



Search & Recommenders IRL

@Albert Heijn

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2022-05-19



Data Science at Albert Heijn



Data Science Lead (Digital)
Search & Recommendations

Background in Natural
Language Processing &
Computer Science

Data Science Teams at AH:

- DS Digital
- DS Operations
- DS Commerce
- DS MLE

We also have 3 Analytics teams (also in the areas Digital, Operations and Commerce).

Data Science at Albert Heijn

Besides Search & Recommendations, what kinds of business problems do we try to solve?

- "How many cucumbers should store 123 order for day XYZ?"
- "What is roughly the time needed for the AH delivery van to stop at address XYZ?"
- "When and how many croissants do we need to bake in store XYZ so that we balance freshness and food waste?"
- "Product X in store Y is expiring today. What discount should we give so that it still gets sold in-time before we have to throw it away?"
- "What is the ideal promotion period and type for product X?"
- "Product X doesn't sell well. If we discontinue it, what other products could replace it and how much sales would we lose?"
- "What advice can we give to the category manager responsible for frozen products so that he/she can reach his sales target?"
- ...

Search & Recommenders at AH

Producten Bonus Recepten Meer ▾ Online bestellen Mijn profiel 0.00

Nutri-Score

- Score A (46)
- Score B (14)
- Score C (13)

Toon meer

Merk

- Voordeelpakken 8 NIEUW 1

Afdeling

- Houdbaar 1
- Near food 1
- Vers 15

Toon meer

Graansoort

- Rijst (180)
- Mais (31)
- Tarwe (29)

Anderen kochten ook

- Jasmijn, pandanrijst 0.89
- Basmatirijst 1.69
- Rijst met toevoegingen 1.69
- Toon meer

Relevante

11:39 80%

Maak compleet

Niets vergeten?

- AH Paprika mix 2.09 3 stuks +
- AH Romaatje 1.99 250 g +
- AH Kastanjechampignons 2.09 400 g +
- Oatly! Verse Haverdrank Vol 1.99 1 l +
- AH Biologisch Vegan tofu nat... PREMIUM 10% KORTING 1.27 1.14 375 g +

17.70 58.77

Volgende

4 ⋮

Zoek op merk

Princes [5]
John West [3]
Reddy [3]

Toon meer ▾

Smaak

- Zonnebloemolie 18 AH Zonnebloemolie Tijdelijk uitverkocht Kies alternatief ▾
- John West Tonijnstukken in zonnebloemolie 2.99 345 g
- AH Biologisch Zonnebloemolie 3.49 314 g Tijdelijk uitverkocht Kies alternatief ▾
- Reddy Zonnebloemolie 3.29 11 Tijdelijk uitverkocht Kies alternatief ▾

Toevoeging

Kies een alternatief

- AH Sesamolie 2.69 250 ml
- AH Olijfolie 4.59 500 ml
- AH Oosterse wok olie 3.49 500 ml
- AH Olijfolie mild 3.79 500 ml
- John West Tonijnstukken in zonnebloemolie 2.29 145 g

11:40 80%

Activeer nog 8 aanbiedingen!

BONUS BOX 2e GRATIS

Alle AH en Proper popcorn 2 verpakkingen vanaf maandag 1.99 3.98

Mijn Bonus Box

Met deze week nog meer 2e gratis

BONUS BOX 2e GRATIS

Alle Zuivelhoeve 2 verpakkingen vanaf maandag

Home Bonus Koken Producten Bestelling 28

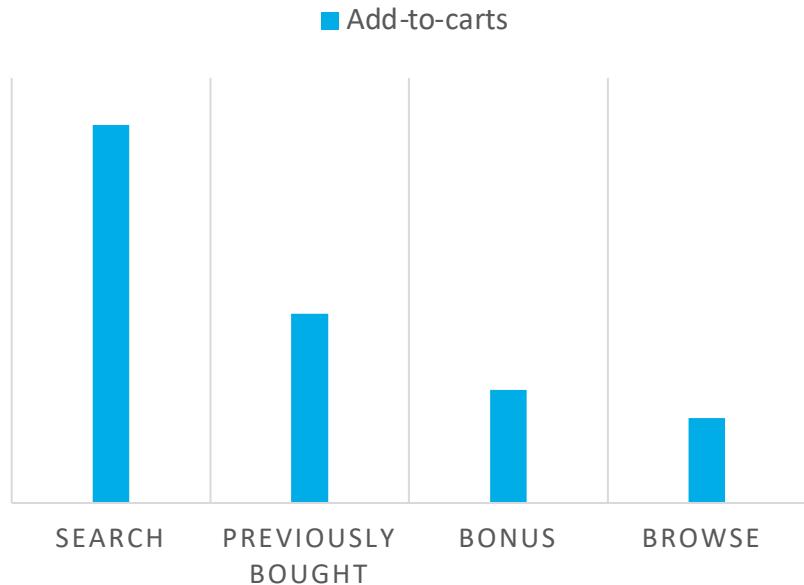
Why group search and recommenders together?

- Both have the same goal: connecting the users to their needs
 - Search: Users express their information needs explicitly through a query
 - Recommender: Query is implicitly specified, e.g., the user itself can be considered a query, or a specific product of interest
- Similar methods and evaluation metrics (ranking metrics etc.)
- The boundary between the two is becoming increasingly blurry...

Why are we working on search and recommenders? What is the goal?

