Course introduction and overview

CUSTOMER ANALYTICS AND A/B TESTING IN PYTHON

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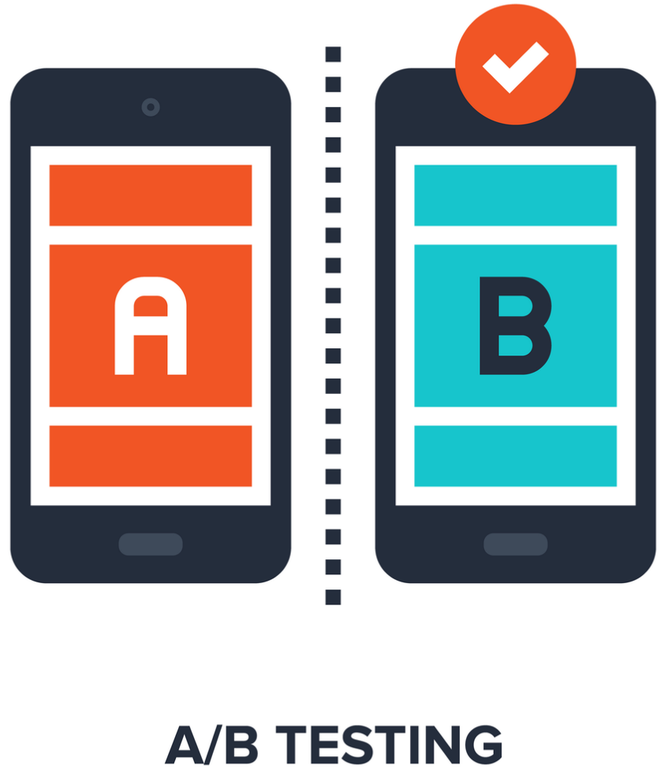
What is A/B testing?

- **A/B Testing:** Test different ideas against each other in the real world
- Choose the one that statistically performs better

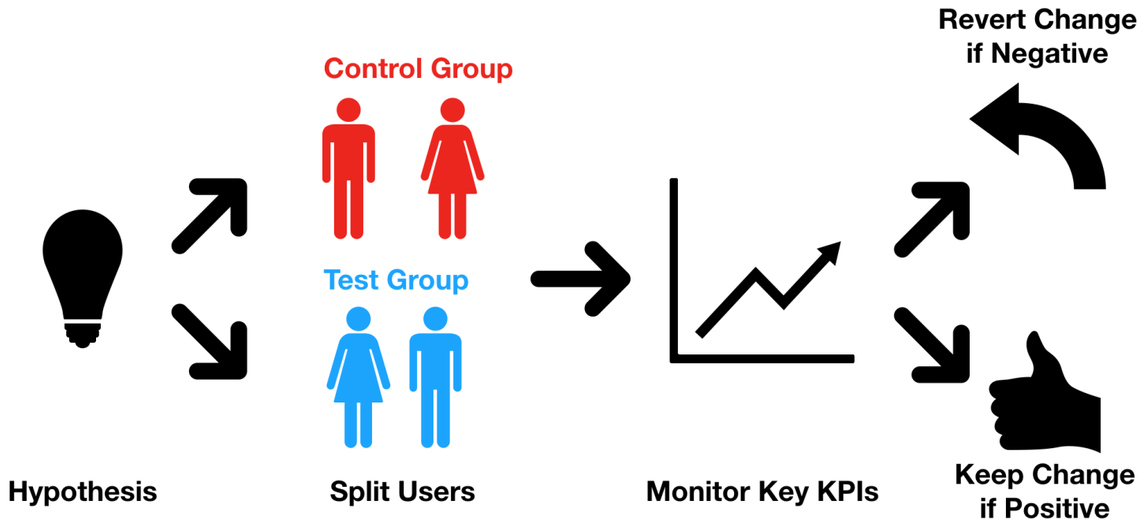
Why is A/B testing important?

- No guessing
- Provides accurate answers - quickly
- Allows to rapidly iterate on ideas
- ...and establish causal relationships



A/B test process

1. Develop a hypothesis about your product or business
2. **Randomly** assign users to two different groups
3. Expose:
    - Group 1 to the the current product rules
    - Group 2 to a product that tests the hypothesis
4. Pick whichever performs better according to a set of KPIs



Where can A/B testing be used?

