The Relationship between Price, Popularity and Ratings for Apps and Claimed Features

Anthony Finkelstein, Mark Harman, Yue Jia,
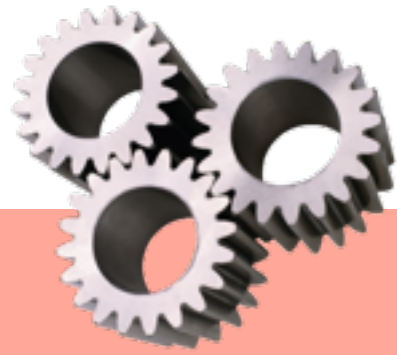William Martin, Federica Sarro and Yuanyuan Zhang
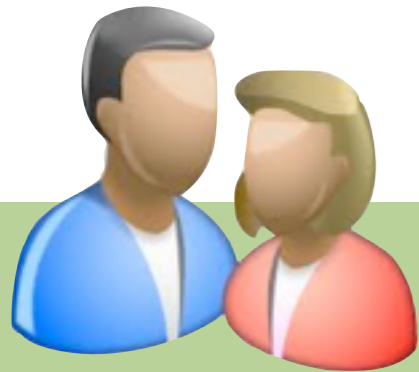
UCLappA - UCL Appstore Analysis Group

Agenda

▷ App analysis framework

▷ Metrics for feature analysis

▷ Six research questions

▷ Results analysis

▷ Conclusions

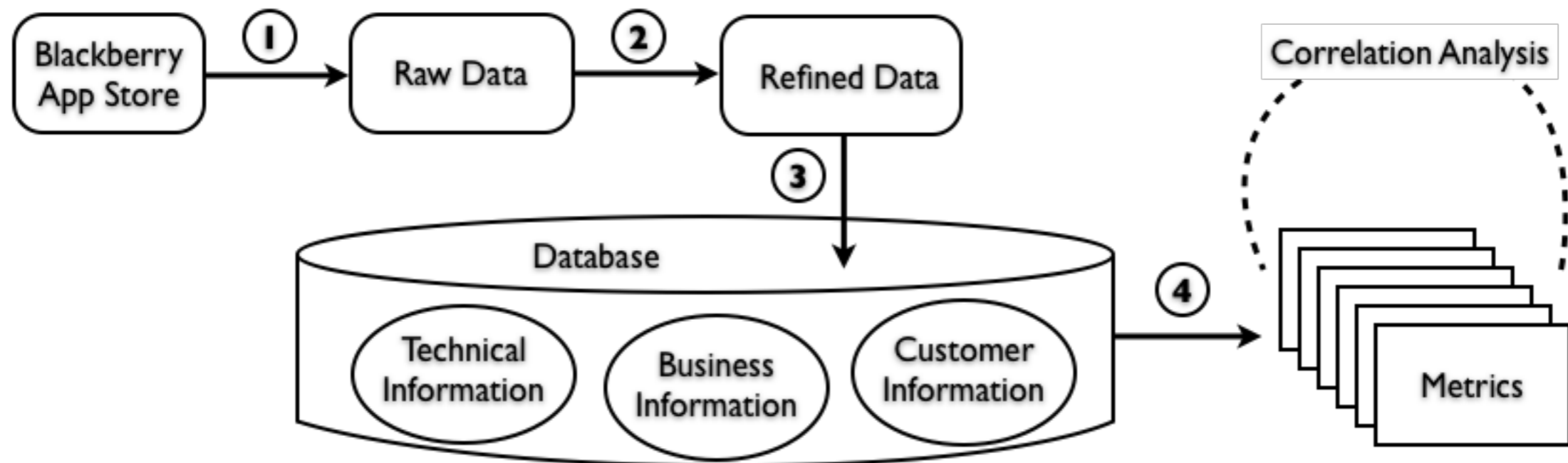Technical

Features

Customer
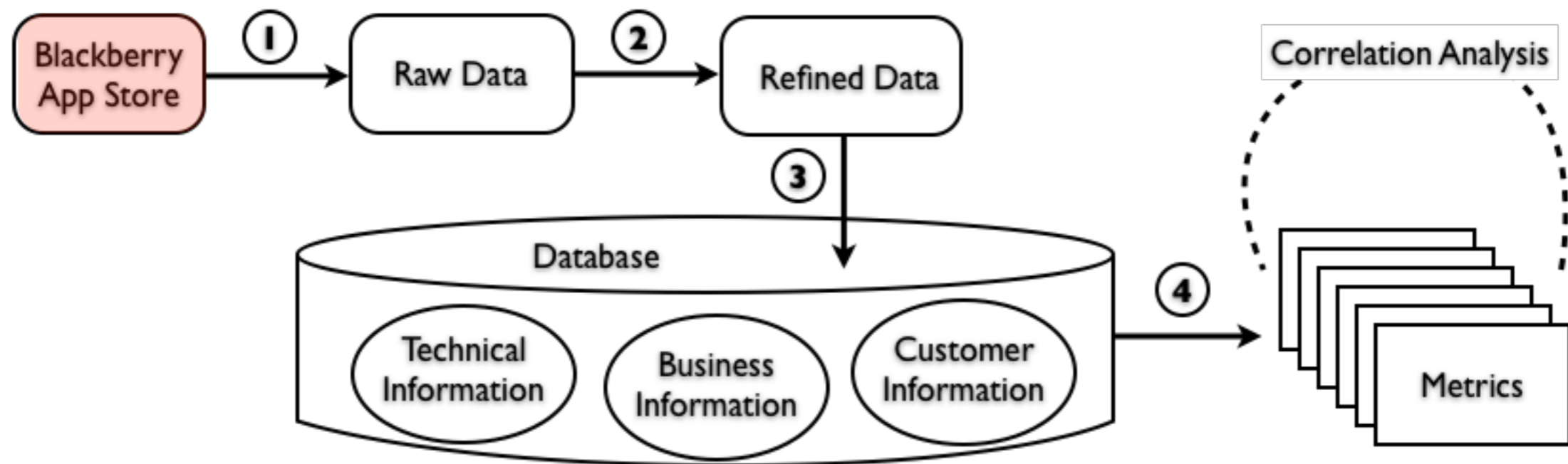
Ratings
Popularity

Business

Price

App Store Repository

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Blackberry App Store → ① → Raw Data → ② → Refined Data

③

Database
- Technical Information
- Business Information
- Customer Information

④

Correlation Analysis

Metrics

Framework
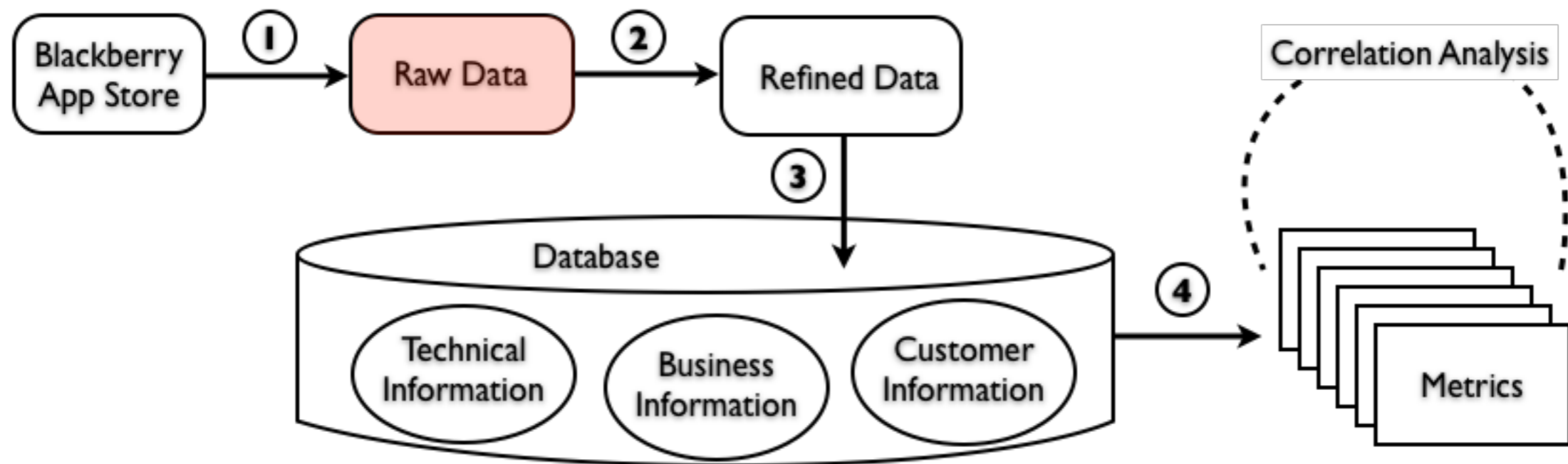
Yuanyuan Zhang
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Framework

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Framework

Blackberry App Store → ① → Raw Data → ② → Refined Data → ③ → Database (Technical Information, Business Information, Customer Information) → ④ → Metrics

Correlation Analysis

BlackBerry App World™

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Blackberry App Store → ① → Raw Data → ② → Refined Data

Correlation Analysis

③

Database

Technical Information | Business Information | Customer Information

④ → Metrics

BlackBerry App World > Apps > Finance > Financial Services >

Mortgage Calculator PRO

By Davide Perini

★★★★★ 59 reviews

Rated: General

US$7.99 **Purchase ▸**

Try ▸

> Add To Cart

Item Information   Share▼

Version: 5.6.2
Release: May 14, 2012
File Size: 445 KB
Support Email: support@dpsoftware.org

Item Description

(One time buy, no subscription, free upgrade only.)