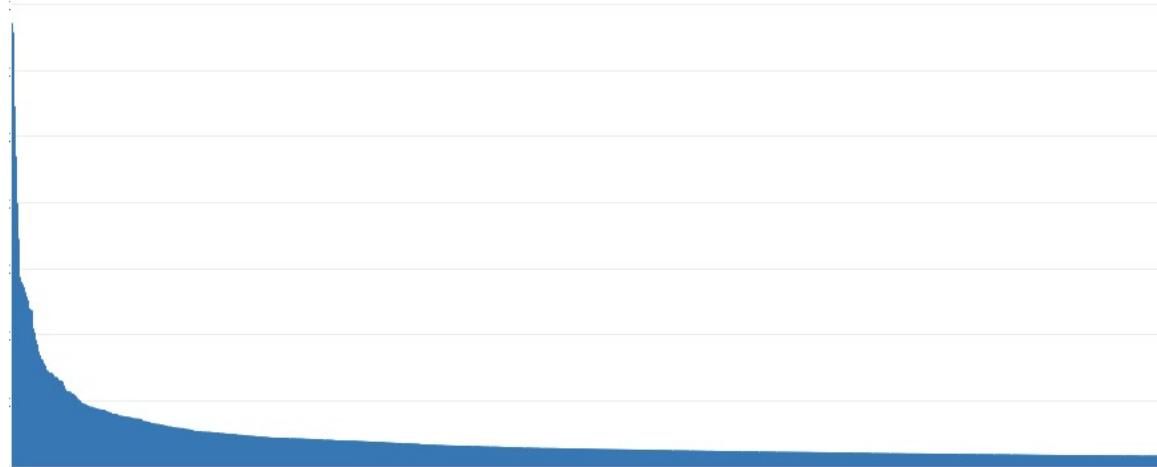
Inspiration

ADD-TO-CARTS ON WEB

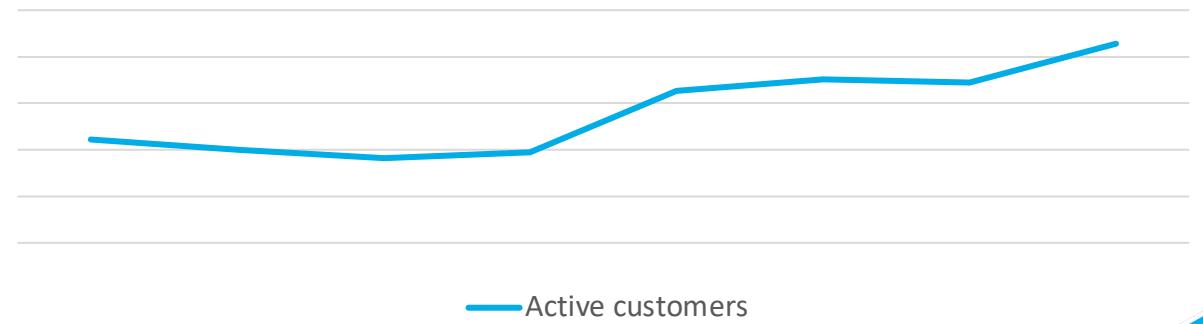


Customer Effort

Product add-to-cart distribution



Active customers



Loyalty

Goal of this talk

What does it take to deliver a successful search/recommender?

Why is it more than just what you learn in a typical ‘ML Algorithms’ class at university?

- Experimentation
- Metrics and stakeholders
- Offline evaluation
- Part of a bigger value chain: upstream and downstream components
- Deploying models to production and after

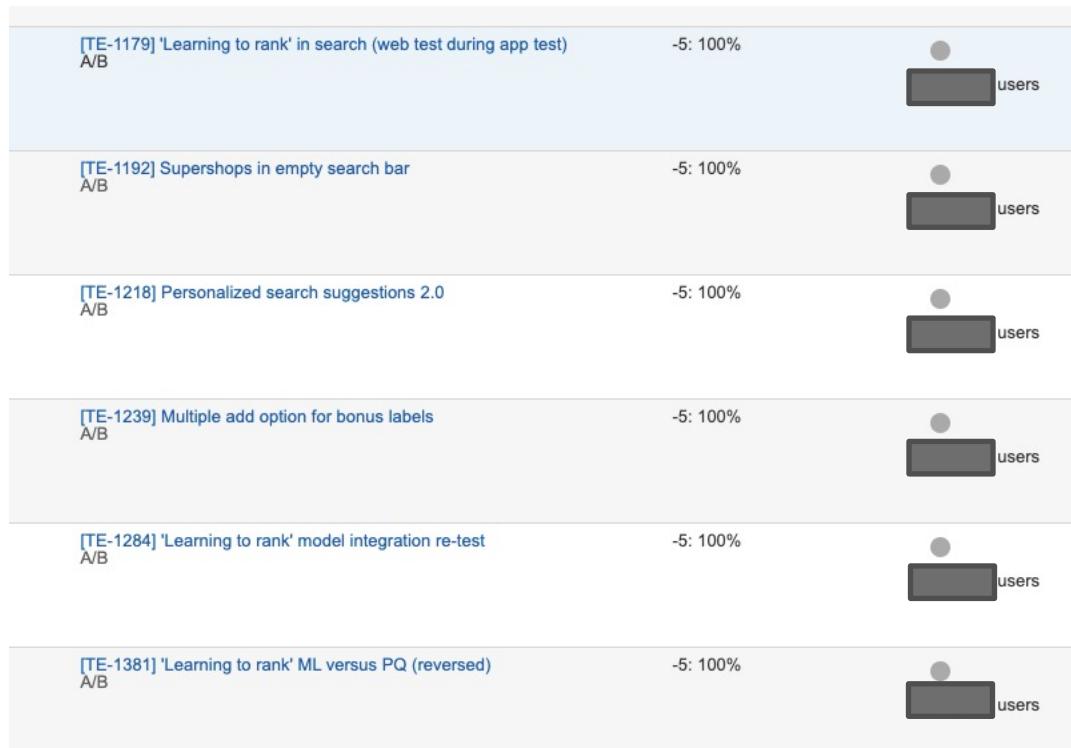


Mentimeter open question:
How will you know if the solution you
built is successful?
What general approach could you take?