Users + ideas → A/B test

- testing impact of drugs
- incentivizing spending
- driving user growth
- ...and many more!

Course progression

1. Understanding users — *Key Performance Indicators*
2. Identifying trends — *Exploratory Data Analysis*
3. Optimizing performance — *Design of A/B Tests*
4. Data driven decisions — *Analyzing A/B Test Results*

Key performance indicators (KPIs)

- **A/B Tests**: Measure impact of changes on KPIs
- **KPIs** — metrics important to an organization
  - likelihood of a side-effect
  - revenue
  - conversion rate
  - ...

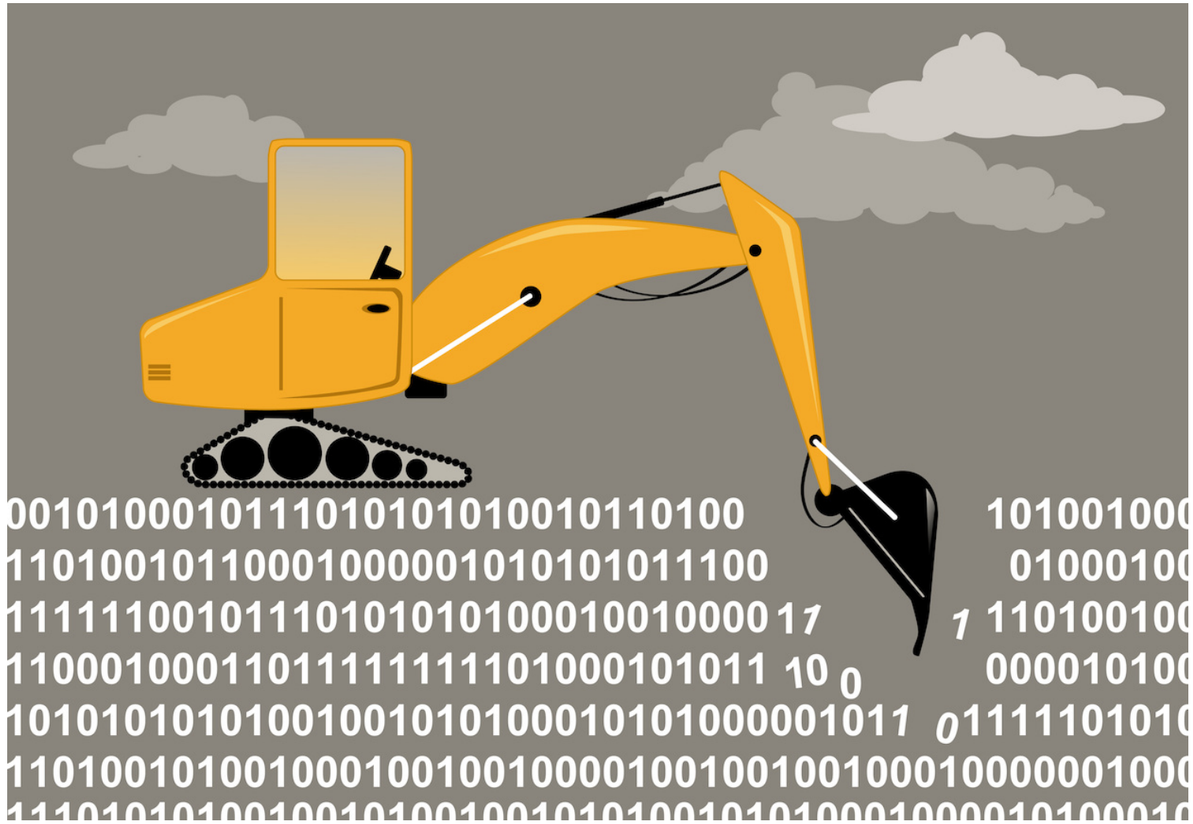
How to identify KPIs

Experience + Domain knowledge + Exploratory data analysis

- **Experience & Knowledge** - *What is important to a business*
- **Exploratory Analysis** - *What metrics and relationships impact these KPIs*

Next Up...

- Exploratory Data Analysis (EDA)
- Identify KPIs and areas for further analysis



Let's practice!