Why is it important to have a mortgage calculator on the go?

...e Calculator Pro is a quick and easy to use calculator for brokers, realtors, and home buyers.

...hopping for a house, comparing mortgage brokers, comparing properties, and looking over the numbers

Screenshots

Mortgage Calculator PR 123

Mc Calculator MORTGAGE PRO.

────Input
Loan Amount: $250,000.0
Loan Term: 25.0 years
Interest Rate: 7.0 %
────Output
Monthly Payment PI:

Framework

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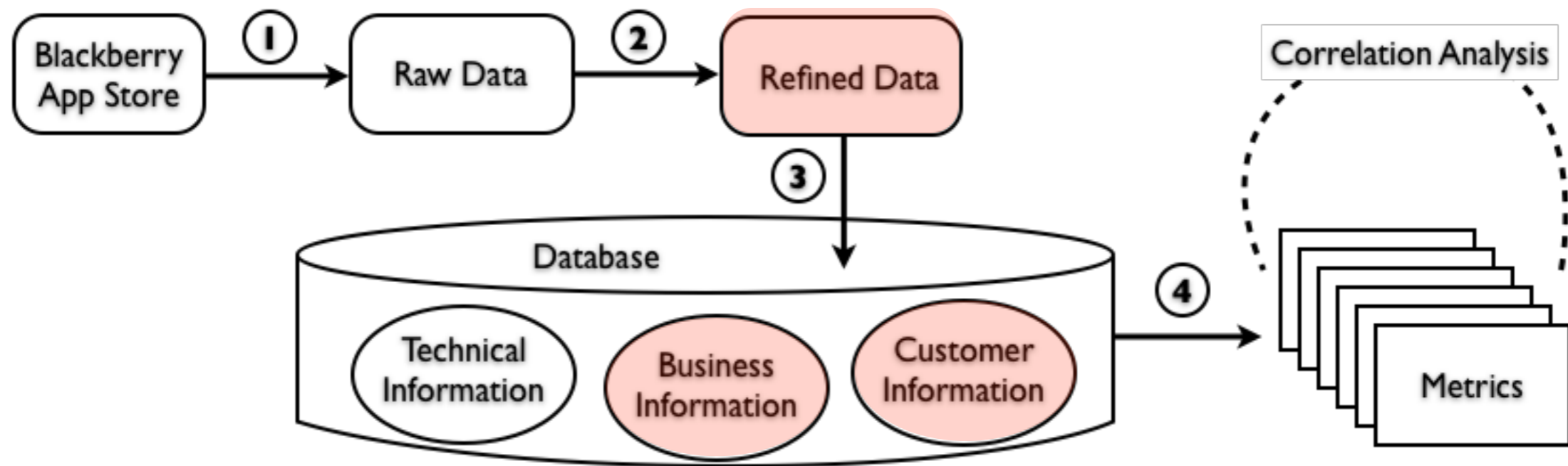
Item Description

(One time buy, no subscription, free upgrade only.)

Why is it important to have a mortgage calculator on the go?

Mortgage Calculator Pro is a quick and easy to use calculator for brokers, realtors, and home buyers.

When shopping for a house, comparing mortgage brokers, comparing properties, and looking over the numbers with your significant other, the most important thing to know is how much it is going to cost you.
By knowing this information, it can help you to make important decisions while you are on the go.

When choosing a house, make sure you can afford the property easily.
This mortgage calculator is also quick and easy to use. All you need to do is enter the loan amount, the interest rate, and the amortization. After this is complete, the calculator will calculate your payments.
The home mortgage refinance calculator helps you assess the impact of mortgage refinancing. Enter your current loan information as well as the proposed refinance loan information to calculate the break-even point and potential cost savings from refinancing your mortgage.

Mortgage Calculator PRO is a professional suite and it can be used for either loans, mortgages and mortgage refinancing.

Brief description:
Mortgage loan payments calculator with full amortization schedule, interest calculator, mortgage refinancing, mortgage comparison, affordability calculator, rent vs buy, tax, insurance and much more.

Screenshots

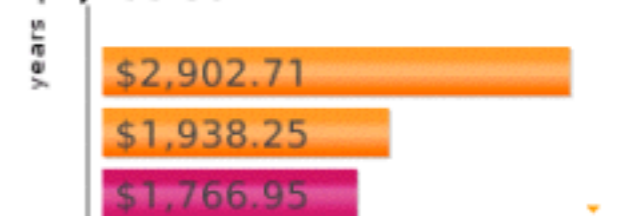**Mortgage Calculator PR** 123

—Input
Loan Amount: $250,000.0
Loan Term: 25.0 years
Interest Rate: 7.0 %
—Output

Monthly Payment PI:
$1,766.95

$2,902.71
$1,938.25
$1,766.95

Menu

› View more screen shots

Supported Devices

Blackberry App Store → ① → Raw Data → ② → Refined Data

③

Database

Technical Information | Business Information | Customer Information

④ → Metrics

Correlation Analysis

> **Add To Cart**

Item Description

(One time buy, no subscription, free upgrade only.)

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Mortgage Calculator PR 123

Calculator **MORTGAGE** PRO.

Input
Loan Amount: $250,000.0
Loan Term: 25.0 years
Interest Rate: 7.0 %

Output

Monthly Payment PI:
$1,766.95

years
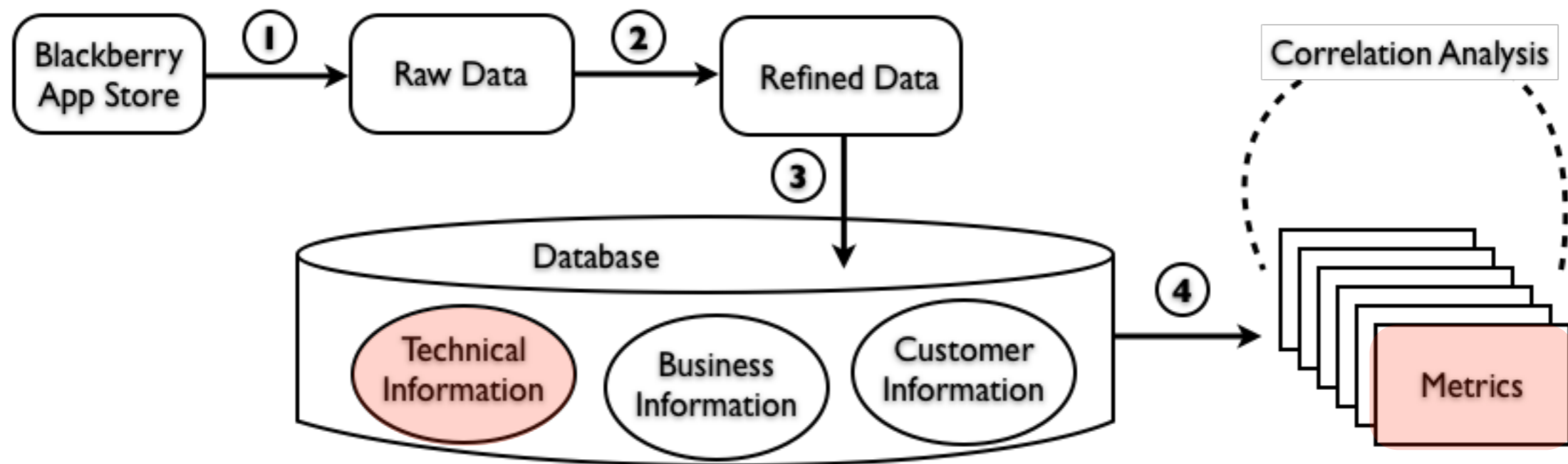
$2,902.71
$1,938.25
$1,766.95

Menu

> View more screen shots

Supported Devices

Item Description

(One time buy, no subscription, free upgrade only.)