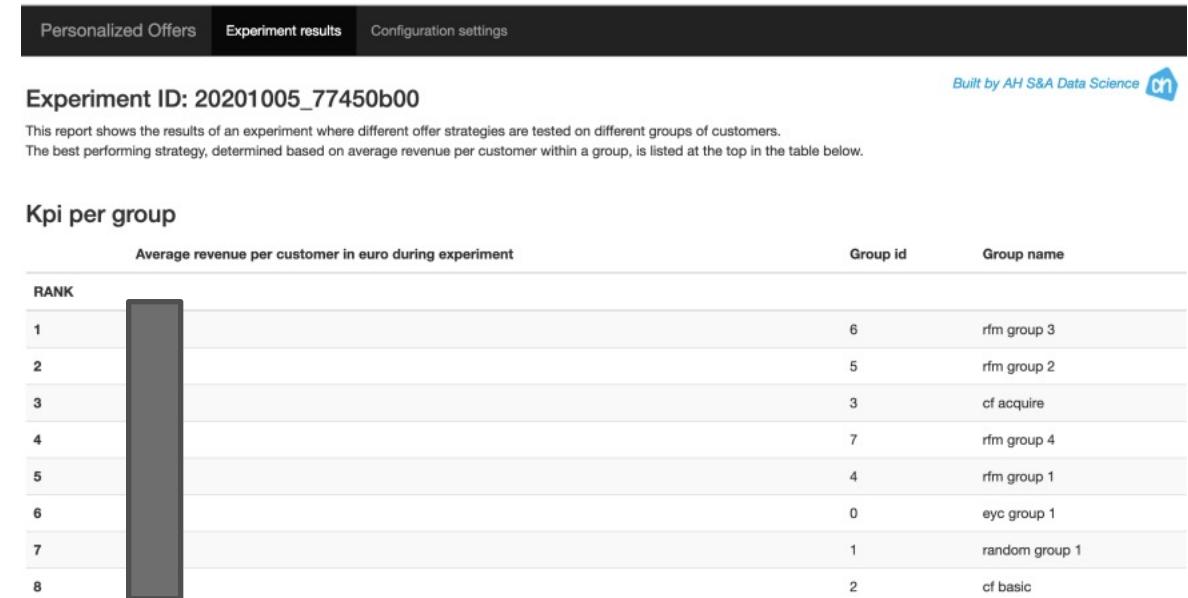
Measuring success requires experimentation (and tooling that supports it)

We run experiments set up as A/B tests (same idea as randomised controlled trials).

A/B testing framework for the website



A/B testing framework for Bonus Box

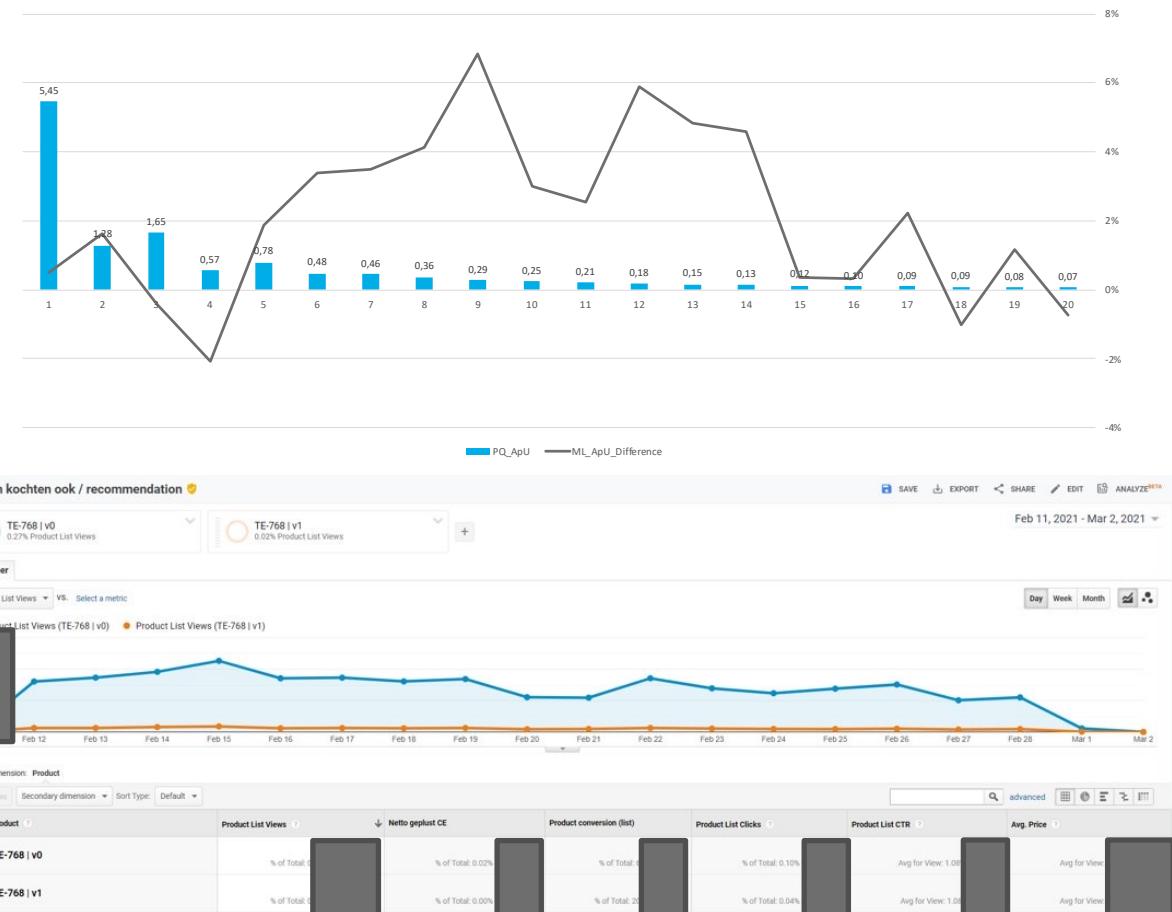


Measuring success requires experimentation (and tooling that supports it)