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Identifying and understanding KPIs

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Example: meditation app

Services

- Paid subscription
- In-app purchases

Goals/KPIs

- Maintain high free → paid conversion rate

Dataset 1: User demographics

```
import pandas as pd

# load customer_demographics
customer_demographics = pd.read_csv('customer_demographics.csv')

# print the head of customer_demographics
print(customer_demographics.head())
```

```
uid         reg_date    device     gender     country       age
54030035    2017-06-29     and          M         USA        19
72574201    2018-03-05     iOS          F         TUR        22
64187558    2016-02-07     iOS          M         USA        16
92513925    2017-05-25     and          M         BRA        41
99231338    2017-03-26     iOS          M         FRA        59
```

Dataset 2: User actions

```
# load customer_subscriptions
customer_subscriptions = pd.read_csv('customer_subscriptions.csv')

# print the head of customer_subscriptions
print(customer_subscriptions.head())
```

```
uid         lapse_date     subscription_date      price
59435065    2017-07-06     2017-07-08             499
26485969    2018-03-12     None                   0
64187658    2016-02-14     2016-02-14             499
99231339    2017-04-02     None                   0
64229717    2017-05-24     2017-05-25             499
```

KPI: Conversion Rate

- **Conversion Rate**: Percentage of users who subscribe after the free trial
  - Of users who convert within one week? One month?...
  - Across all users or just a subset?
  - ...

Choosing a KPI

- Stability over time
- Importance across different user groups
- Correlation with other business factors

Joining the demographic and subscription data

- Merging — equivalent of SQL `JOIN`
- In `pandas` :
  - `pd.merge(df1, df2)`
  - `df1.merge(df2)`

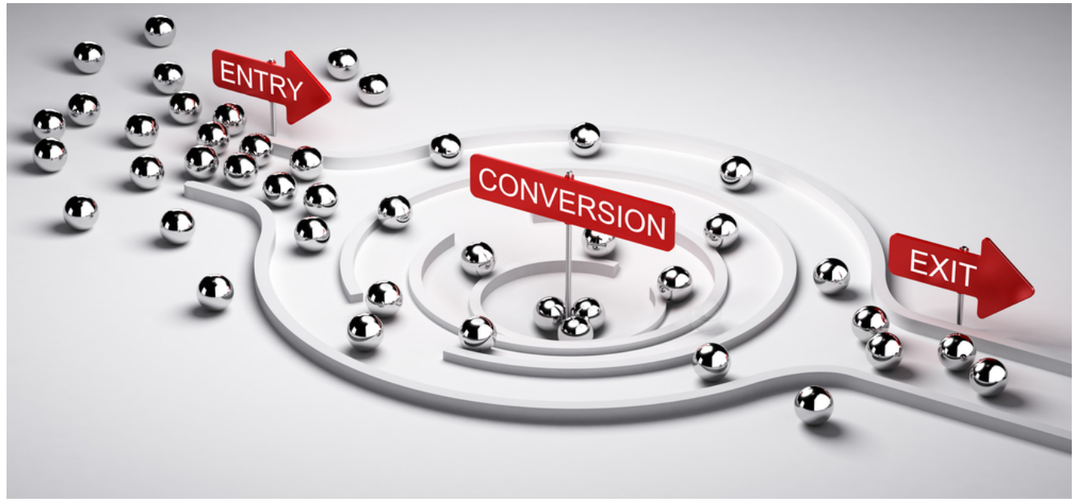
Merging mechanics

```
# merge customer_demographics (left) and customer_subscriptions (right)
sub_data_demo = customer_demographics.merge(
                    # right dataframe
                    customer_subscriptions,
                    # join type
                    how='inner',
                    # columns to match
                    on=['uid'])
sub_data_demo.head()
```

```
uid          reg_date        device   ...price
54030729     2017-06-29      and      ...499
```

Next steps

- Aggregate combined dataset
- Calculate the potential KPIs



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Exploratory analysis of KPIs

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KPIs

- **Reminder**: conversion rate is just one KPI
- Most companies will have many KPIs
- Each serves a different purpose

Methods for calculating KPIs

Group: `pandas.DataFrame.groupby()`

```
DataFrame.groupby(by=None, axis=0, level=None,
                  as_index=True, sort=True,
                  group_keys=True, squeeze=False, **kwargs)
```