Why is it important to have a mortgage calculator on the g[...]

Mortgage Calculator Pro is a quick and easy to use calcula[...]

When shopping for a house, comparing mortgage brokers,[...]
with your significant other, the most important thing to kn[...]
By knowing this information, it can help you to make impo[...]

When choosing a house, make sure you can afford the pr[...]
This mortgage calculator is also quick and easy to use. All[...]
rate, and the amortization. After this is complete, the calc[...]
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loan information as well as the proposed refinance loan in[...]
potential cost savings from refinancing your mortgage.

Mortgage Calculator PRO is a professional suite and it can[...]
refinancing.

Brief description:
Mortgage loan payments calculator with full amortizatio[...]
mortgage comparison, affordability calculator, rent vs buy[...]
Bar chart and pie chart support.
Send your results via Email/SMS or export it in Excel or Word.
Extremely powerful but easy to use.
Support for different currencies and different compounding periods, US mortgages, Canadian mortgages and
other international mortgages.
English, Française, Deutsch, Español, Italiano.
Stunning skinnable user interface.
Constantly upgrading features, free for existing customers.
Customers support answer in less than 24 hours.
You can transfer your license on new BlackBerry® devices and other Smartphones.

Algorithm 1 Feature Extraction Algorithm

```
Require: apps
    rawFeatures = [ ]
    featureLets = [ ]
    for all apps do
        if featurePattern exists in currentApp.descreption then
            rawFeatures.append (extractFeaturePattern (currentApp))
        end if
    end for
    for all rawFeatures do
        refineRawFeatures (currentRawFeature)
    end for
    featureLets = findTrianGramCollocation (refineRawFeatures) {NLTK}
    features = getGreedyClusters (featureLets)
    return features
```

Tablet: 1.0.0 or higher

Extracting features from description of apps

A **feature** to be a property, captured by a set of words (bitri-grams) in the app description and shared by a set of apps.
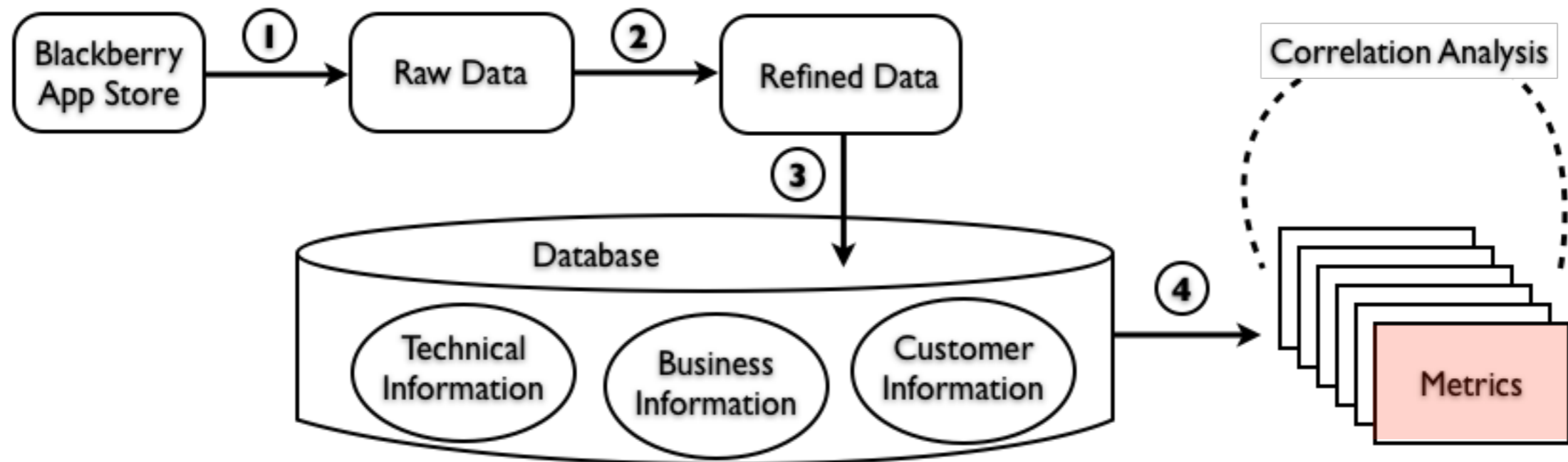
e.g. Finance

- setup, bank, accounts
- calculate, monthly, expenses
- e-mail, alerts, stock
- create, watch, lists
- financial, business, news

e.g. Travel

- free, wifi
- wifi, hotspot, near
- download, offline, use
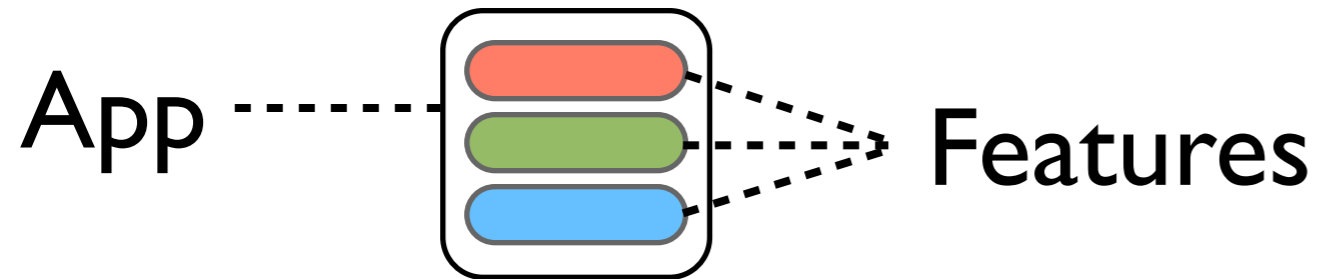- restaurants, plotted, map
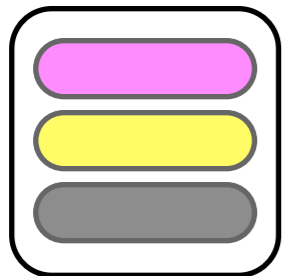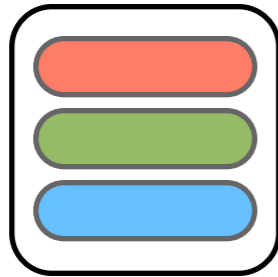- bus, service

Metrics for Features

Metrics

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Metrics for Features

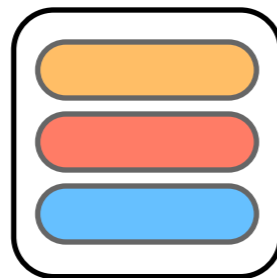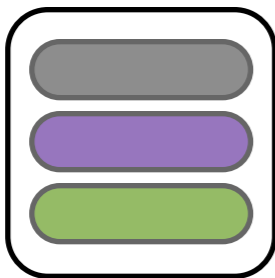App ----→ [ ] ---→ Features

Metrics

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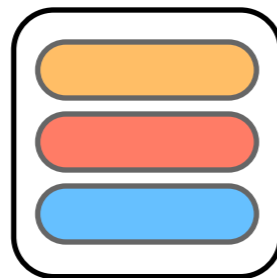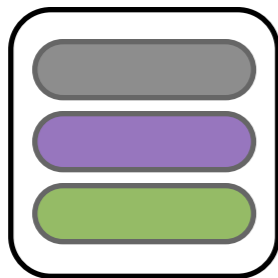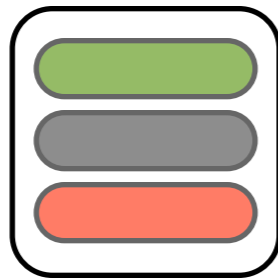
Metrics for Features

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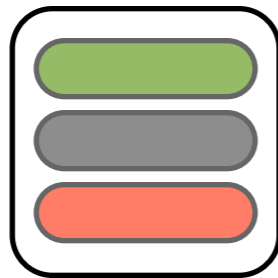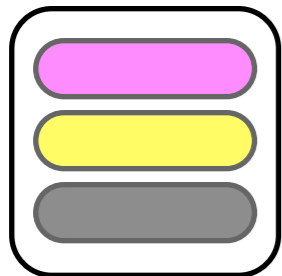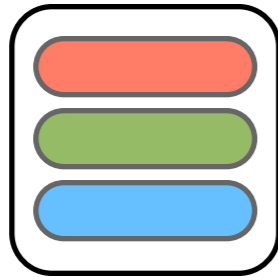# Metrics for Features