Knowledgebase of previously run A/B tests

Personal cross-sell (Web) (Pop-up leidend)	TE-446
Cross-sell uitzetten (feb. 2020)	TE-476
Cross-sell: 'Niets vergeten?' lane on Maak compleet page above and below Kassakoopjes (app)	TE-1220 Online
Cross-sell: New algorithm behind Niets vergeten lane (RFM: 3, 1, 1) (web)	TE-1428 Online
Cross-sell: Hide Niets vergeten? lane on Maak compleet page (reversed test) (web)	TE-1465 Online
Cross-sell: Hide Andere Soorten (app)	TE-1406 Online
Cross-sell: 'Niets vergeten?' New model: RFM (1, 1, 1) (web)	TE-1427 Online
Cross-sell: New recommendations model - 'Anderen kochten ook' P2V KM (web)	TE-1271 Online
Cross-sell: 'Niets vergeten?' boven Kassakoopjes (web)	TE-1269 Online
Cross-sell: API test Anderen kochten ook	TE-1390 Online
Cross-sell: Kassakoopjes in List view vs Carousel view (App)	TE-1321 Online
Cross-sell: Increase exposure to cross-sell popup by adding pages (bonus, eerder gekocht, home, /shop)	TE-1030 Online
Cross-sell: 'Niets vergeten?' personalized lane on Maak compleet page V3 (RFM, 1, 3, 1) (web)	TE-1268 Online
Cross-sell: Add recipe cards on PDP (web)	TE-1018 Online
Cross-sell: Updated algorithm 'Anderen kochten ook' (sequences) (web)	TE-988 Online
Cross-sell: Niets vergeten? personalized lane on Maak compleet page vs No Lane (web)	TE-1290 Online

Experiment deepdives





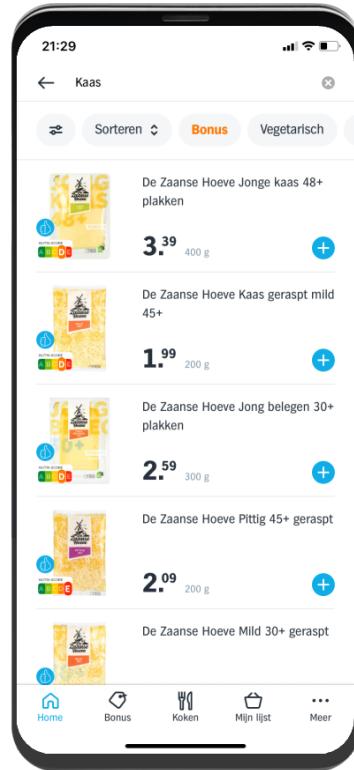
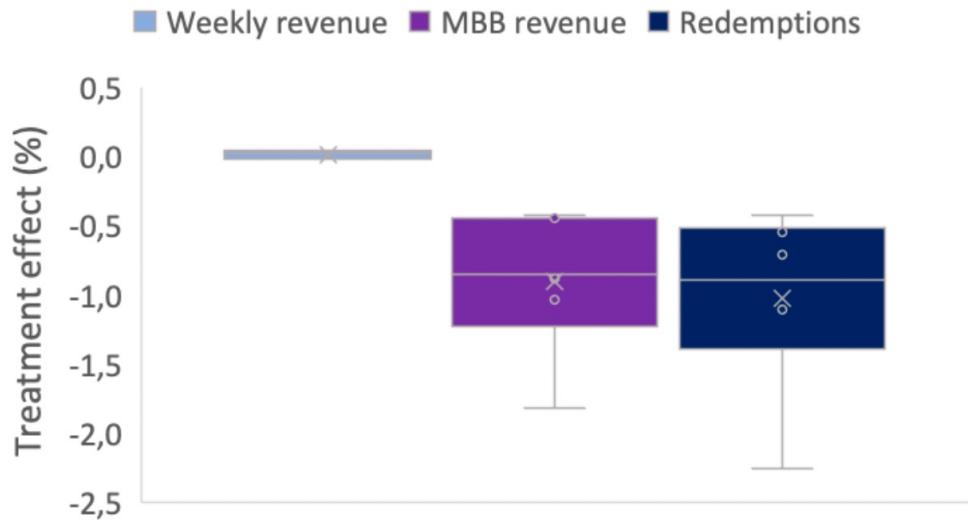
Mentimeter open question:
What metric(s) would you use to
measure the success of the “Andere
kochten ook” lane?

Choosing a good metric is hard

- What makes a good metric?
 - Measurable / feasible to implement
 - Contributes to business success
 - Unambiguous in direction
 - Sensitive to our solution
 - Tight feedback loop
 - Low variability
- Search:
 - Average order value (AOV) / basket value
 - Order conversion rate (OCR)
 - Add-to-cart rate
 - Ranking metrics
- Cross-sell lanes:
 - Average order value / basket value
 - Add-to-cart rate from the lane
 - Ranking metrics
- Bonus Box:
 - Revenue per customer overall
 - BB revenue overall, BB revenue per customer
 - Customer with redemptions, number of redemptions per customer
 - Number of activations per customer
 - Ranking metrics

When different metrics tell different stories ...

