

Einführung in die künstliche Intelligenz

EKI05 – Complex Event Processing

Prof. Dr. A. del Pino

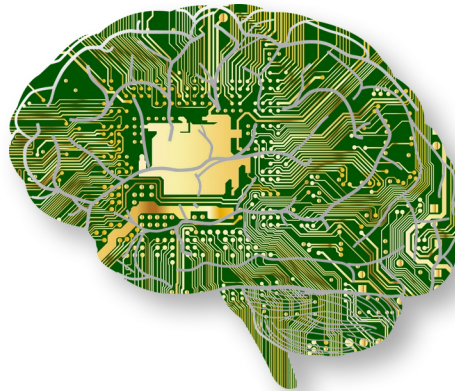


Bild: https://en.wikipedia.org/wiki/Machine_learning#/media/File:Anatomy-1751201_1280.png

Aufbau

- Überblick
- CEP Anwendungen
- CEP Konzepte und Technologien
- Beispiel
- Mini-Test

Die KI-Landkarte

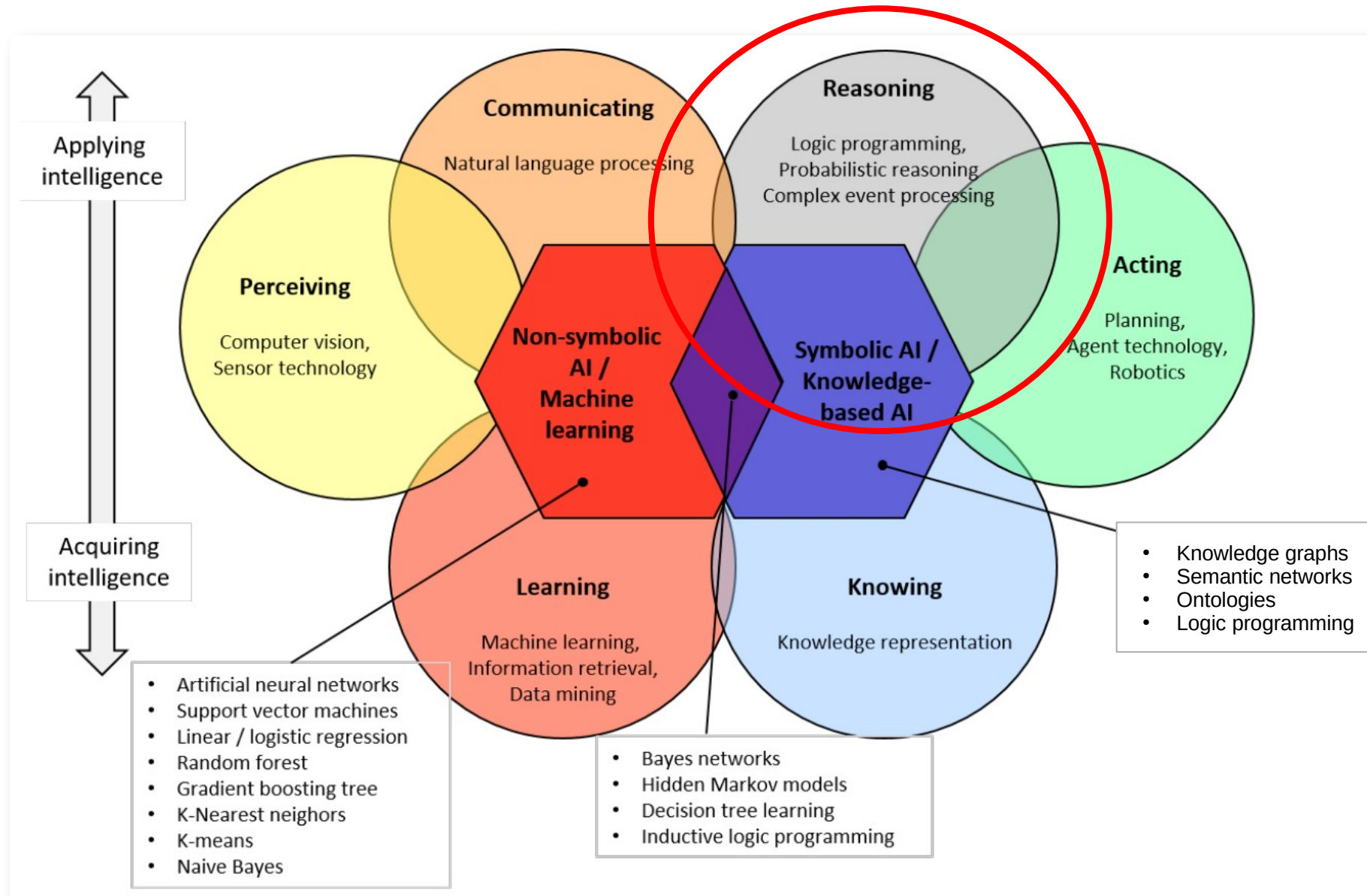


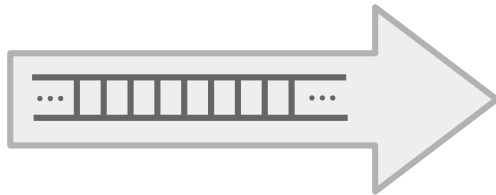
Bild: B. Humm "Applied Artificial Intelligence", S. 4

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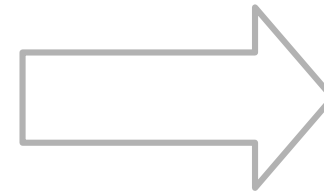
Erkennen von Betrugsversuchen (fraud detection)

Strom von
Kreditkarten-Transaktionen



CEP

Prüfe auf
ungewöhnlich hohe
Transaktionen in
kurzer Zeit



Betrugswarnung:

