Brand Tracking with Bayesian Models and Metaflow

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How many people have heard of our brand?

TIER

headspace

monday.com

Blinkist

duolingo

N26

EPIC GAMES

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How well known is the brand in target group?

How do people perceive the brand?

Have there been changes?

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What makes Brand Tracking difficult?

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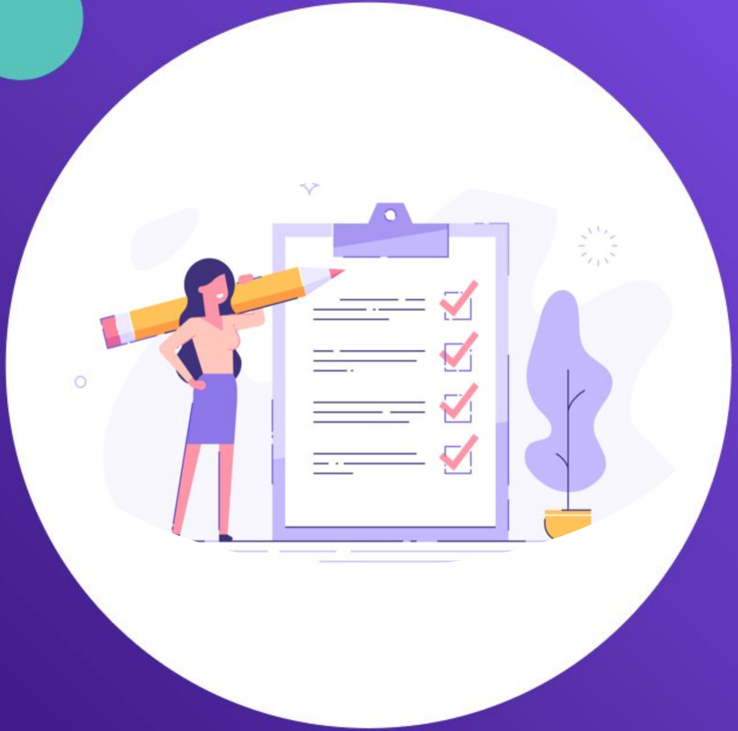
Survey Problems

- Small target groups
- Signal or Noise?
- Representativeness of respondents



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Traditional Approaches

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Weighting

	18-30	30-60	60+
♀			
♂			

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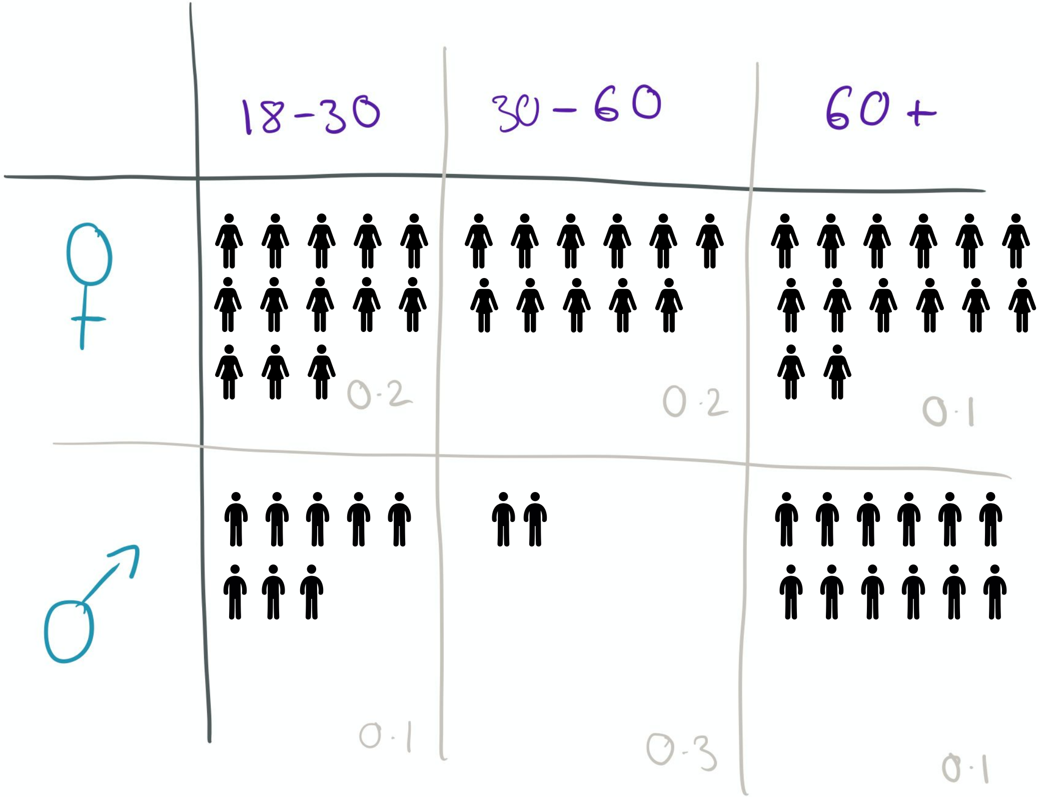
Weighting