Sometimes business stakeholders may only care about top-line metrics, but beware that it usually doesn't tell the full story:



Top-line KPIs:

- Average order value: n/s
- Order conversion rate: n/s

Lower level KPIs:

- Add-to-cart rate: **+3.67%**
- Avg. add-to-cart position: **-1.31%**
- Avg. add-to-cart price: **-2.59%**

Offline evaluation to choose a model to be tested

- How can we identify the most promising model we want to test online **before** we test it online?
- → Offline evaluation, i.e., quantitative evaluation usually based on historical data
- However, for recommenders this is usually difficult: If our new model recommends a product that a user has never bought before, does it automatically mean that the recommended product is not relevant for the user?
- Complement with qualitative methods:

	NASANbr	ItemDescrLong	MIAC	Similarity
1	767833	Ysco beker vanille light met stevia	dieetjjs	1
2	578631	Speculaas met stukjes amandel	suikerbewust	0.7934571504592896
3	94078	Koffiewafels sb	suikerbewust	0.7798566818237305
4	829573	WEB chocoffee zonder suiker	suikerbewust	0.778068482875824
5	565820	Reep melk	suikerbewust	0.7772800326347351
6	645258	Hagelslag melk	suikerbewust	0.773036777973175
7	853121	Koek framboos & rooibos sv	suikerbewust	0.771142303943634
8	839544	Orange delight sb	suikerbewust	0.7680001258850098
9	24924	SB mini cake citroen	glutenvrij	0.7678442001342773
10	727006	Oppo White Chocolate Sticks	handijs room	0.7654337882995605
11	853118	Double delight sb	suikerbewust	0.7622836828231812

	NASANbr	ItemDescrLong	Similarity
1	21100	Zoete Spaanse wijn	1
2	637960	Spatlese nahe	0.8584262728691101
3	13678	Vruchtenwijn framboos bessen	0.8554828763008118
4	613976	Whisky cream original	0.8476563096046448
5	811454	Moscatel blanco verano sweet white wine	0.8369296193122864
6	31015	Canei spark white	0.8091043829917908
7	644573	Graves superieures	0.8031729459762573
8	538633	Red fruit	0.8019835948944092
9	722585	Mosel Weisswein	0.7955172061920166
10	21076	Selection clemence blanc	0.792765200138092
11	844831	Amaretto	0.7902275919914246



Our solution is only one part of a bigger
value chain.

Many things outside of our control may
not go as expected.

When there is an issue with the input data...



There was an error in your Azure Databricks job run

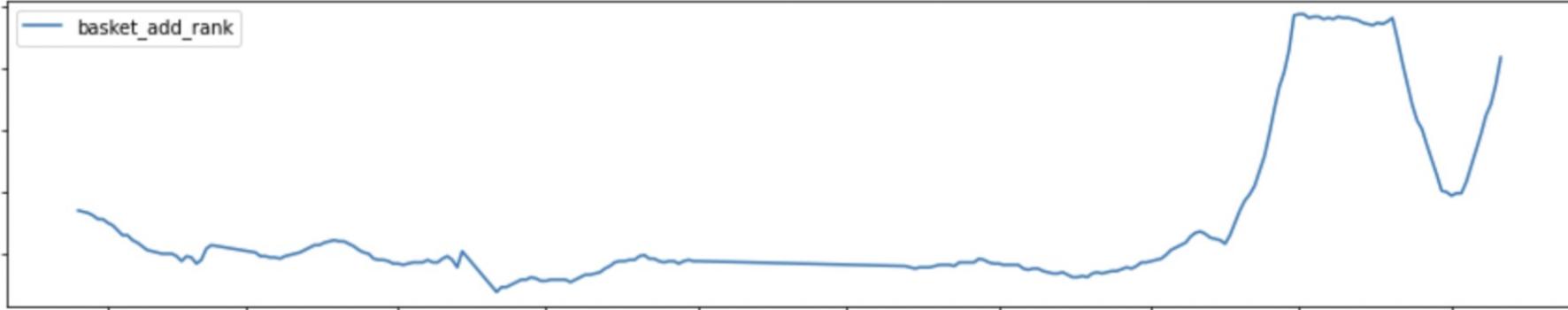
We're sorry—there was an error in your run. Run number 2864644 of po-main has terminated with the error: Run failed..

[Check the error on this run >](#)

	A	B	C
1	Week	OfferID	CLUSTER
15	2022-11	910234	LNDNL
16	2022-12	914922	LNDNL
17	2022-13	911844	LNDNL
18	2022-13	911864	LNDNL
19	2022-13	911876	LNDNL
20	2022-14	912771	LNDNL
21	2022-16	917918	LNDNL
22	2022-17	915331	LANDLK
23	2022-18	917950	BELGIE
24	2022-18	917194	BELGIE
25	2022-18	918034	BELGIE
26	2022-18	919342	LANDLK
27	2022-19	916781	LANDLK
28	2022-19	917263	LANDLK
29	2022-19	917260	LANDLK
30	2022-20	918955	LANDLK
31	2022-21	920043	LANDLK
32	2022-22	920486	LANDLK
33	2022-23		
34	2022-24		
35	2022-25		

Manual input can have many unexpected edge cases

When there is an issue with the input data...