Menschlicher
Eingriff notwendig

Bild: <https://p2.piqsels.com/preview/377/158/322/credit-credit-card-finance-credit-cards.jpg>

Predictive Maintenance

Strom von
Sensordaten aus einer
Maschine in einer Fabrik

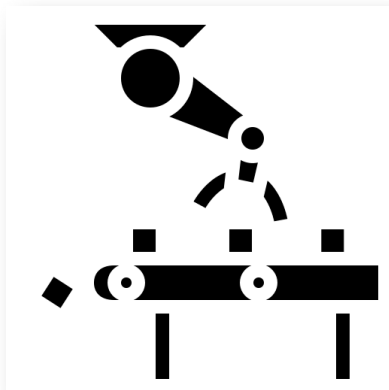
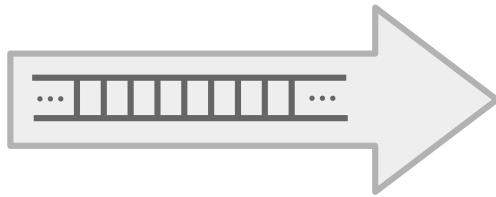


Bild: <https://game-icons.net/icons/000000/ffffff/1x1/delapouite/factory-arm.png>

CEP

Prüfe auf Muster,
welche auf
Verschleiß
hinweisen, z.B.
Vibrationen

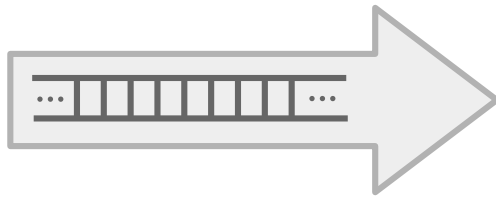


Hinweis:

Teil sollte bald
ersetzt werden

Logistik

Strom von
RFID Signalen



CEP

Prüfe auf
Bedingungen, die
bestimmte Aktionen
benötigen



Informiere den
Logistikpartner
über den
Transport

Informiere den
Kunden über die
Auslieferung

Warnung, z.B. bei
einer
unterbrochenen
Kühlkette

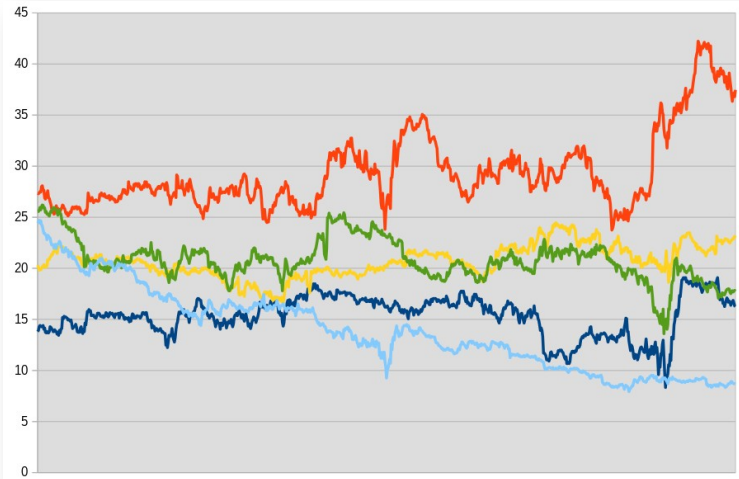
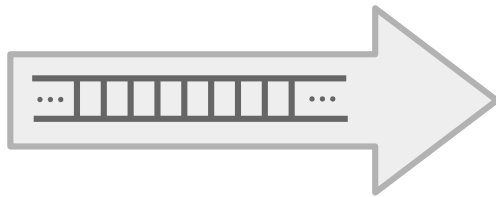
...



Bild: https://1.bp.blogspot.com/-j2rezbiNZnl/XX0qT_mMqXI/AAAAAAAAAL6E/yt764xK4mLM4xFGe0_ayJgY4FJl9T3igQCLcBGAsYHQ/s1600/Logistics+%28III%29.jpg

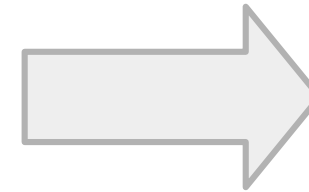
Wertpapierhandel

Strom von
Börsen- und
anderen
Marktdaten



CEP

Klassifiziere die
Situation in Hinblick
auf Kauf- und
Verkauf-
Entscheidungen



Kauf

Verkauf

Aufbau

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Definition von CEP

Complex Event Processing (CEP)

Das Verarbeiten eines Stroms von Ereignissen und das Ableiten von Schlüssen daraus.

Was ist ein Ereignis?

Ereignis (event)

Etwas besonderes, was passiert ist.

Beispiele:

- Eine Finanztransaktion
- Ein landendes Flugzeug
- Ein Sensor, der einen Messwert erfasst hat
- Eine Änderung in einer Datenbank, ein Zustandswechsel
- Ein Tastendruck
- Ein historisches Ereignis, z.B. die französische Revolution

Ereignisobjekt

Ereignisobjekt (event object)

Ein Datensatz, welcher ein Ereignis repräsentiert.

Beispiele:

- Eine Kaufbestätigung
 - Eine Nachricht mit einem Kurswechsel
 - Ein RFID Datensatz mit Sensordaten
-
- Der Begriff Ereignis wird oftmals stellvertretend für das Ereignisobjekt benutzt

Ereignistyp

Ereignistyp (event type, event class)

Der Ereignistyp spezifiziert die Struktur von Ereignisobjekten, d.h. ihrer Attribute und Datentypen.