	18-30	30-60	60+
♀	0.2	0.2	0.1
♂	0.1	0.3	0.1

Weighting



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Quota Sampling

	18-30	30-60	60+
♀	200	200	100
♂	100	300	100

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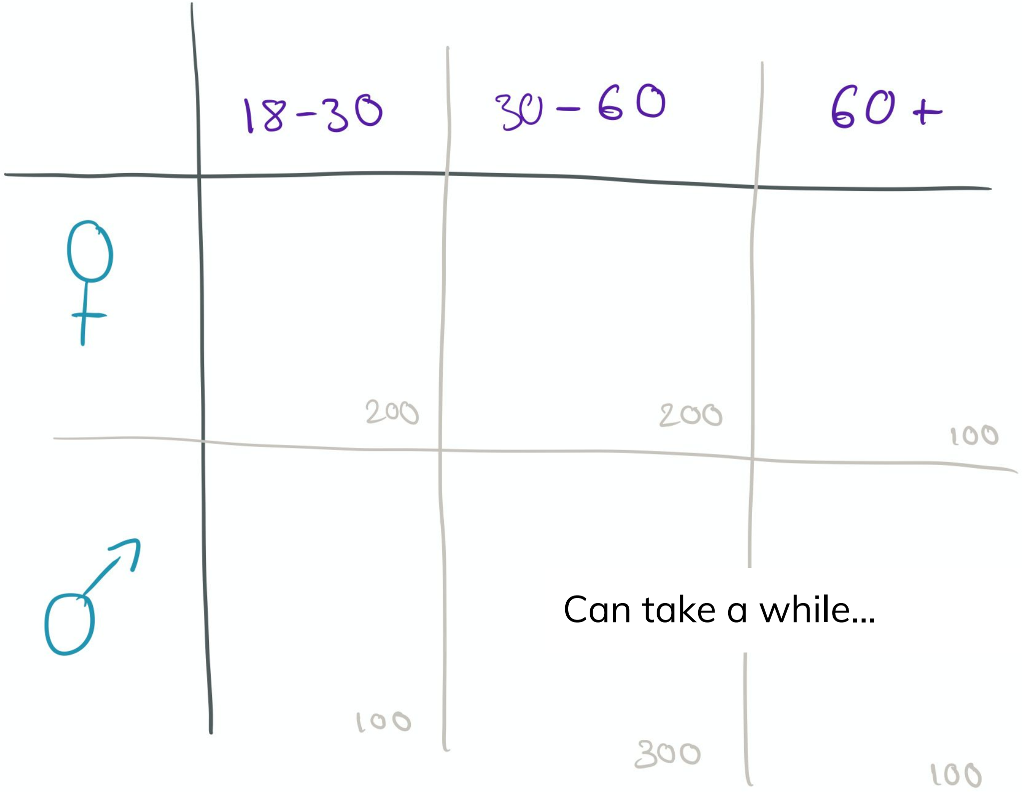
Quota Sampling



Can take a while...