Product List Name	zoeken														
Product Views	Week of Year														
Position in search result	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46
1	10956	11212	12044	11688	10573	11503	4603	1002	751	606	672	9876	7770	746	2875
2	10819	11057	11861	11854	11189	11828	4550	1395	4584	4589	1841	9804	7714	724	2822
3	10260	10397	11242	10908	9867	10642	4381	989	795	755	794	9217	7341	811	2831
4	8943	9099	9869	9815	9361	9718	3673	1028	3653	3697	1440	7925	6236	506	2254
5	6381	6750	7174	6945	6576	6689	2627	370	355	303	349	5158	4350	1861	2964
6	6290	6644	7074	7184	7407	7130	6501	6018	3517	3735	5257	5828	6014	5553	5392
7	5757	6116	6458	6618	6881	6673	6178	5551	3271	3490	4897	5400	5719	6113	5924
8	5711	6076	6415	6773	7298	6930	6133	5684	4973	5226	5453	5371	5725	6189	6014
9	2382	2596	2752	3005	3155	3060	2468	2229	2090	2150	2310	2331	2443	2539	2543
10	2228	2439	2585	2848	2982	2893	2314	2088	1940	2023	2174	2193	2285	2391	2411
11	2209	2415	2560	2820	2953	2864	2295	2064	1921	1992	2152	2163	2242	2364	2380
12	2190	2389	2539	2795	2927	2844	2273	2044	1903	1975	2124	2140	2216	2348	2362
13	1384	1477	1553	1786	1816	1651	1444	1341	1260	1289	1403	1399	1427	1463	1517
14	1373	1467	1543	1791	1810	1625	1433	1330	1248	1276	1380	1380	1406	1447	1533
15	1350	1454	1528	1771	1783	1592	1417	1321	1238	1270	1367	1358	1390	1432	1514
16	1296	1407	1470	1682	1719	1547	1368	1281	1198	1235	1319	1312	1347	1394	1479
17	999	1045	1130	1279	1248	1109	999	950	925	947	995	992	971	1019	1075
18	406	400	406	377	347	343	152	107	899	919	971	945	941	1002	1050
19	392	382	382	365	334	332	405	278	6	11	266	343	341	393	422
20	386	377	379	395	417	384	141	40	351	357	122	7	3	3	3

A screenshot of an online grocery store search results page for "chiazaad". The search bar shows "chiazaad". The results list includes several items:

- AH Biologisch Chiazaad (Vegan, Premium 25% KORTING, 275 g, 3.99)
- AH Chiazaad (Vegan, Premium 25% KORTING, 125 g, 1.59)
- De Kleine Keuken Letterkoekjes met... (AH Verrijker chiazaad, 120 g, 2.79)
- AH Verrijker chiazaad (AH Verrijker chiazaad, 180 g, 2.25)
- AH Pijnboompitten (4.99)
- AH Slaverrijker gerosterde... (6.99)
- AH Pistachenoten (2.69)

The page also features a "Relevantie" dropdown and sections for "Ook wat voor jou?" featuring other products like pijnboompitten and pistachenoten.

Beware of downstream changes

22:06

← Zout

Jozo Naturel tafelzout	0.55	125 g	+
Klene Engelse drop	1.99	340 g	+
AH Keukenzout met jodium, bus	0.59	500 g	+
Klene Muntdrop	1.89	230 g	+
La Baleine Zeezout fijn	1.59	500 g	+
Klene Zakkenrollers			

Home Bonus Koken Mijn lijst Meer



Hertog Jan Natuurzuiver bier krat

24 x 30 cl Prijs per LT € 2,45

17.65

Voeg toe +

Hertog Jan pilsener is het visitekaartje van Hertog Jan. Gebrouwen van zacht water uit de Ardennen en van zorgvuldig geselecteerde hop en mout. Uit liefde voor bier.

- Categorie: pilsener
- Soort, smaak: vol, met een aangenaam bittere afdronk
- Brouwerij, plaats: Hertog Jan brouwerij, Arcen, Nederland
- Alcoholpercentage: 5.1%

Omschrijving

- BIER CAT.1

Alcoholpercentage: 5.1%

Extra informatie

Ons pilsener is het visitekaartje van Hertog Jan binnen de reeks bieren. Vanzelfsprekend selecteren we alle ingrediënten die we voor het brouwen gebruiken met de allerkroostste zorg. Alleen de rijkste mout, de mooiste hop en kristalhelder natuurzuiver water uit de Eifel zijn goed genoeg voor ons bier. Dankzij deze ingrediënten en natuurlijk de kunde van onze brouwers krijgt het bier die prachtige gouden kleur en vormt het een mooie, volle schuimkraag. Ons pils is een bier om trots op te zijn.

Anderen kochten ook



AH Fruitbox



Grolsch Pilsener krat



Beware of downstream changes

AH Kiwi groen



1 kg
prijs per kg € 3,19

3.19* Volg toe

Wat is Nutri-Score?

Een groene kiwi is fris van smaak en rijk aan vitamine C. Heerlijk door een fruitsalade of gewoon als gezond tussendoortje.

- Smaak kiwi heeft een frisse en lichtzure smaak.
- Bereiden: Halver de kiwi en eet met een lepel. Of schil de kiwi en maak er blokjes of schijfjes van.
- Bewaren: Buiten de koelkast.

Omschrijving

- KW

Inhoud en gewicht

1 Kilogram

Kenmerken

- Veganistisch
- Glutenvrij
- Lactosevrij

Ingrediënten

Waaran toegevoegde suikers 0,00g per 100 gram en waarvan toegevoegd sout 0,00g per 100 gram

Voedingswaarden

Dit product bevat geen bewerkte ingrediënten.