Beispiel:

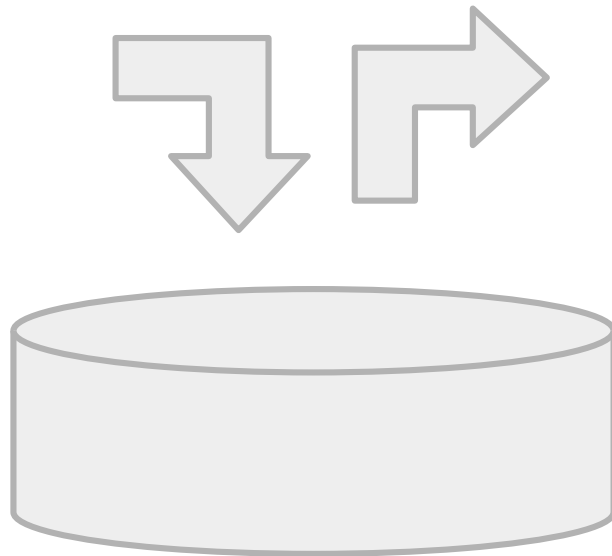
Die Klasse Kaufereignis mit den Attributen

- Zeitstempel
- Käufer
- Produkt
- Preis

DBMS vs. CEP

DBMS

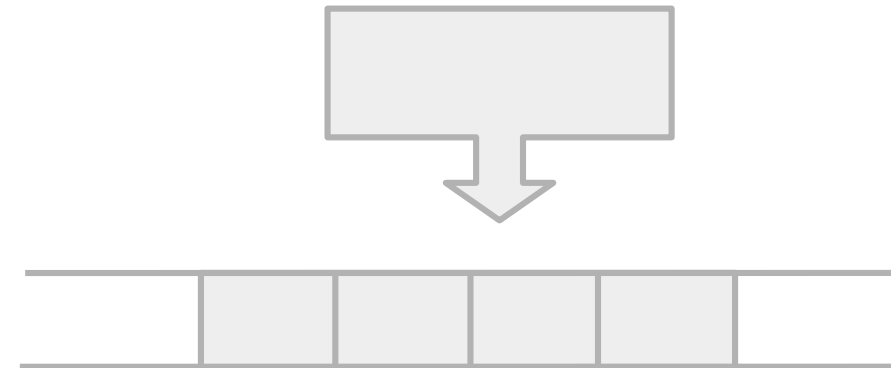
DBMS Query-Ausführung:
Volatil



DBMS Daten: Persistent

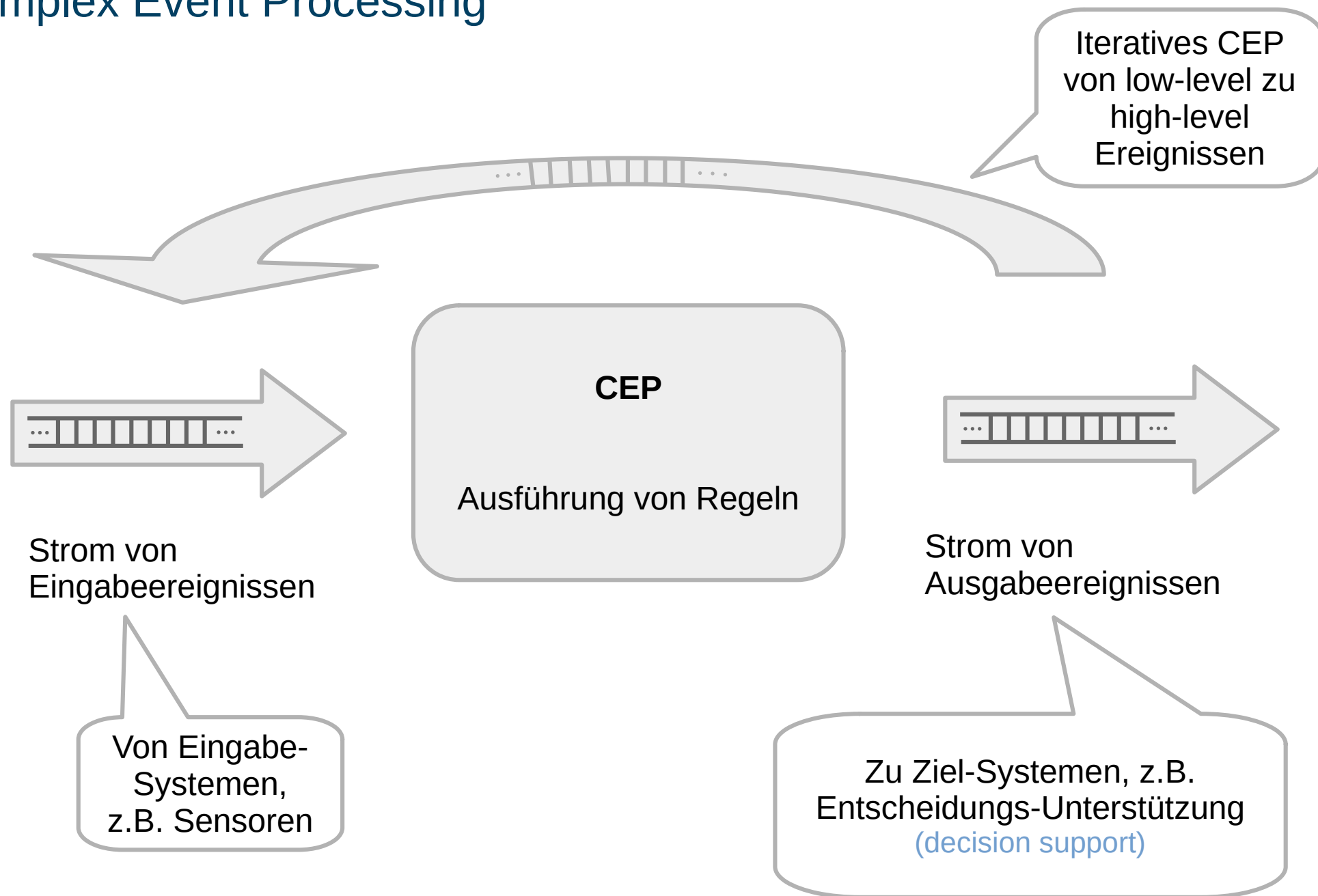
CEP

CEP Regel:
Persistent