Introducing: Mr. P
Multilevel Regression & Poststratification

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Multilevel Regression

Multilevel Regression

knows brand $\sim$ Bernoulli(p)

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Multilevel Regression

$$\text{knows brand} \sim \text{Bernoulli}(p)$$

$$\text{logit}(p) = \alpha_{[\text{gender}]} + \beta_{[\text{age}]}$$

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Multilevel Regression

$$\text{knows brand} \sim \text{Bernoulli}(p)$$

$$\text{logit}(p) = \alpha_{[gender]} + \beta_{[age]}$$

$$\alpha_{[gender]} \sim \text{Normal}(\mu_\alpha, \sigma_\alpha)$$

$$\beta_{[age]} \sim \text{Normal}(\mu_\beta, \sigma_\beta)$$

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Multilevel Regression

$$\text{knows brand} \sim \text{Bernoulli}(p)$$

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$$\mu_\alpha, \mu_\beta \sim \text{Normal}(0, 1)$$

$$\sigma_\alpha, \sigma_\beta \sim \text{Normal}_+(0, 1)$$

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Multilevel Regression

$$\text{knows brand} \sim \text{Bernoulli}(p)$$

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Multilevel

$$\alpha_{[gender]} \sim \text{Normal}(\mu_\alpha, \sigma_\alpha)$$

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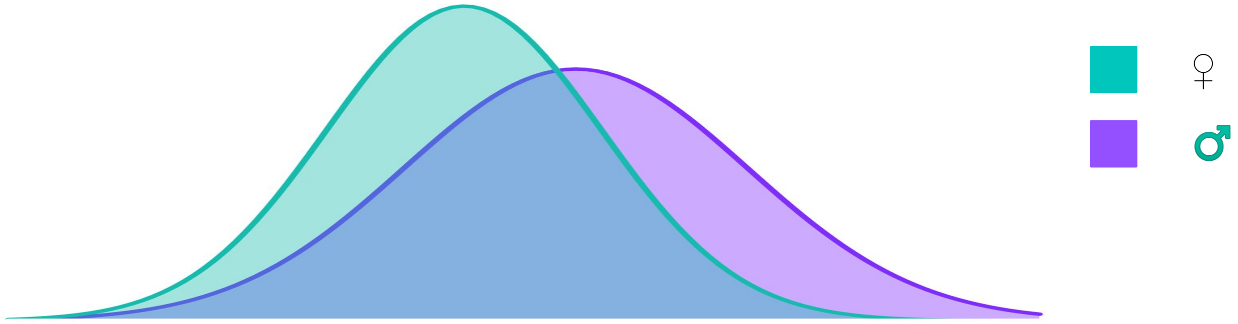
Multilevel Regression