E.g price for feature

Metrics

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Metrics for Features

E.g price for feature ▭

$$\frac{C(\text{▭}) + C(\text{▭}) + C(\text{▭})}{3}$$

Metrics

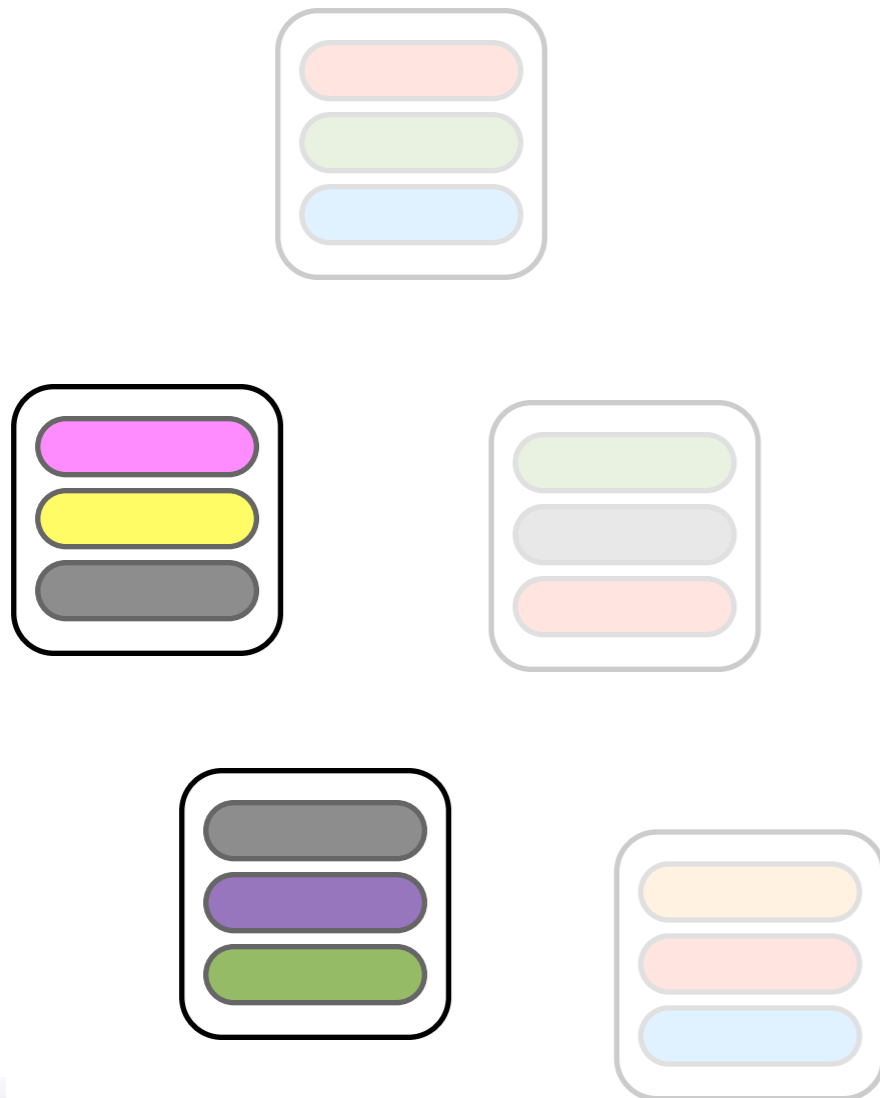Yuanyuan Zhang
yuanyuan.zhang@ucl.ac.uk
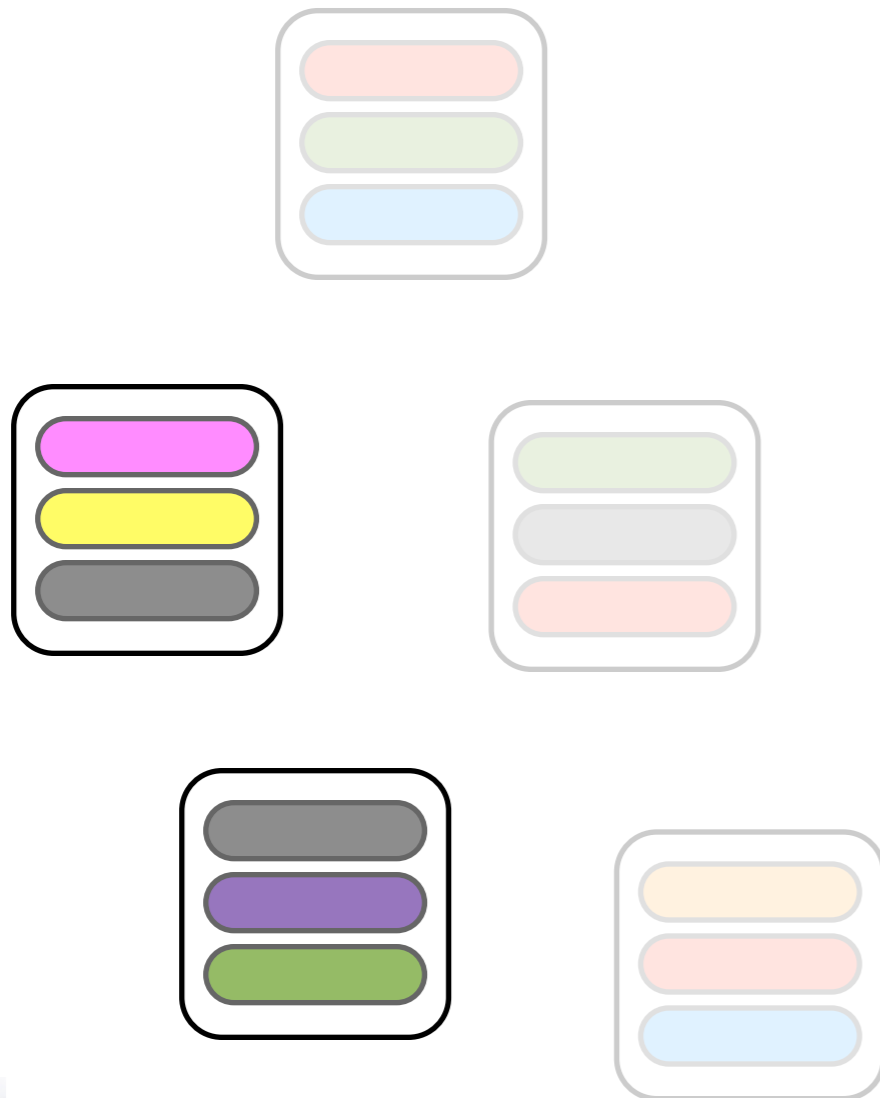
Metrics for Features

E.g price for feature

$$\frac{C(\ \square\ )+C(\ \square\ )+C(\ \square\ )}{3}$$

$$F(f,d) = \frac{\displaystyle\sum_{a_i \in S(f,d)} A(a_i, d)}{\sharp(S(f,d))}$$

Metrics

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Research Questions

RQ0: Baseline data on Price, Rating and Feature Distributions

RQ1: Price/Rating Correlation

RQ2: Price/Popularity Correlation

RQ3: Rating/Popularity Correlation

RQ4: Do extracted bitri-grams denote meaningful features to human developers?