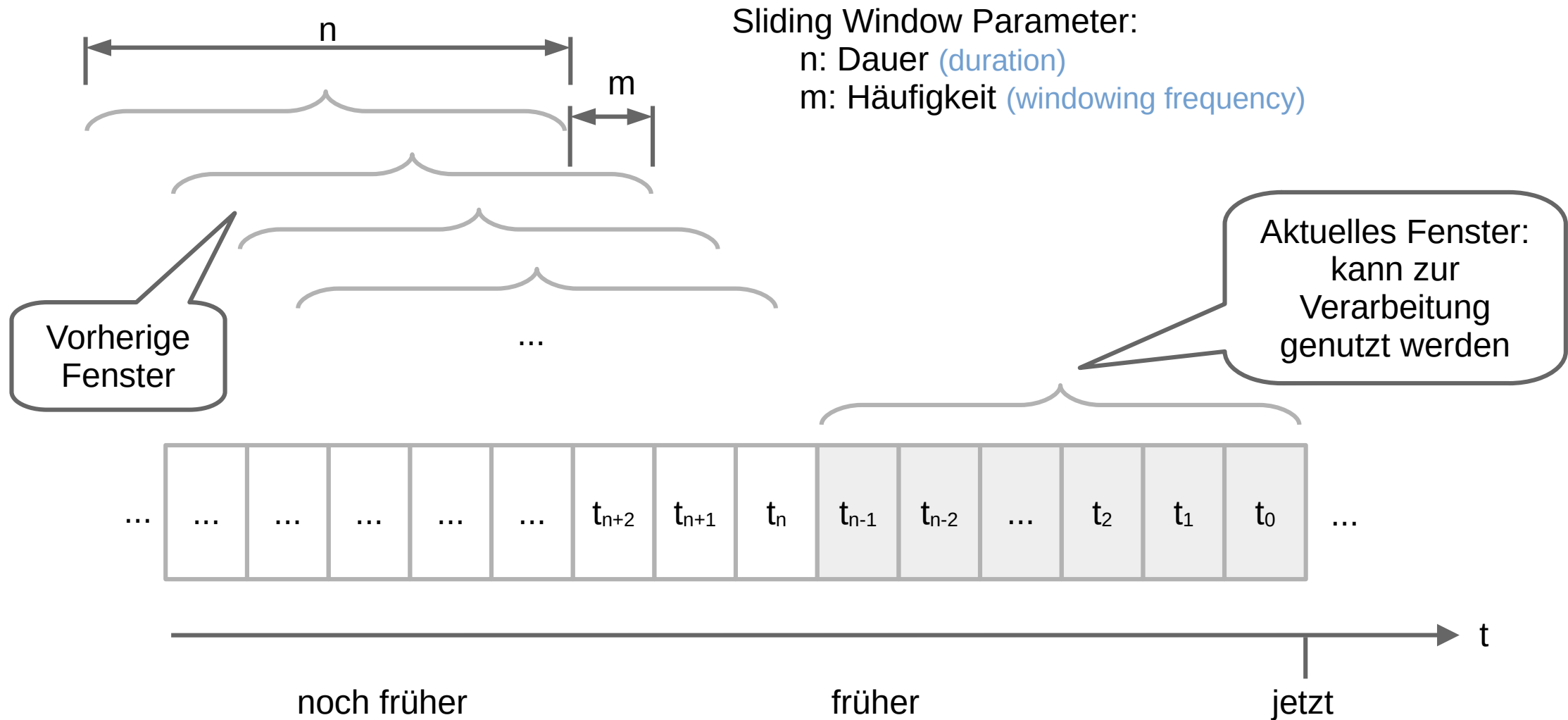


Strom von Ereignissen: Fließend

Complex Event Processing



Sliding “Rolling” Window



CEP Technologien

- Apache Kafka
- Apache Flink
- Apache Spark
- Drools Fusion
- MS Azure Stream Analytics
- Oracle Stream Analytics
- SAG Apama
- SAP ESP
- SAS ESP
- TIBCO
- IBM WebSphere Business Events