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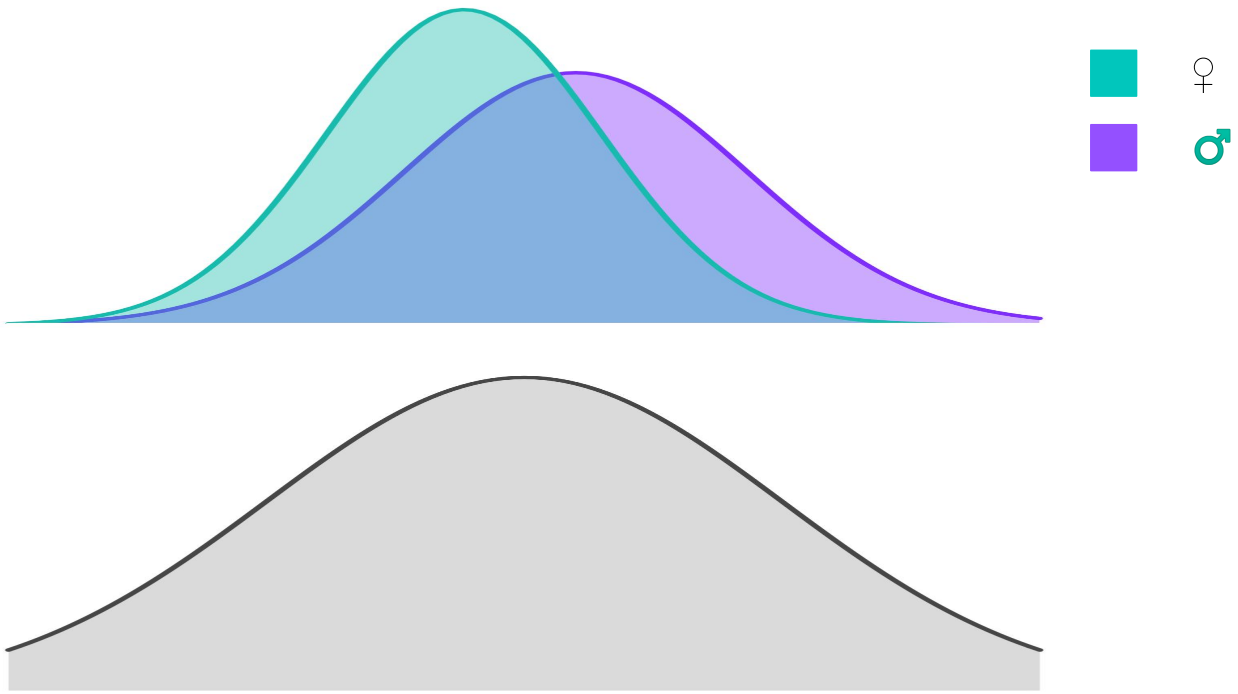
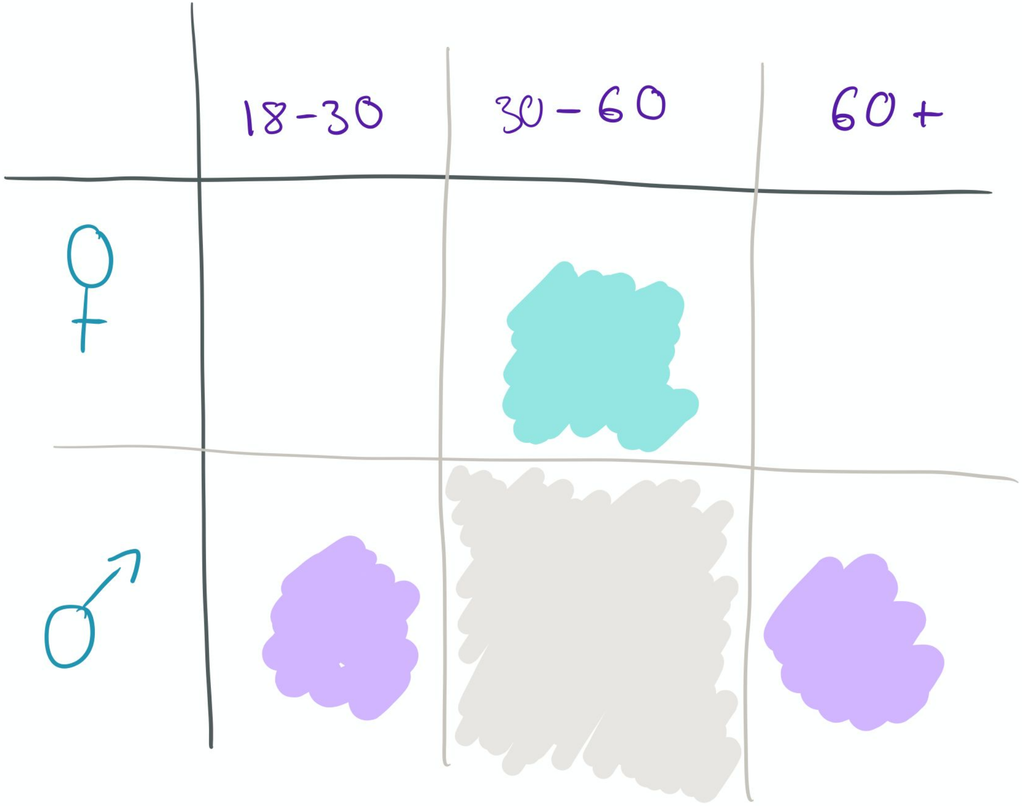
Multilevel Regression