Aggregate: `pandas.DataFrame.agg()`

```
DataFrame.agg(func, axis=0, *args, **kwargs)
```

Grouping Data: .groupby()

- `by` : fields to group by
- `axis` : `axis=0` will group by columns, `axis=1` will group by rows
- `as_index` : `as_index=True` will use group labels as index

```
# sub_data_demo - combined demographics and purchase data
sub_data_grp = sub_data_demo.groupby(by=['country', 'device'],
                                     axis=0,
                                     as_index=False)

sub_data_grp
```

```
<pandas.core.groupby.DataFrameGroupBy object at 0x10ec29080>
```

Aggregating data - mean price paid per group

```
# Mean price paid for each country/device
sub_data_grp.price.mean()
```

```
    country    device    price
0    BRA         and        312.163551
1    BRA         iOS        247.884615
2    CAN         and        431.448718
3    CAN         iOS        505.659574
4    DEU         and        398.848837
```

Aggregate data: .agg()

Pass the name of an aggregation function to `agg()` :

```
# Find the mean price paid with agg
sub_data_grp.price.agg('mean')
```

```
    country    device    price
0    BRA         and        312.163551
1    BRA         iOS        247.884615
2    CAN         and        431.448718
3    CAN         iOS        505.659574
4    DEU         and        398.848837
```

.agg(): multiple functions

Pass a list of names of aggregation functions:

```
# Mean and median price paid for each country/device
sub_data_grp.price.agg(['mean', 'median'])
```

```
                        mean      median
country device
BRA      and         312.163551     0
         iOS         247.884615     0
CAN      and         431.448718     699
         iOS         505.659574     699
DEU      and         398.848837     499
         iOS         313.128000     0
```

.agg(): multiple functions, multiple columns

Pass a dictionary of column names and aggregation functions

```
# Calculate multiple metrics across different groups
sub_data_grp.agg({'price': ['mean', 'min', 'max'],
                  'age': ['mean', 'min', 'max']})
```

	country	device	price			age		
			mean	min	max	mean	min	max
0	BRA	and	312.163551	0	999	24.303738	15	67
1	BRA	iOS	247.884615	0	999	24.024476	15	79
2	CAN	and	431.448718	0	999	23.269231	15	58
3	CAN	iOS	505.659574	0	999	22.234043	15	38
4	DEU	and	398.848837	0	999	23.848837	15	67
5	DEU	iOS	313.128000	0	999	24.208000	15	54

.agg(): custom functions

```
def truncated_mean(data):
    """Compute the mean excluding outliers"""
    top_val = data.quantile(.9)
    bot_val = data.quantile(.1)
    trunc_data = data[(data <= top_val) & (data >= bot_val)]
    mean = trunc_data.mean()
    return(mean)

# Find the truncated mean age by group
sub_data_grp.agg({'age': [truncated_mean]})
```

```
    country    device    age
                            truncated_mean
0    BRA         and                22.636364
...
```

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Calculating KPIs - a practical example

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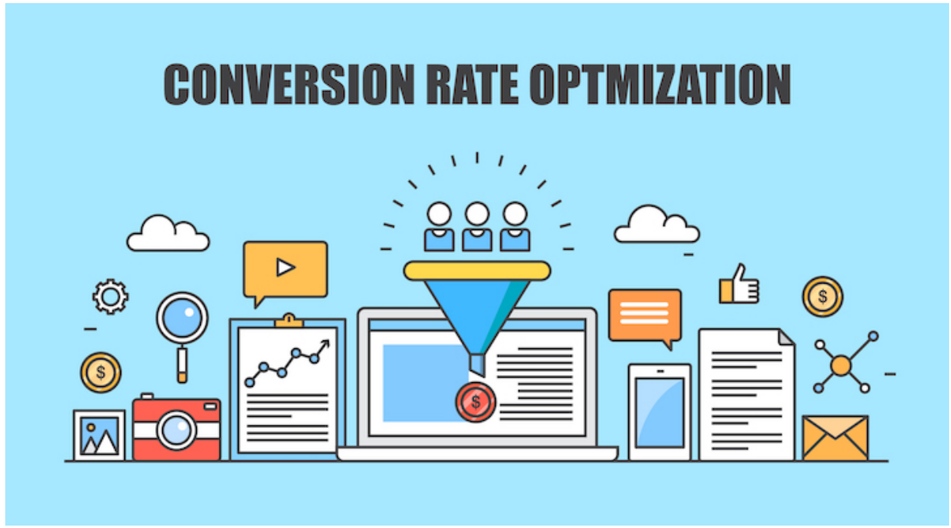
Goal - comparing our KPIs