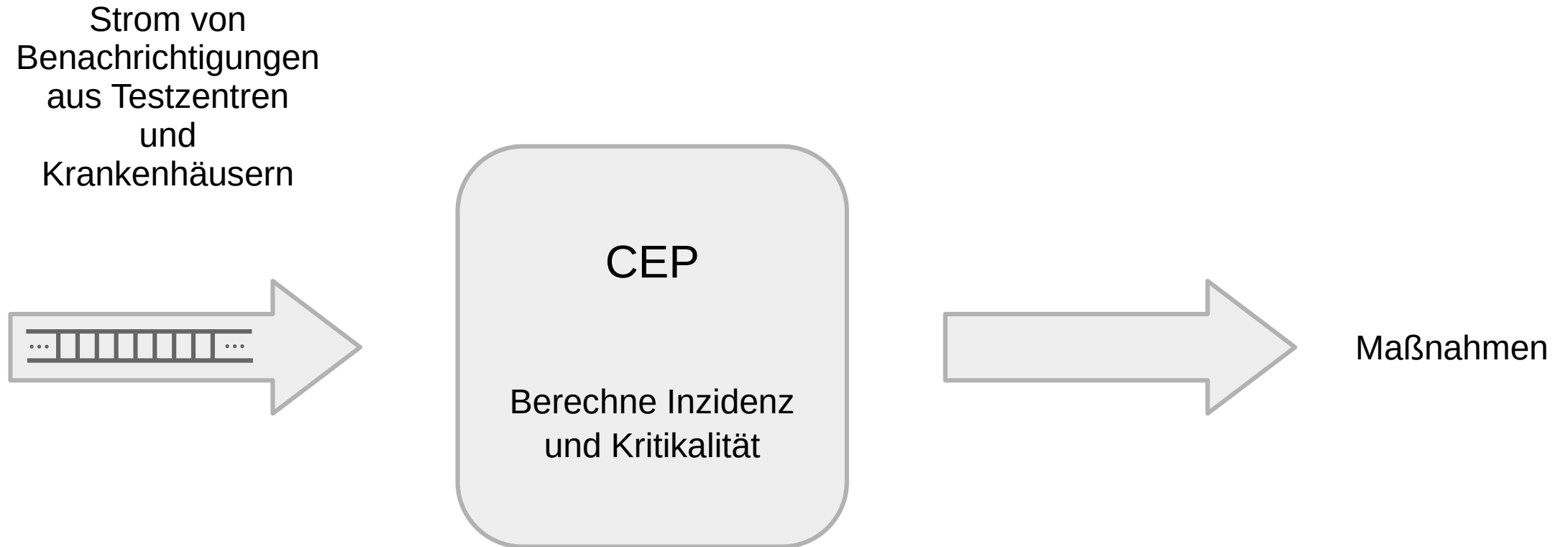
CEP Technologien sind komplex

- Komplex aufgrund der inhärenten Verteilung
- Schwer zu installieren und handzuhaben
- Daher: In unserem Kurs werden wir mit Python das Konzept der Sliding Windows ausprobieren, ohne eine vollständige CEP Technologie zu benutzen

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- Mini-Test

COVID-19 Monitoring



Datensatz: COVID-19 Singapur

<https://data.world/hxchua/covid-19-singapore>

The screenshot shows the Data.world interface for the dataset 'COVID-19 Singapore' by Hui Xiang Chua. The page includes a search bar, user profile, and navigation tabs for Overview, Discussion, and Activity. The Overview section contains a description, summary, and notes. The right sidebar provides metadata about the dataset, including sharing settings, creation date, size, tags, license, and dictionary. Below the main content, there are sections for related projects and recent updates.

data.world Search data.world Sign in Join

Hui Xiang Chua > **COVID-19 Singapore** Comment 1,849 Launch workspace

Overview Discussion Activity

Overview

DESCRIPTION

Time series data on covid-19 cases in Singapore on counts of confirmed, discharged, hospitalised, deaths, imported cases

SUMMARY

The [googlesheet](#) also contains some data visualizations.

Notes:

- All figures (excluding variables with names containing "MOH report") are as at press release within the day and are **not back-dated** to update any changes that the Ministry of Health (MOH) might have made. More specifically, number of daily confirmed, discharged (and to isolation), imported, death and intensive care unit counts are extracted and the cumulative figures are computed based on these (as follows). It is important to note that there are inconsistencies with the cumulative discharged reported beginning 11 Apr in the press release where the previous day figure and daily count doesn't add up to the cumulative discharged and hence these cumulative figures are not extracted from the press release (See Figure 1-3).

[Show more](#)

About this dataset

SHARED WITH [Everyone](#)

CREATED 3 years ago by @hxchua

SIZE 288.81 KB · [Download](#)

TAGS [coronavirus](#), [covid19](#), [singapore](#), [time series](#), [health](#)

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DICTIONARY 1 file, 36 columns, 0 tables · [View](#)

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[Country-level COVID-19 datasets](#)
Liz Friedman · 3 years ago