Multilevel Regression



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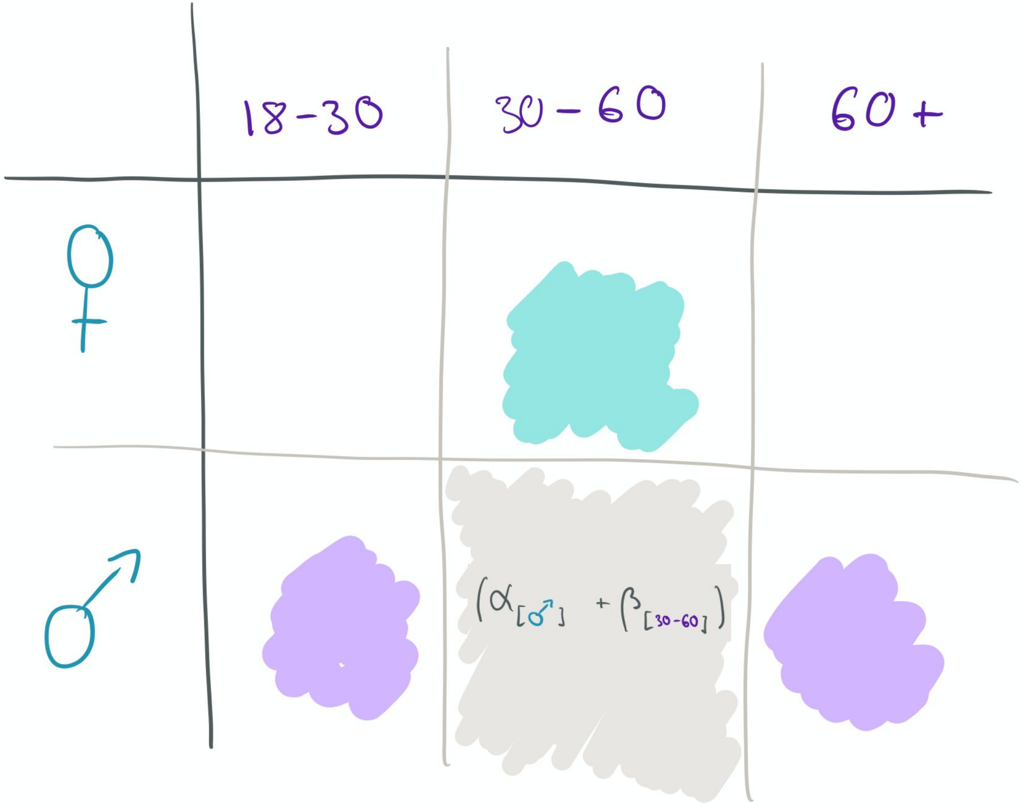
Multilevel Regression



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Poststratification

Poststratification

	18-30	30-60	60+
♀	0.2	0.2	0.1
♂	0.1	0.3	0.1

Poststratification

Total proportion of people that know brand = 0.5 × Proportion of men that know brand + 0.5 × Proportion of women that know brand

Weight

Prediction from our Model

Poststratification

Total proportion of people that know brand $= 0.5 \times$ Proportion of men that know brand $+ 0.5 \times$ Proportion of women that know brand

P(gender)

P(knows brand | gender)

Poststratification

$$\begin{pmatrix} 0.75 \\ 0.71 \\ \vdots \\ 0.68 \end{pmatrix} = 0.5 \times \begin{pmatrix} 0.63 \\ 0.68 \\ \vdots \\ 0.71 \end{pmatrix} + 0.5 \times \begin{pmatrix} 0.88 \\ 0.75 \\ \vdots \\ 0.64 \end{pmatrix}$$

On scale: Metaflow

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What do you associate with this brand?

duolingo

- [x] Affordable
- [ ] Effective
- [x] Fun
- [ ] Innovative
- [ ] User-friendly
- [ ] None of these

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One model per answer option

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One model per answer option

One question per brand, different competitor brands per market

~500 - 1500 models per project

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One model per answer option

One question per brand, different competitor brands per market

~500 - 1500 models per project

~20min per model

= ~10 days compute time

METAFLOW

- Integrates with AWS Batch
- Easy to use for Data Scientists
- Supports reproducibility

MRP as Metaflow

```
from metaflow import FlowSpec,step

class MRPFlow(FlowSpec):

    @step
    def start(self):
        Self.data, self.questions = load_data()
        self.next(self.run_model, foreach="questions")

    @step
    def run_model(self):
        question = self.input
        self.result = run_mrp(question, self.data)
        self.next

    @step
    def join(self, inputs):
        for result in inputs:
            save(result)

        self.next(self.end)

    @step
    def end(self):
        pass
```