Soort	Per 100 Gram	RD*
Energie	250 kJ / 59 kcal	
Vet	0 g	
waarvan verzadigd	0,2 g	
waarvan onverzadigd	0,4 g	
Koolhydraten	11 g	
waarvan suikers	10 g	
Voedingsvezel	2,3 g	
Eiwitten	0,7 g	
Zout	0 g	
Folat	34,2 µg	171%
Vitamine C	79 mg	98,8%
Potassium	372 mg	15,6%

*Referentie-inname voor een volwassen vrouw is 8400 kJ / 2000 kcal

Bewaren

Herkomst

Contactgegevens

AH Rode peper



per stuk
0,45

Volg toe

Wat is Nutri-Score?

Rode peper ook wel Spaanse peper genoemd, is een verzamelaar voor de bekende rode lange en slanke chilipeper. Daarom dankt zijn smaak aan een stof dat capsicine heet. -Rode peper heeft een zeer pikante smaak. Bewaren thuis in de koelkast.

Omschrijving

- Rode peper

Inhoud en gewicht

1 Stuk(s)

Kenmerken

- Veganistisch
- Glutenvrij
- Melkvrij

Contactgegevens

Andere soorten

Soort	Per 100 Gram	RD*
AH Jalapeño peper groen	0,16	1,4%
AH Jalapeño peper groen 4...	0,16	1,4%
AH Jalapeño peper rood	0,35	3%
AH Adjika peper	0,24	2%
AH Ají amarillo	1,38	11,6%
AH Ají amarillo 4 pack	1,38	11,6%
AH Roma tomaten	2,58	21,5%
AH Bosui	0,45	3,8%
AH Bokkegroot Plessiespoen	2,25	19,5%
AH Bokkegroot Suisstelen	1,71	15,6%
AH Platte petensels...	1,19	10,6%
AH Citroen	1,19	10,6%

Anderen gekochte ook

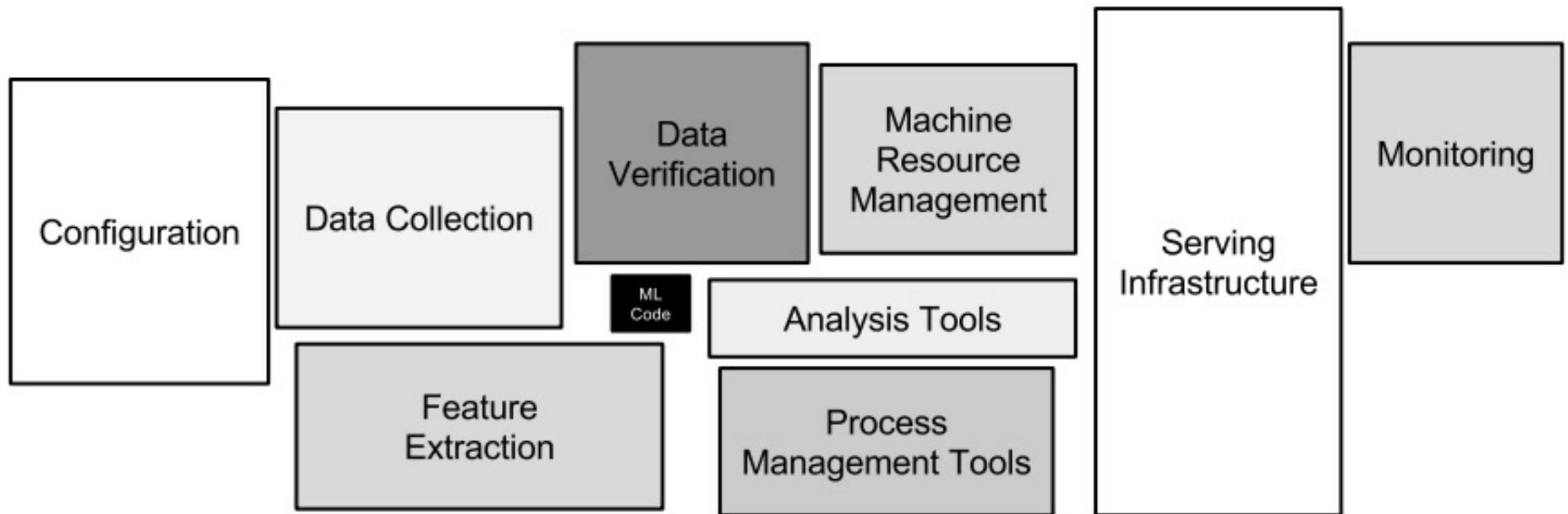
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AH Bosui	0,45	3,8%
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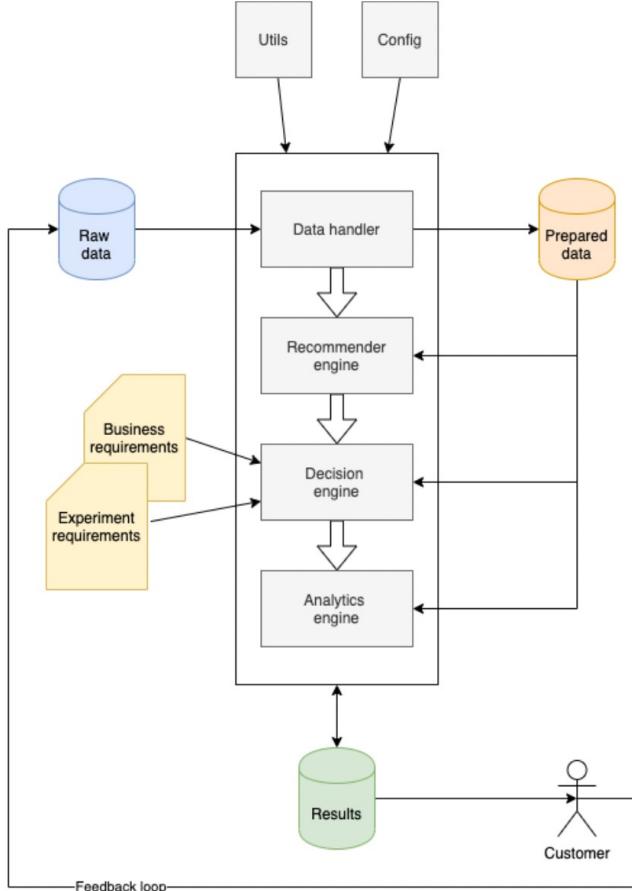
Building production-grade systems
requires many more components than
just the algorithm.