[Covid-19 in Singapore](#)
Shubham Tomar · 2 years ago

[covidsg](#)
Ang Kok Hwee · 3 years ago

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1 file Sort ▾

Bild: <https://data.world/hxchua/covid-19-singapore>

Daten seit dem COVID-19 Ausbruch mit vielen Features

Inzidenz

Weitere
Features

Jan. 2020
bis Jan.
2022

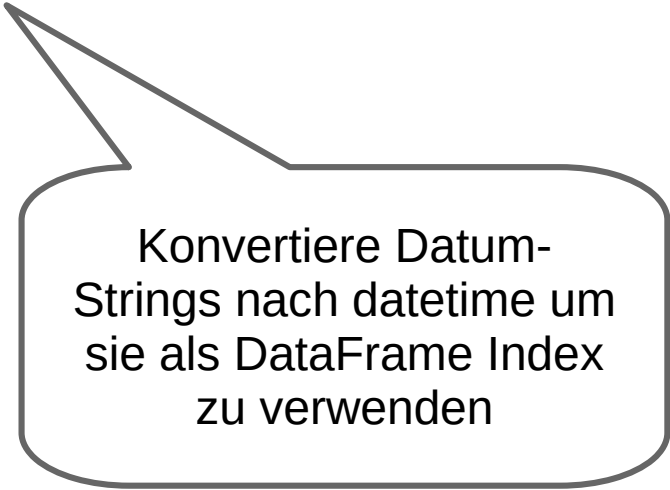
In einem
Krankenhaus

Todesrate

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
Date	Daily Confirmed	False Positives Found	Cumulative Confirmed	Daily Discharged	Passed but not due to COVID	Cumulative Discharged	Discharged to Isolation	Still Hospitalised	Daily Deaths	Cumulative Deaths	Tested positive demise	Daily Imported	Daily Local transmission	Local cases residing in dorms MOH report	Local cases not residing in dorms MOH report	Intensive Care Unit (ICU)
2020-04-08	142		1623	29	0	406	542	669	0	6	0	2	140	65	75	29
2020-04-09	287		1910	54	1	460	559	885	0	6	0	3	284	214	70	29
2020-04-10	198		2108	32	0	492	734	875	1	7	0	0	198	141	57	32
2020-04-11	191		2299	35	0	527	820	944	1	8	0	0	191	152	39	31
2020-04-12	233		2532	32	0	559	988	977		8	0	0	233	188	45	31
2020-04-13	386		2918	26	0	585	1165	1159		9	0	0	386	334	52	29
2020-04-14	334		3252	25	0	610	1316	1316		10	0	0	334	275	59	28
2020-04-15	447		3699	41	0	651	1540	1497		10	1	0	447	406	41	26
2020-04-16	728		4427	31	0	682	184	1886	0	10	0	0	728	676	52	23
2020-04-17	623		5050	25	0	707	227	1113		11	0	1	622	559	63	22
2020-04-18	942		5992	38	0				0		0	0	942	893	49	23
2020-04-19	596		6588	26	0				0		0	0	596	544	52	22
2020-04-20	1426		8014	33	0				0		0	0	1426	1371	55	23
2020-04-21	1111		9125	39	0				0		0	0	1111	1050	61	27
2020-04-22	1016		10141	57	0				0		0	0	1016	967	49	25
2020-04-23	1037		11178	36	1	936	8874	1355	0	12	0	0	1037	982	55	26
2020-04-24	897		12075	38	0	974	9878	1210	0	12	0	0	897	852	45	24
2020-04-25	618		12693	46	0	1020	10465	1195	0	12	0	0	618	597	21	24
2020-04-26	931		13624	58	0	1078	11241	1292	0	12	0	2	929	886	43	22
2020-04-27	799		14423	35	0	1113	11863	1432	2	14	0	0	799	764	35	20
2020-04-28	528		14951	33	0	1146	12120	1670	0	14	0	0	528	511	17	21
2020-04-29	690		15641	62	0	1208	12725	1693	0	14	0	0	690	660	30	22
2020-04-30	528		16169	56	0	1264	13202	1687	1	15	0	0	528	488	40	21
2020-05-01	932		17101	24	0	1288	14053	1743	1	16	0	0	932	905	27	23
2020-05-02	447		17548	79	0	1367	14474	1688	1	17	1	0	447	431	16	24
2020-05-03	657		18205	61	0	1428	15149	1608	1	18	0	0	657	626	31	22
2020-05-04	573		18778	49	0	1477	15812	1469	0	18	0	0	573	560	13	25
2020-05-05	632		19410	62	1	1539	16289	1562	0	18	0	0	632	605	27	24
2020-05-06	788		20198	115	0	1654	17082	1440	2	20	0	0	788	760	28	23

Daten laden und vorbereiten

```
import pandas as pd  
  
from datetime import datetime  
  
df = pd.read_csv('Covid-19_SG.csv')  
df.index = df['Date'].apply(lambda s: datetime.strptime(s, '%Y-%m-%d'))
```



Konvertiere Datum-Strings nach datetime um sie als DataFrame Index zu verwenden

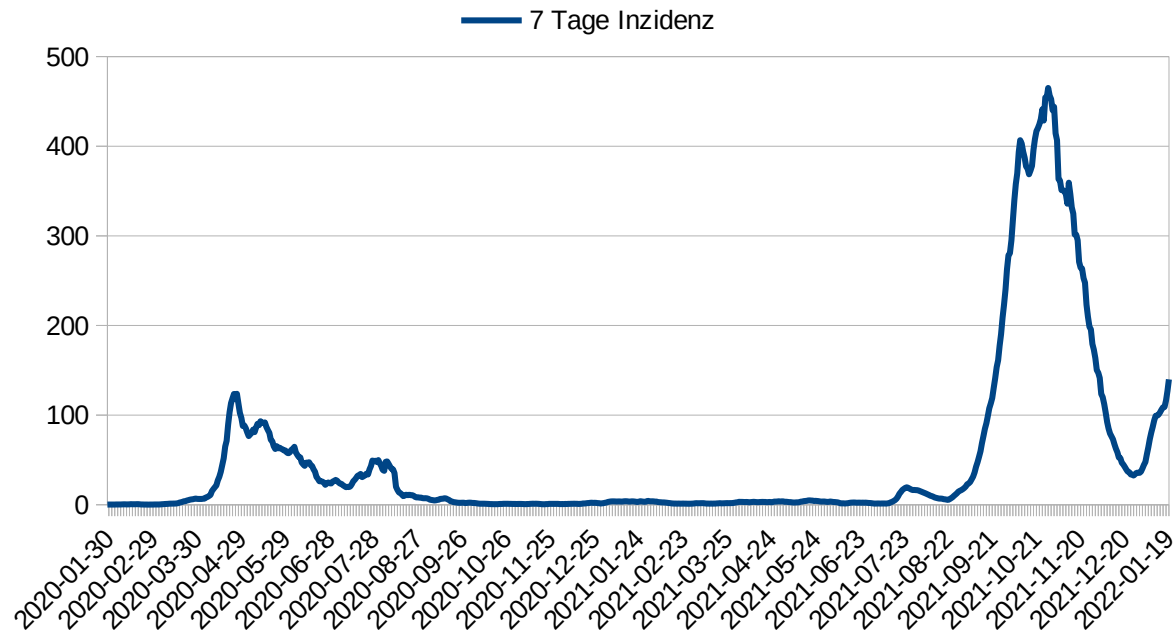
7-Tage Inzidenz

- Definition 7-Tage Inzidenz

$$7\ inc = \sum_{i=1}^7 inc_i * \frac{100,000}{population}$$

7 Tage Sliding Window

- Population Singapur: 5,686 Millionen



Pandas DataFrame Windowing


[Getting started](#)
[User Guide](#)
[API reference](#)
[Development](#)
[Release notes](#)