RQ5: Is there a stronger correlation involving Price when we 'zoom in' on specific ranges of price or between price and number of features or shared features in an app?
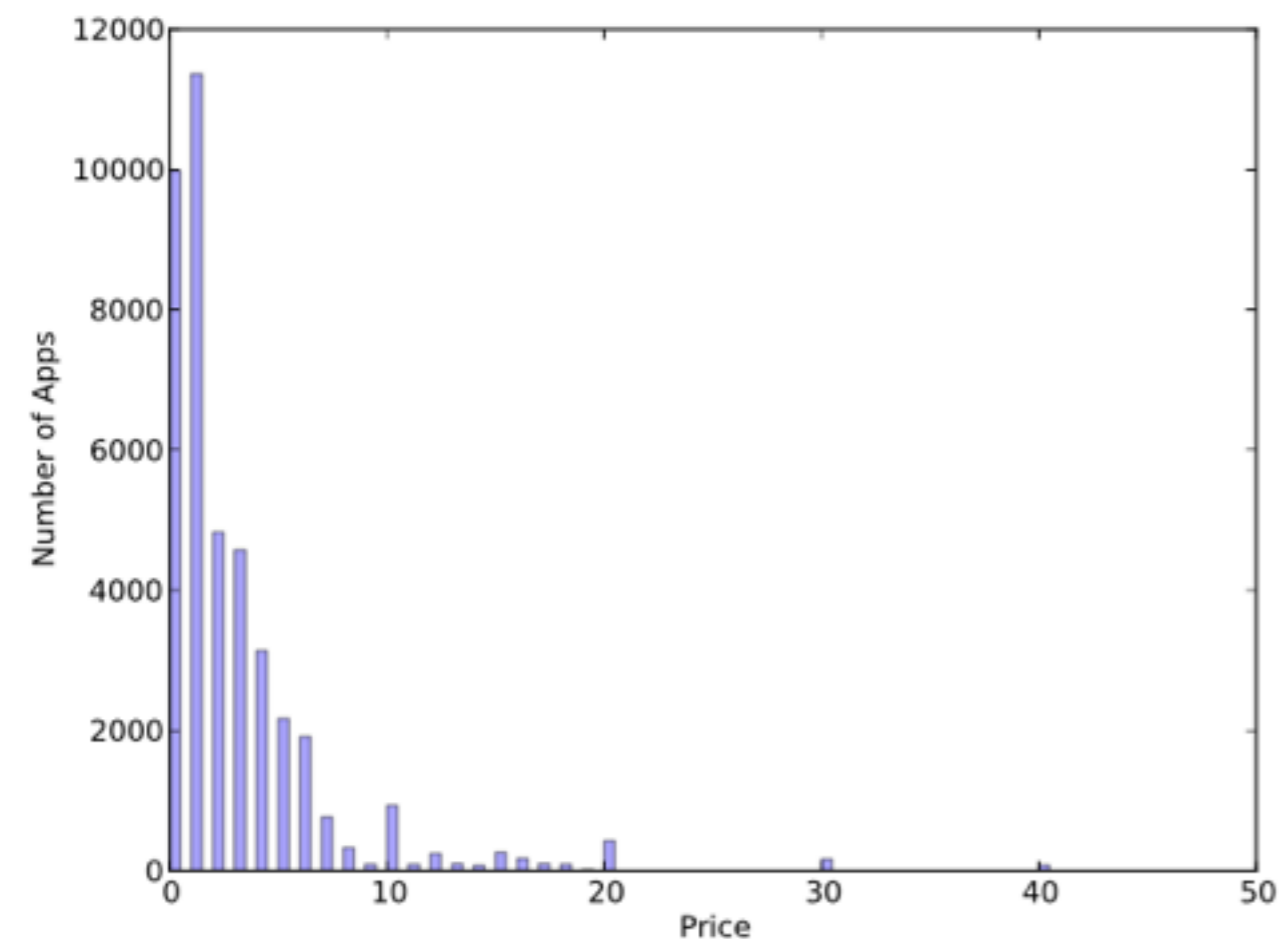
Data Employed

BlackBerry App World™

- Snapshot on the 1st of September 2011

- 19 categories for **32108** non-free and **9984** free apps

- extracted **1008** features from the app descriptions

Category Name	Non-Free Apps							Free Apps					
	Number of	Number of	Price ($)	Rank of Downloads			Rating	Number of	Number of	Rank of Downloads			Rating
	Apps	Features	Mean	Mean	Median	Min	Mean	Apps	Features	Mean	Median	Min	Mean
Business	350	75	12.57	19063.48	18031	817	1.79	874	69	19491.55	16723	135	1.65
Education	576	58	5.68	22222.18	21739	1595	1.38	353	32	19024.98	15823	933	1.92
Entertainment	908	64	5.76	18413.13	16364	134	1.86	565	38	9721.01	6985	8	2.62
Finance	193	57	4.38	19593.59	16619	251	1.93	513	66	15394.49	12826	96	2.01
Games	2604	36	2.64	15919.49	13550.5	153	2.13	928	36	7109.65	5132.5	9	2.99
Health & Wellness	626	53	15.95	19852.88	18295.5	266	1.58	329	54	16168.94	13771	29	1.79
IM & Social Networking	150	55	4.42	14242.26	11513	22	2.55	305	60	8932.63	6171	0	2.29