- **Goal**: Examine the KPI "user conversion rate" after the free trial
- **Week One Conversion Rate**: Limit to users who convert in their first week after the trial ends



Conversion rate : maximum lapse date

```
import pandas as pd
from datetime import datetime, timedelta


current_date = pd.to_datetime('2018-03-17')
```

- **Lapse Date**: Date the trial ends for a given user

```
# What is the maximum lapse date in our data
print(sub_data_demo.lapse_date.max())
```

```
'2018-03-17'
```

KPI calculation : restrict users by lapse date

```
# latest lapse date: a week before today
max_lapse_date = current_date - timedelta(days=7)

# restrict to users lapsed before max_lapse_date
conv_sub_data = sub_data_demo[(sub_data_demo.lapse_date < max_lapse_date)]

# count the users remaining in our data
total_users_count = conv_sub_data.price.count()
print(total_users_count)
```

```
2787
```

KPI calculation: restrict subscription date

```
# latest subscription date: within 7 days of lapsing
max_sub_date = conv_sub_data.lapse_date + timedelta(days=7)


# filter the users with non-zero subscription price
# who subscribed before max_sub_date
total_subs = conv_sub_data[
    (conv_sub_data.price > 0) &
    (conv_sub_data.subscription_date <= max_sub_date)
]
# count the users remaining in our data
total_subs_count = total_subs.price.count()
print(total_subs_count)
```

```
648
```

KPI calculation: find the conversion rate

- **Conversion Rate**: *Total Subscribers / Potential Subscribers*

```
# calculate the conversion rate with our previous values
conversion_rate = total_subs_count / total_users_count

print(conversion_rate)
```

```
0.2325080731969859
```

Cohort conversion rate

```
# Create a copy of our dataframe
conv_sub_data = conv_sub_data.copy()

# keep users who lapsed prior to the last 14 days (2 weeks)
max_lapse_date = current_date - timedelta(days=14)
conv_sub_data = sub_data_demo[
    (sub_data_demo.lapse_date <= max_lapse_date)
]
```

Cohort conversion rate

- **Sub Time**: How long it took a user to subscribe

```
# Find the days between lapse and subscription if they
# subscribed ... and pd.NaT otherwise
sub_time = np.where(
        # if: a subscription date exists
            conv_sub_data.subscription_date.notnull(),
        # then: find how many days since their lapse
            (conv_sub_data.subscription_date - conv_sub_data.lapse_date).dt.days,
        # else: set the value to pd.NaT
            pd.NaT)
# create a new column 'sub_time'
conv_sub_data['sub_time'] = sub_time
```

Cohort conversion rate

- `gcr7()` , `gcr14()` : calculate the 7 and 14 day conversion rates

```
# group by the relevant cohorts
purchase_cohorts = conv_sub_data.groupby(by=['gender', 'device'], as_index=False)

# find the conversion rate for each cohort using gcr7,gcr14
purchase_cohorts.agg({sub_time: [gcr7,gcr14]})
```

```
    gender    device    sub_time
                 gcr7    gcr14
0    F    and    0.221963    0.230140
1    F    iOS    0.229310    0.237931
2    M    and    0.252349    0.257718
3    M    iOS    0.218045    0.225564
```

How to choose KPI metrics?

- Infinitely many potential KPIs
- How long does it take to determine
  - Monthly Conversion Rate = *1 Month Wait time*
- Leverage Exploratory Data Analysis
  - *Reveals relationships between metrics and key results*
- **Keep In Mind** How do these KPIs and my Business goals relate

Why is conversion rate important?

- Strong measure of growth
- Potential early warning sign of problems
  - Sensitive to changes in the overall ecosystem

Next chapter: continue exploring conversion rates

- How does this KPI evolve over time?
- See how changes can impact different groups differently

Let's practice!

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