[10 minutes to pandas](#)
[Intro to data structures](#)
[Essential basic functionality](#)
[IO tools \(text, CSV, HDF5, ...\)](#)
[PyArrow Functionality](#)
[Indexing and selecting data](#)
[MultiIndex / advanced indexing](#)
[Copy-on-Write \(CoW\)](#)
[Merge, join, concatenate and compare](#)
[Reshaping and pivot tables](#)
[Working with text data](#)
[Working with missing data](#)
[Duplicate Labels](#)
[Categorical data](#)
[Nullable integer data type](#)
[Nullable Boolean data type](#)
[Chart visualization](#)
[Table Visualization](#)
[Group by: split-apply-combine](#)
[Windowing operations](#)
[Time series / date functionality](#)
[Time deltas](#)
[Options and settings](#)
[Enhancing performance](#)
[Scaling to large datasets](#)
[Sparse data structures](#)
[Frequently Asked Questions \(FAQ\)](#)
[Cookbook](#)

Windowing operations

pandas contains a compact set of APIs for performing windowing operations - an operation that performs an aggregation over a sliding partition of values. The API functions similarly to the `groupby` API in that `Series` and `DataFrame` call the windowing method with necessary parameters and then subsequently call the aggregation function.

```

In [1]: s = pd.Series(range(5))

In [2]: s.rolling(window=2).sum()
Out[2]:
0    NaN
1    1.0
2    3.0
3    5.0
4    7.0
dtype: float64

```

The windows are comprised by looking back the length of the window from the current observation. The result above can be derived by taking the sum of the following windowed partitions of data:

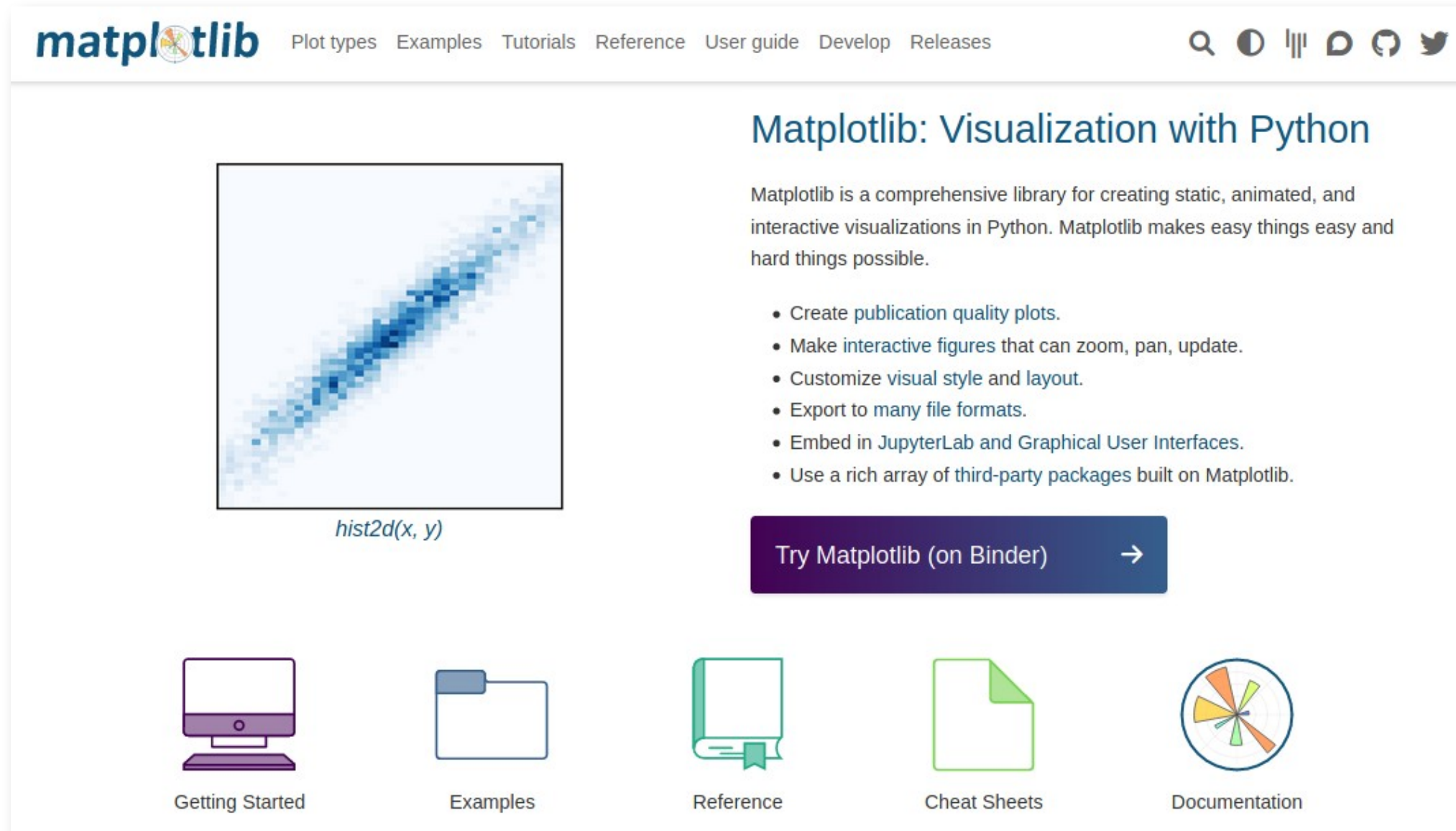
```

In [3]: for window in s.rolling(window=2):
...:     print(window)
...:
0    0
dtype: int64
0    0
1    1
dtype: int64
1    1
2    2
dtype: int64
2    2
3    3
dtype: int64
3    3
4    4
dtype: int64