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MRP as Metaflow

```python
from metaflow import FlowSpec,step

class MRPFlow(FlowSpec):

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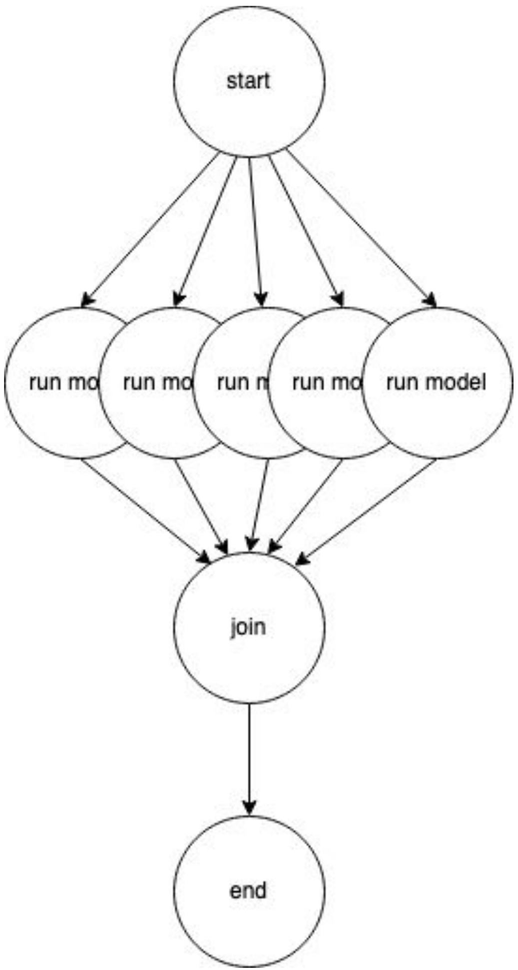

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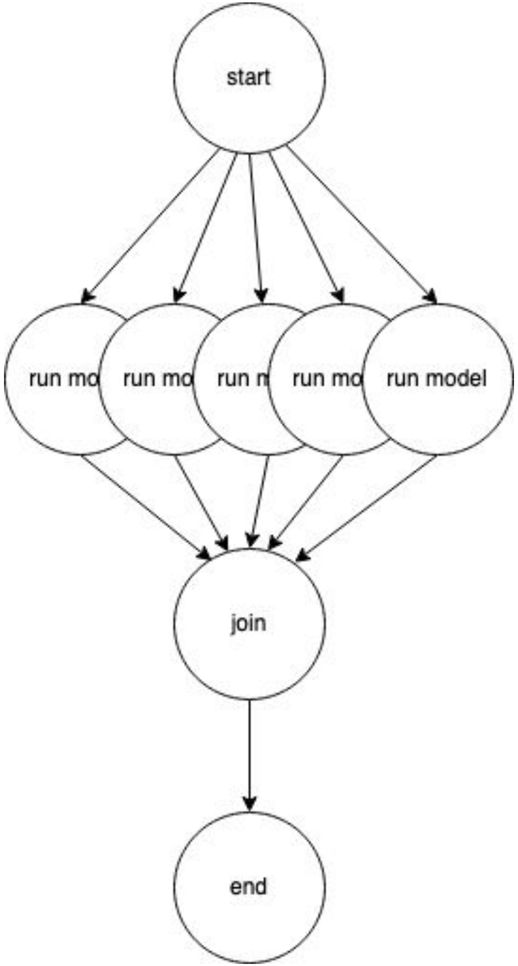

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Parallelizing models

```
@step
def start(self):
    Self.data, self.questions = load_data()
    self.next(self.run_model, foreach="questions")


@step
def run_model(self):
    question = self.input
    self.result = run_mrp(question, self.data)
    self.next
```

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Increasing resources

```
@step
def start(self):
    Self.data, self.questions = load_data()
    self.next(self.run_model, foreach="questions")

