finished, the neutral message is shown again |

REFERENCES

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