Deploying models to production

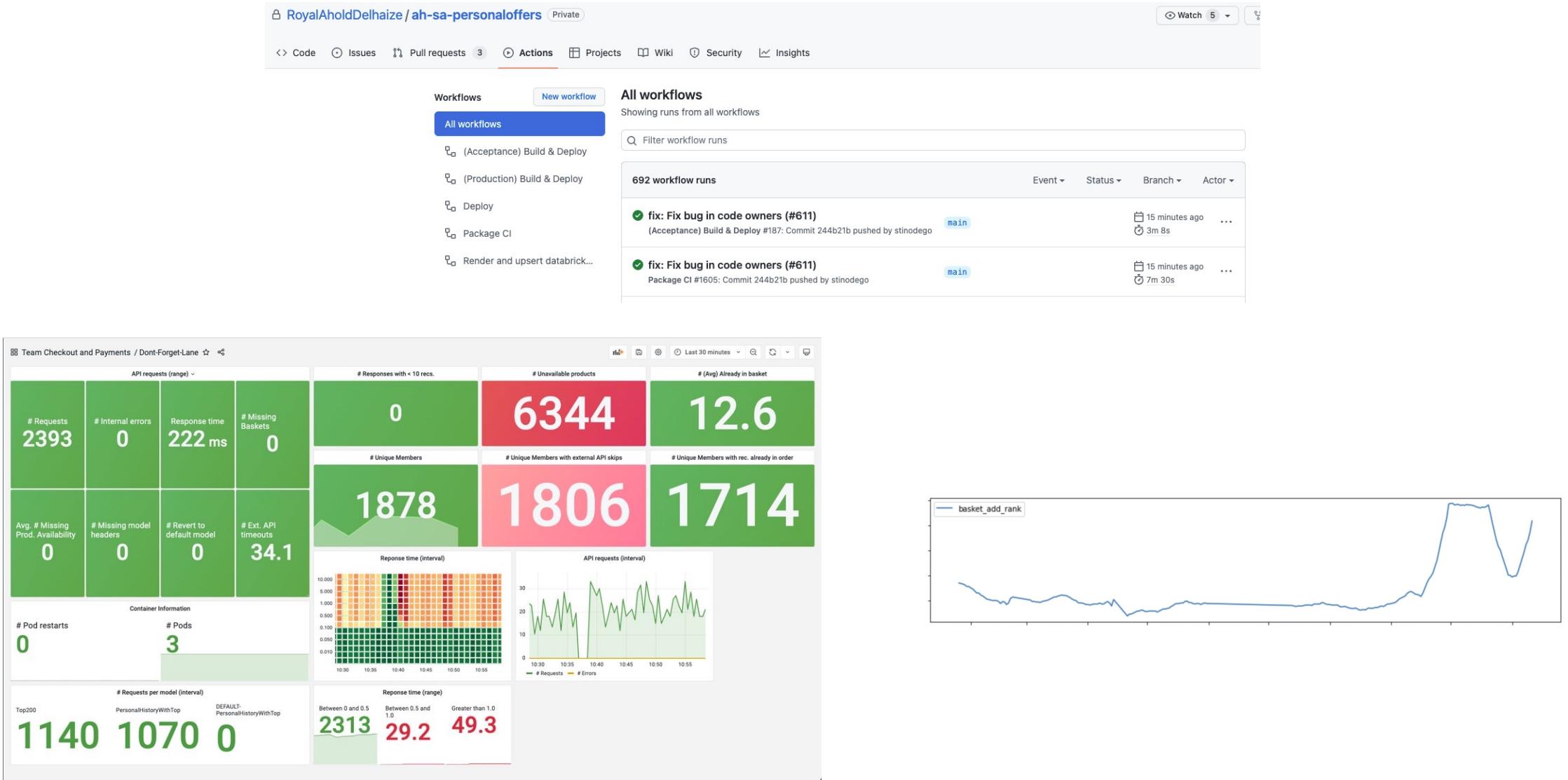
- Systems dimension: testing, monitoring, alerting
- Process dimension: e.g., aligning on interfaces, how to organise updates, ownership questions, SLAs, ...
- People dimension: e.g., working with back-end/front-end engineers, different skillsets and priorities



Data science solutions are software solutions



Data science solutions are software solutions



Building data science solutions in cross-functional teams

- Our search team:
 - 0.5 DS product owner, 0.5 DS lead
 - 3 data scientists
 - 3 back-end engineers
 - 1 CRO analyst
 - Additional support from web analysts for specific hypotheses
- Our recommendations team:
 - 1 product owner, 0.5 DS lead
 - 3 data scientists
 - 2 machine learning engineers
 - 2 analysts
 - 1 CRO analyst

Review the goal of this talk

Do you now have an idea of what it takes to deliver a successful search/recommender?

And why it is more than just what you learn in a typical ‘ML Algorithms’ class at university?

- Experimentation
- Metrics and stakeholders
- Offline evaluation
- Part of a bigger value chain: upstream and downstream components
- Deploying models to production and after



Thank you for your attention.

Questions?

Dat is het *lekker*e van Albert Heijn 