RQ0: Distributions of Price, Rating and Features

(a) Price distribution over apps
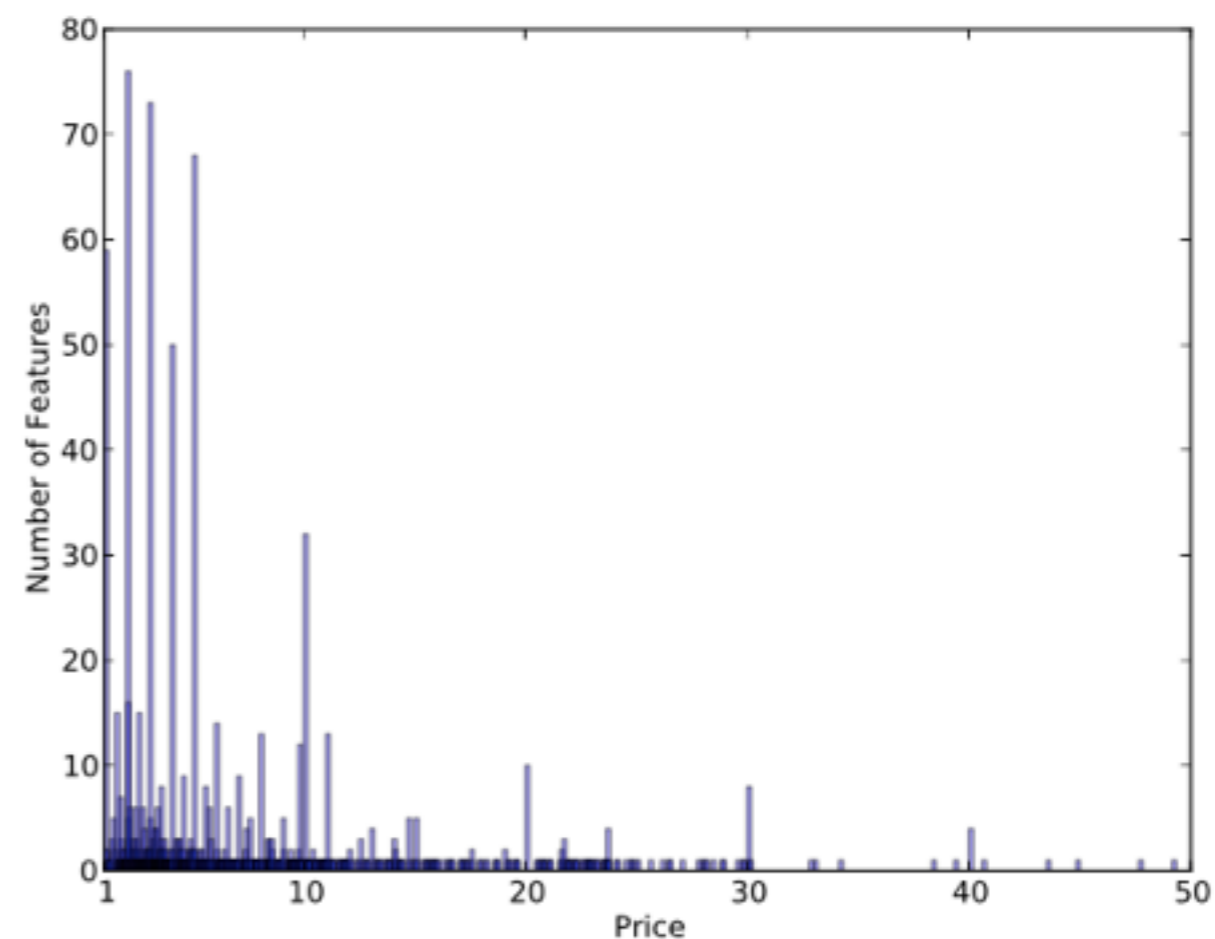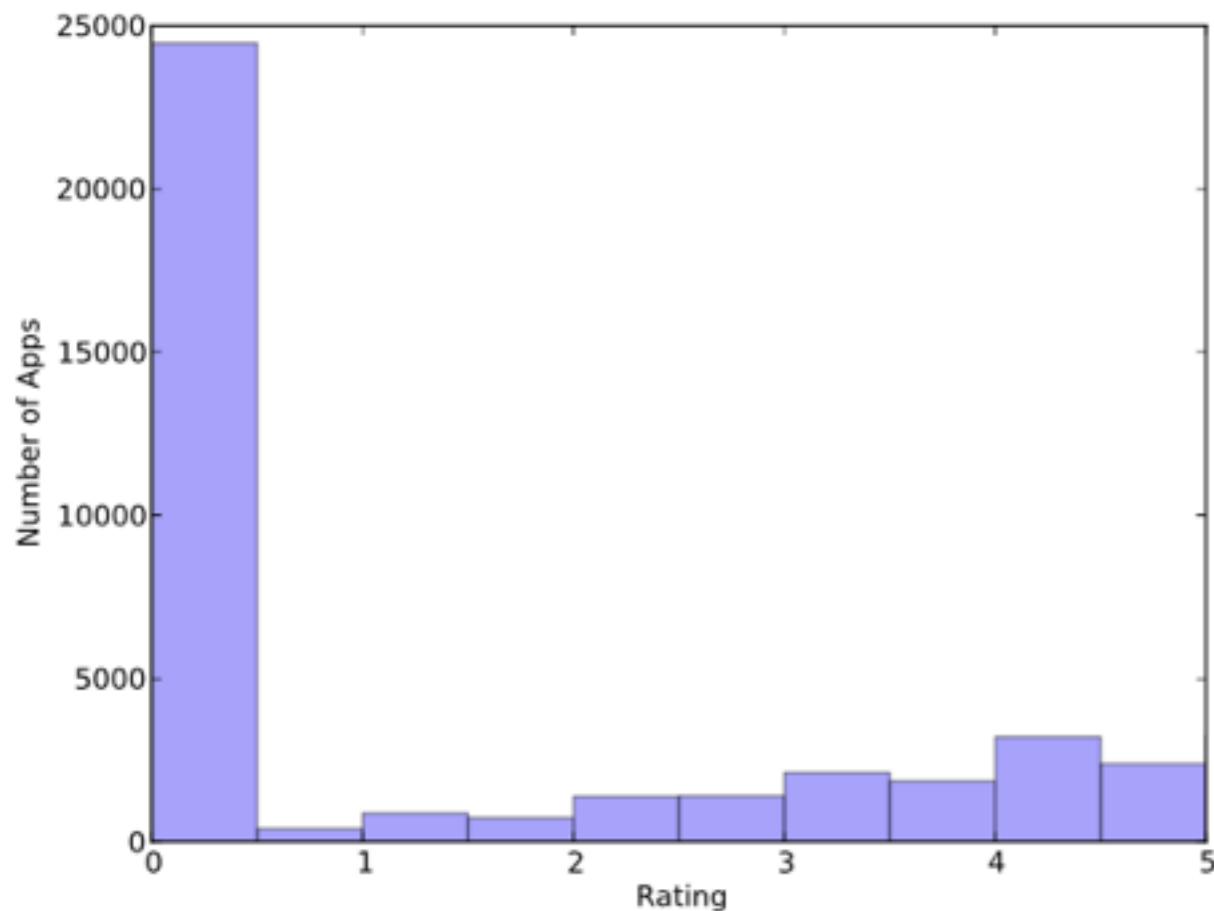
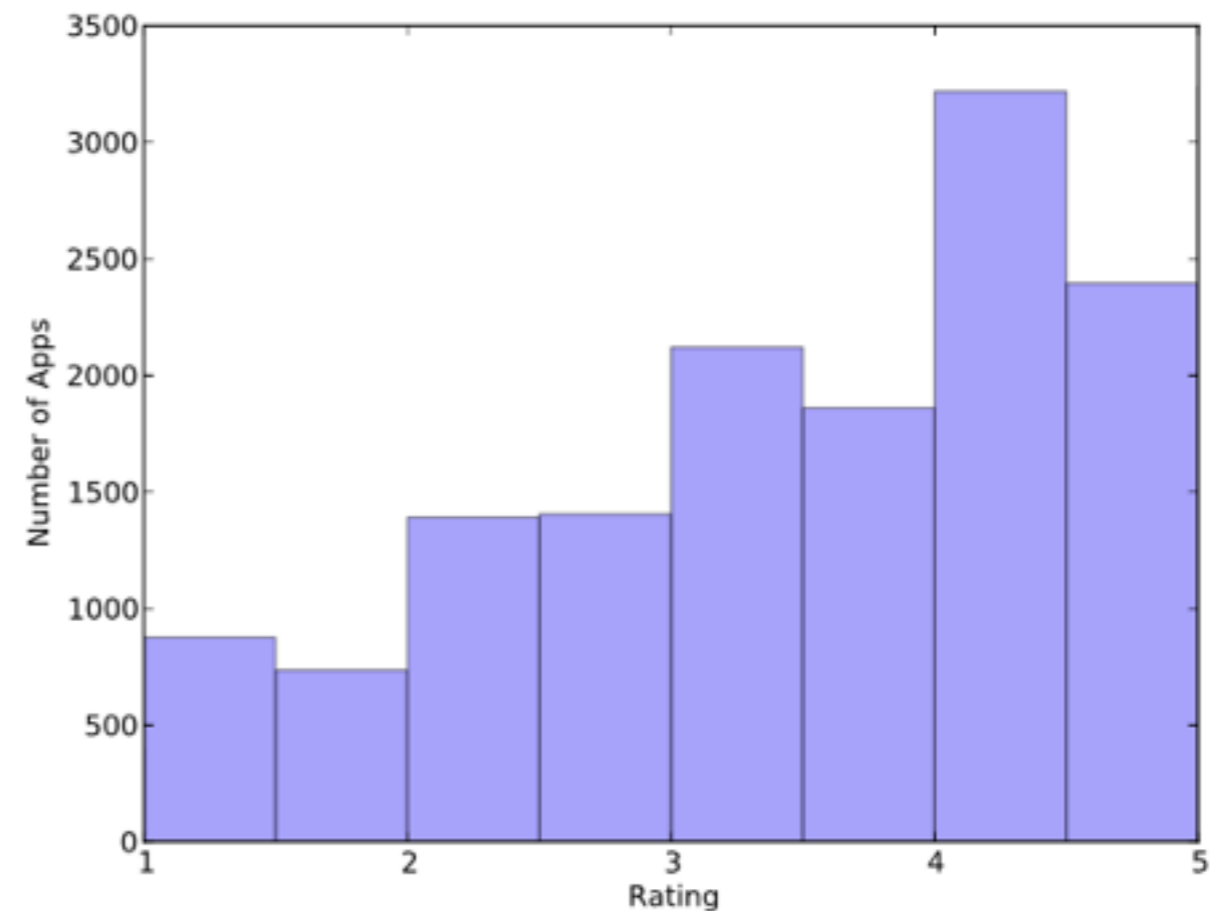(b) Price distribution over features

RQ0

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RQ0: Distributions of Price, Rating and Features

(c) Rating distribution over apps

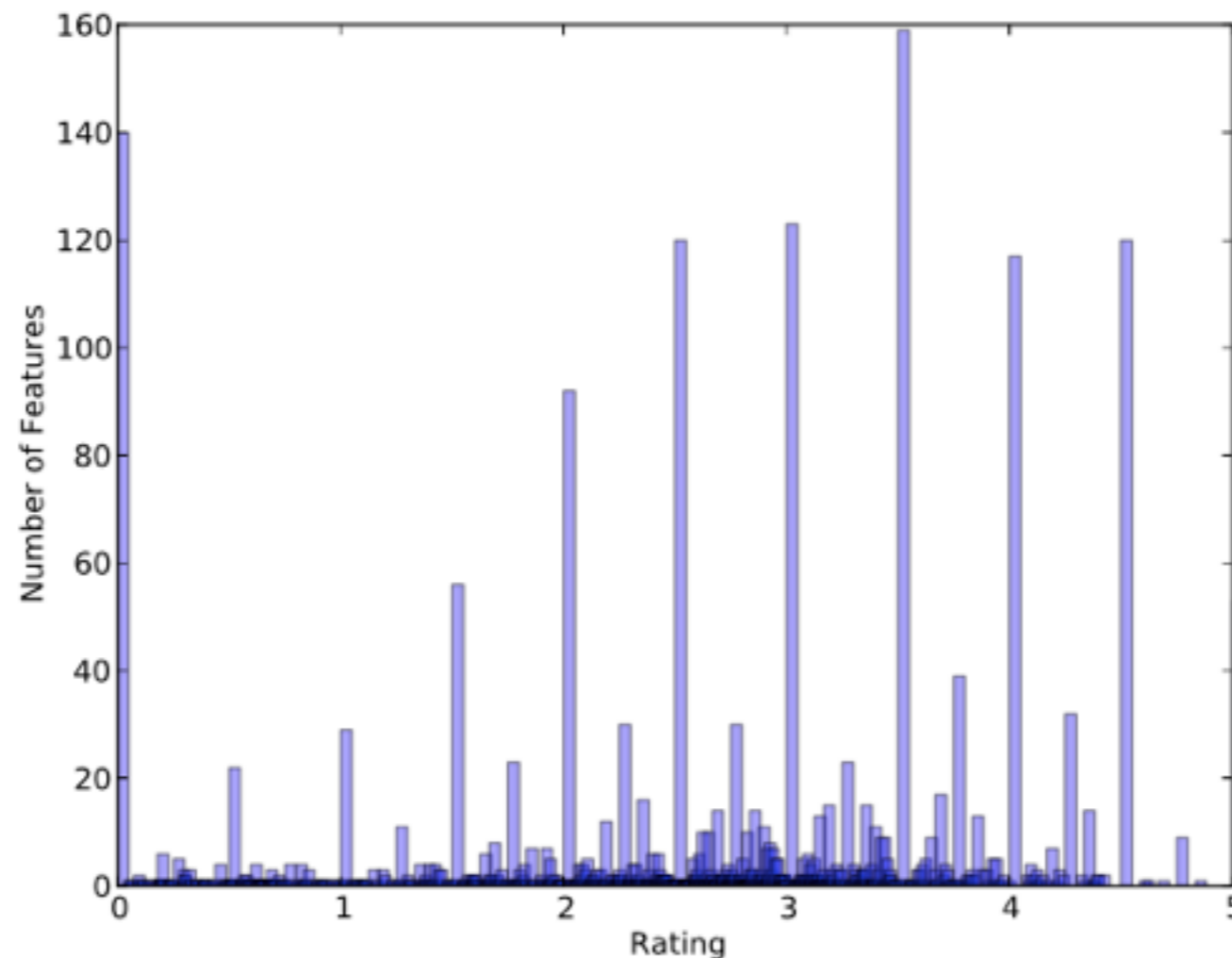(d) Rating distribution over apps - zoom in