@resources(cpu=8, memory=32000)
@step
def run_model(self):
    question = self.input
    self.result = run_mrp(question, self.data)
    self.next
```

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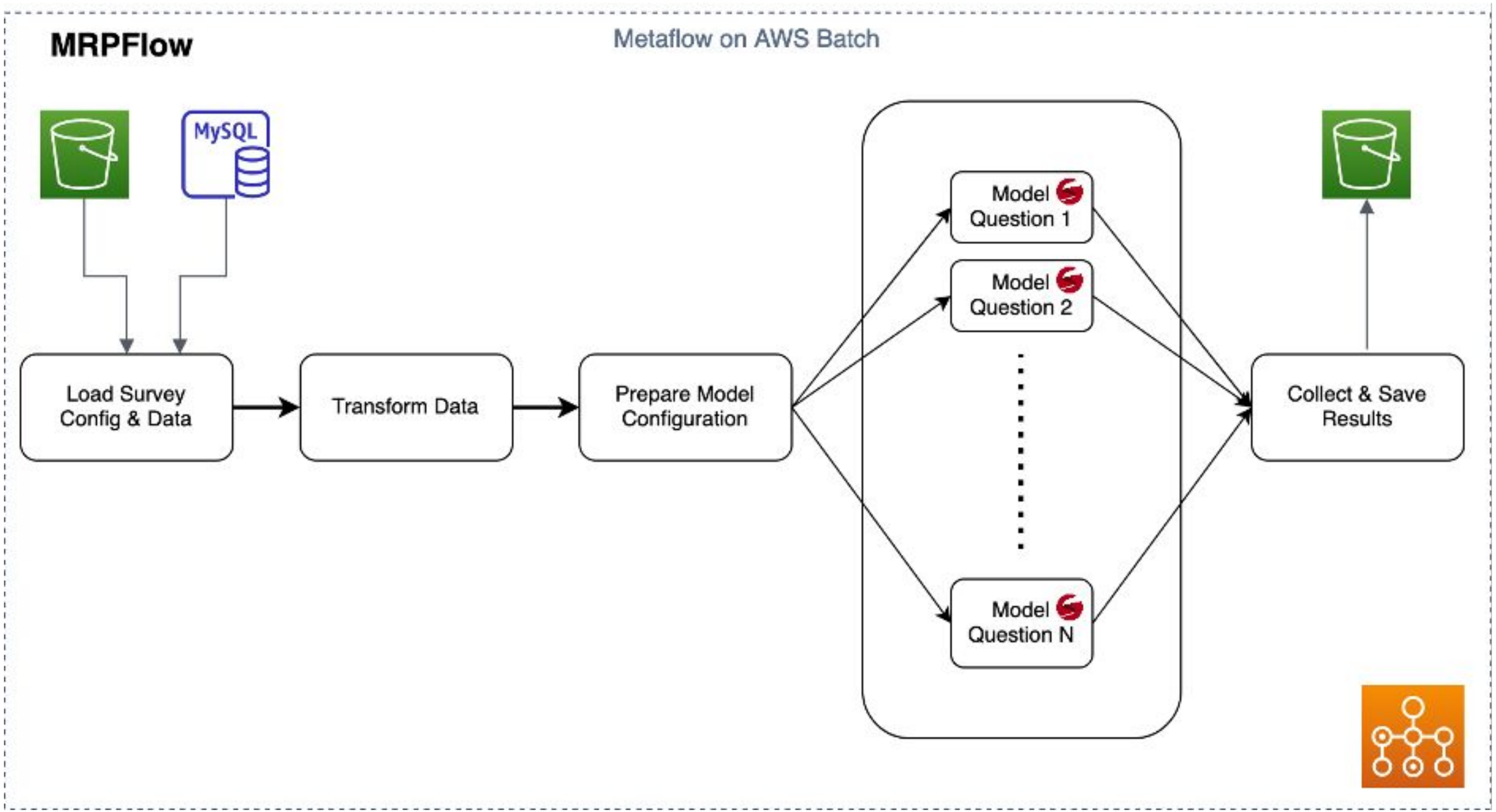
Mr.P on AWS



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Challenges

Convergence

How to monitor convergence of 1000+ models?

More predictor variables

Full joint distribution needed of all predictor variables.

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Summary

- **Multilevel-regression improves errors by using grouped structure**

- **Propagation of uncertainty improves weighting**

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Resources and Links

Introductory book on Bayesian Statistics: https://xcelab.net/rm/statistical-rethinking/

Stan: https://mc-stan.org/

Stan interface brms (R): https://paul-buerkner.github.io/brms/

MRP: Forecasting elections with non-representative polls https://www.sciencedirect.com/science/article/abs/pii/S0169207014000879

Metaflow https://metaflow.org/

MRP at Latana:

- https://latana.com/whitepapers/mrp-vs-traditional-quota-sampling-brand-tracking/
- https://aws.amazon.com/blogs/startups/brand-tracking-with-bayesian-statistics-and-aws-batch/