```

Quelle: https://pandas.pydata.org/pandas-docs/stable/user_guide/window.html

Matplotlib: Visualisieren von Daten



The screenshot shows the Matplotlib website homepage. At the top is the Matplotlib logo and a navigation bar with links: Plot types, Examples, Tutorials, Reference, User guide, Develop, and Releases. On the right are icons for search, dark mode, and social media. The main heading is "Matplotlib: Visualization with Python". Below it is a paragraph describing Matplotlib as a comprehensive library for creating static, animated, and interactive visualizations in Python. To the left of this text is a 2D histogram plot labeled $hist2d(x, y)$. Below the paragraph is a list of features:

- Create publication quality plots.
- Make interactive figures that can zoom, pan, update.
- Customize visual style and layout.
- Export to many file formats.
- Embed in JupyterLab and Graphical User Interfaces.
- Use a rich array of third-party packages built on Matplotlib.

 Below the list is a dark blue button that says "Try Matplotlib (on Binder)" with a right-pointing arrow. At the bottom of the page are five icons with labels: "Getting Started" (computer icon), "Examples" (folder icon), "Reference" (book icon), "Cheat Sheets" (document icon), and "Documentation" (circular plot icon).

matplotlib

Plot types Examples Tutorials Reference User guide Develop Releases

Matplotlib: Visualization with Python

Matplotlib is a comprehensive library for creating static, animated, and interactive visualizations in Python. Matplotlib makes easy things easy and hard things possible.

- Create publication quality plots.
- Make interactive figures that can zoom, pan, update.
- Customize visual style and layout.
- Export to many file formats.
- Embed in JupyterLab and Graphical User Interfaces.
- Use a rich array of third-party packages built on Matplotlib.

[Try Matplotlib \(on Binder\)](#) →

Getting Started Examples Reference Cheat Sheets Documentation

Quelle: <https://matplotlib.org/>

Iteratives CEP: Kritikalität, abgeleitet aus der 7-Tage Inzidenz

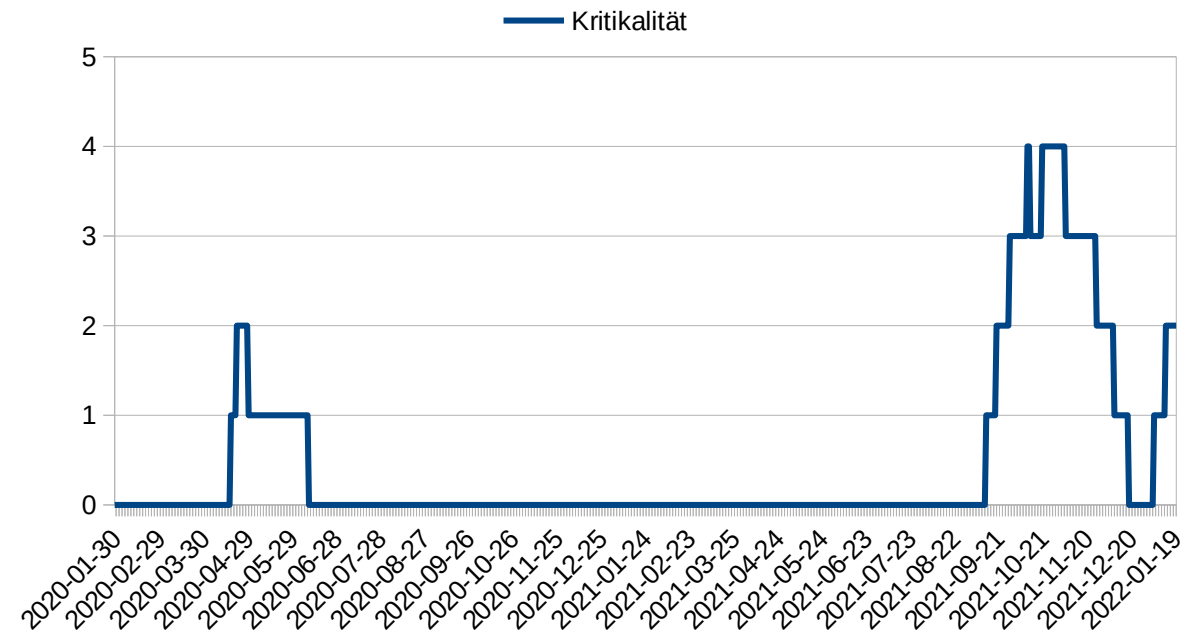
- Beispiel-Definition der Kritikalität zur Nutzung für Regierungsmaßnahmen:

$$\text{crit}(7 \text{ inc}) = \begin{cases} 4, & \text{if } 7 \text{ inc} > 400 \\ 3, & \text{else if } 7 \text{ inc} > 200 \\ 2, & \text{else if } 7 \text{ inc} > 100 \\ 1, & \text{else if } 7 \text{ inc} > 50 \\ 0 & \text{else} \end{cases}$$

- 7-Tage Kritikalitäts-Score

$$7 \text{ crit} = \min_{i=1}^7 (\text{crit}(7 \text{ inc}_i))$$

7 Tage
Sliding
Window



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Mini-Test “Complex Event Processing”

- Was ist CEP?
- Nennen Sie CEP Anwendungen
- Was ist ein Ereignis, Ereignisobjekt und Ereignistyp?
- Wie funktioniert iteratives CEP?
- Was sind sliding (“rolling”) windows?
- Nennen Sie CEP Technologien