RQ0

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RQ0: Distributions of Price, Rating and Features

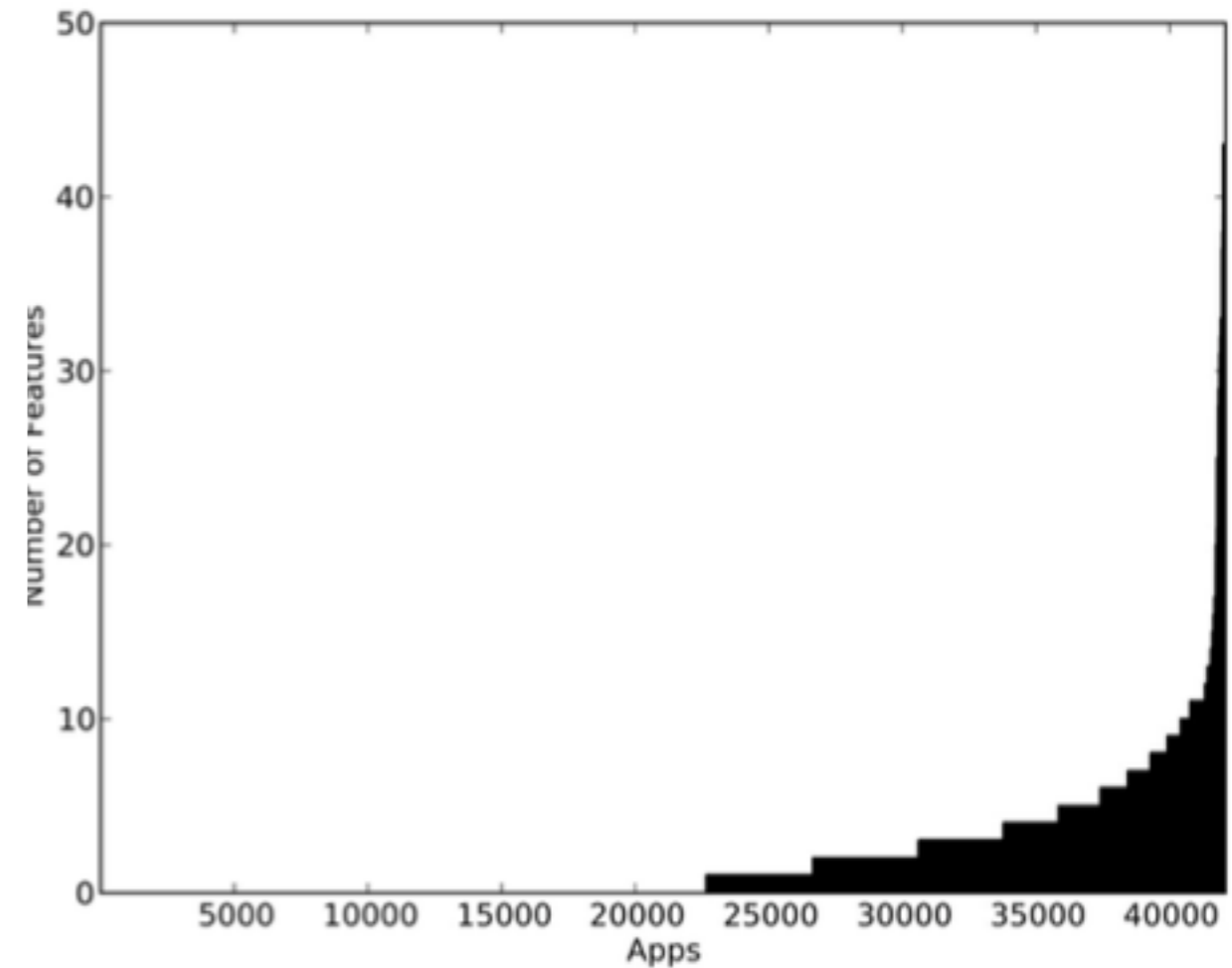(e) Rating distribution over features

RQ0

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RQ0: Distributions of Price, Rating and Features

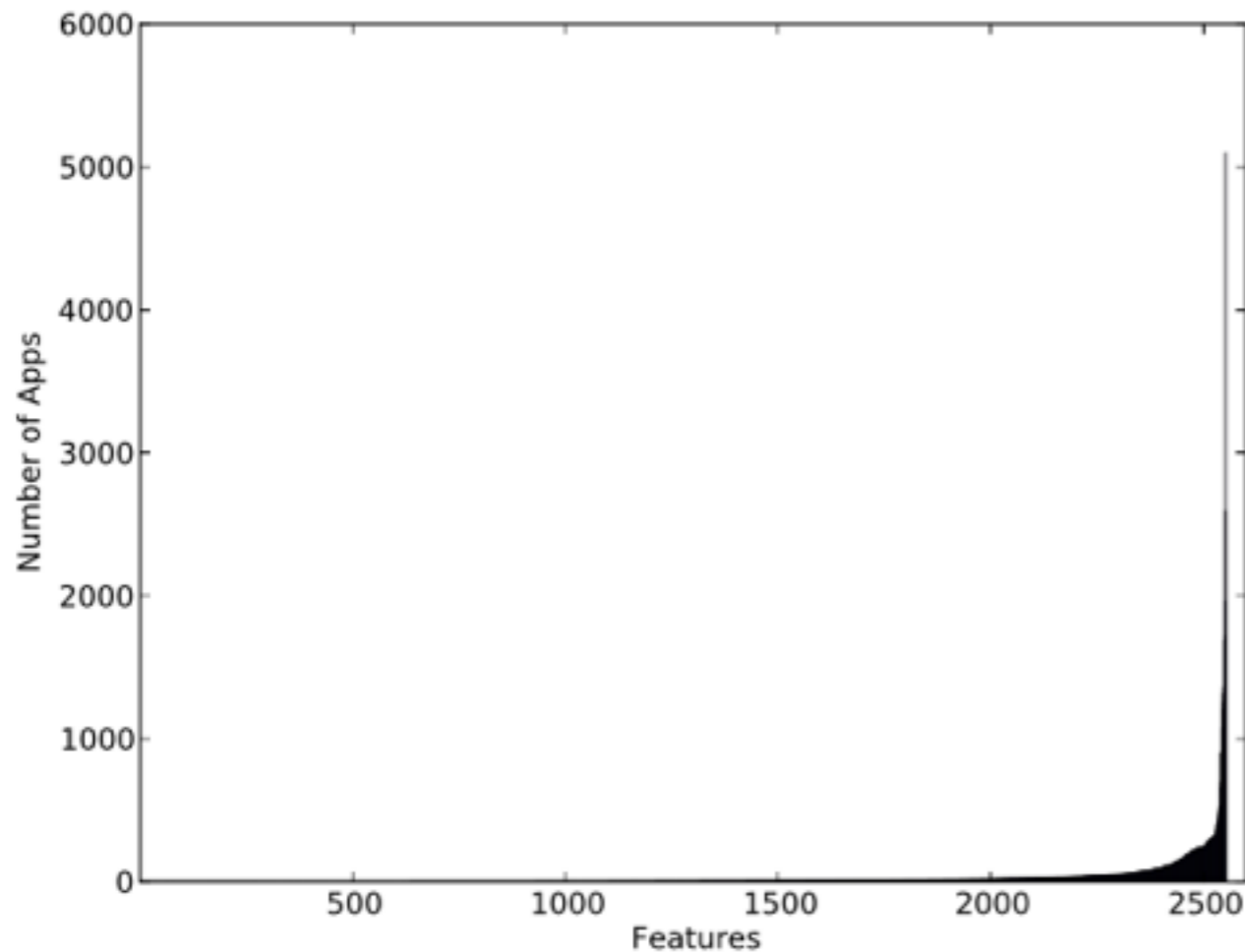Number of apps sharing a same feature

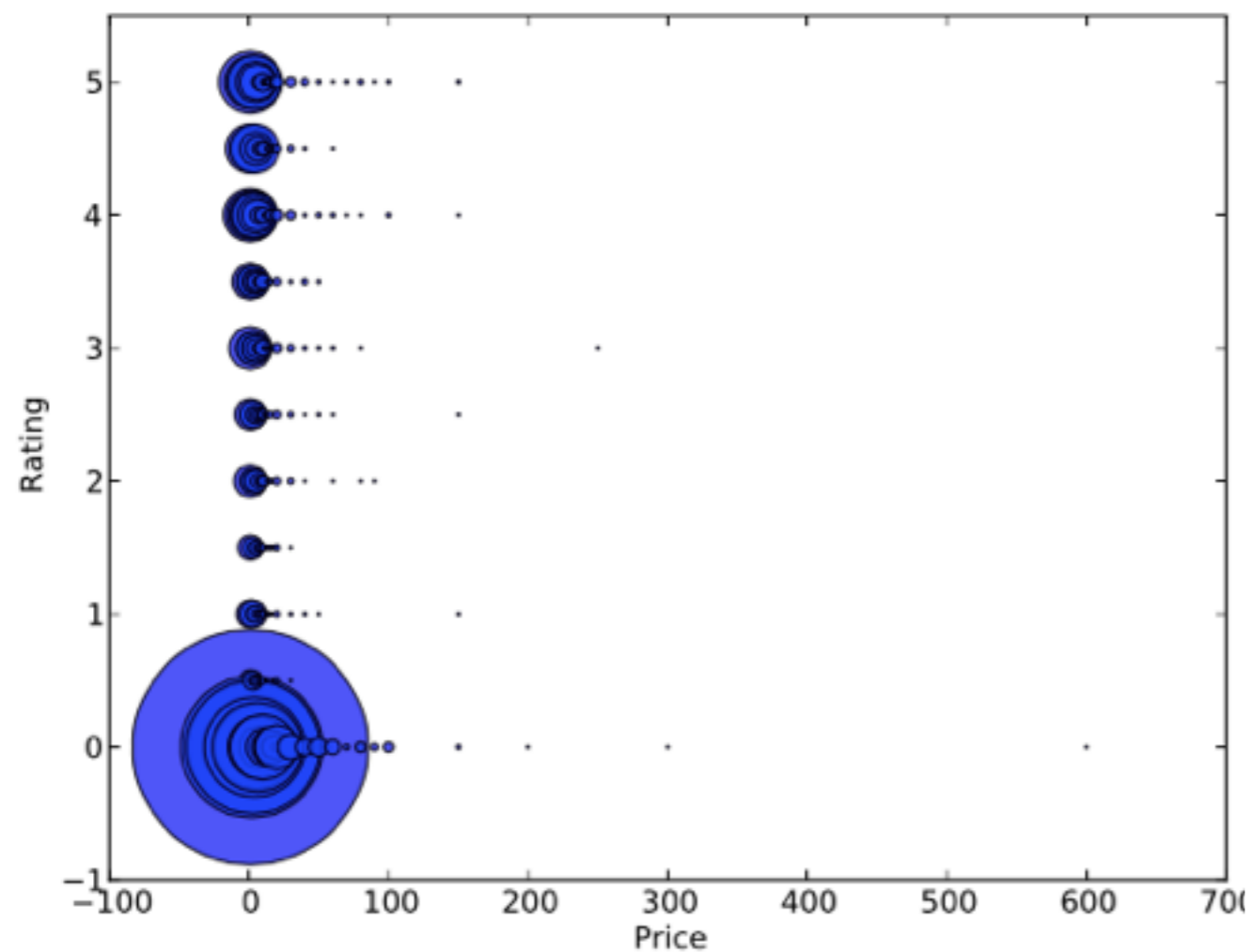(g) Number of features per app

RQ0

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RQ1:
Price/Rating Correlation

(a) PR non-free apps
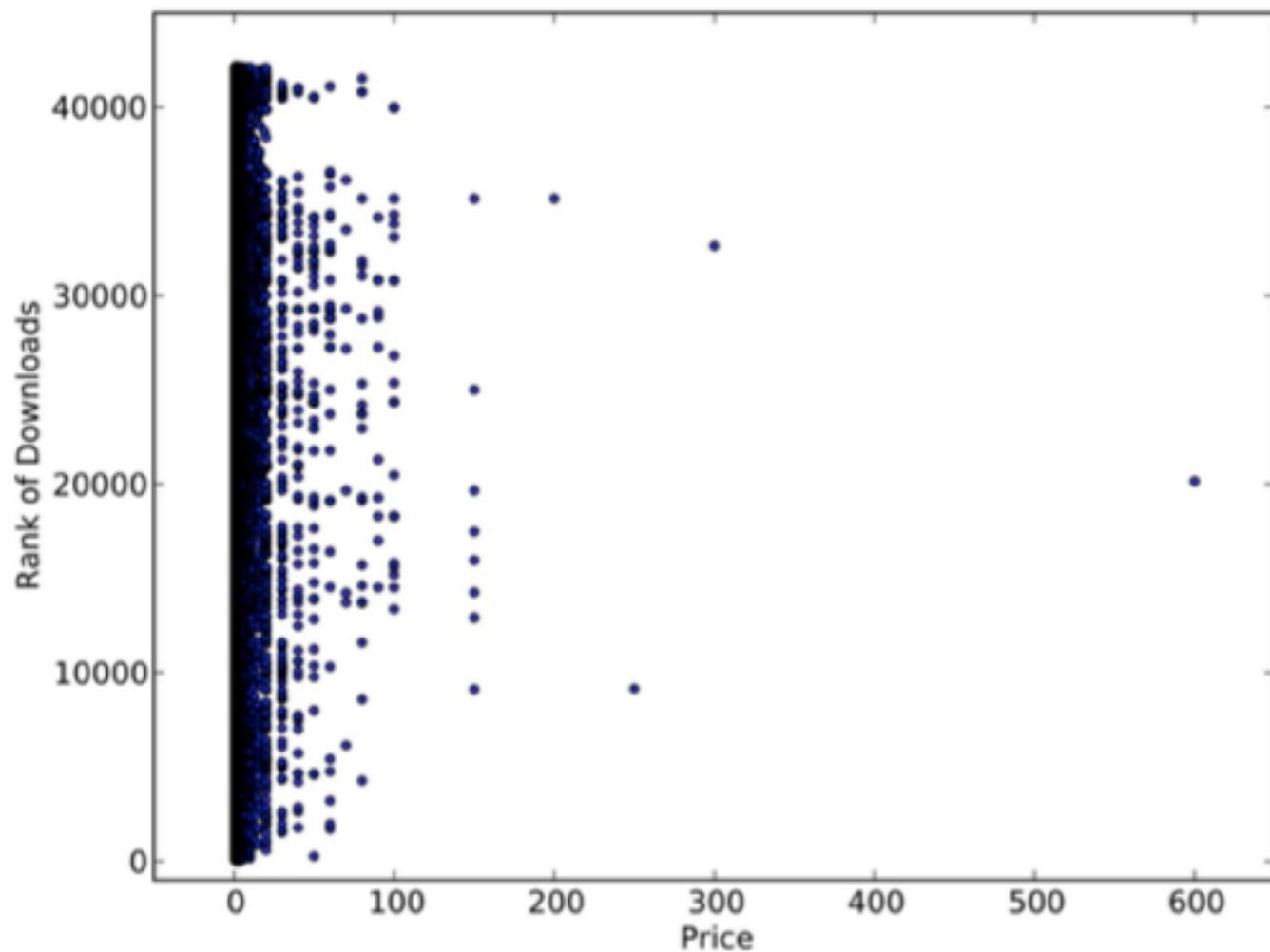
(i) PR non-free features

RQ1
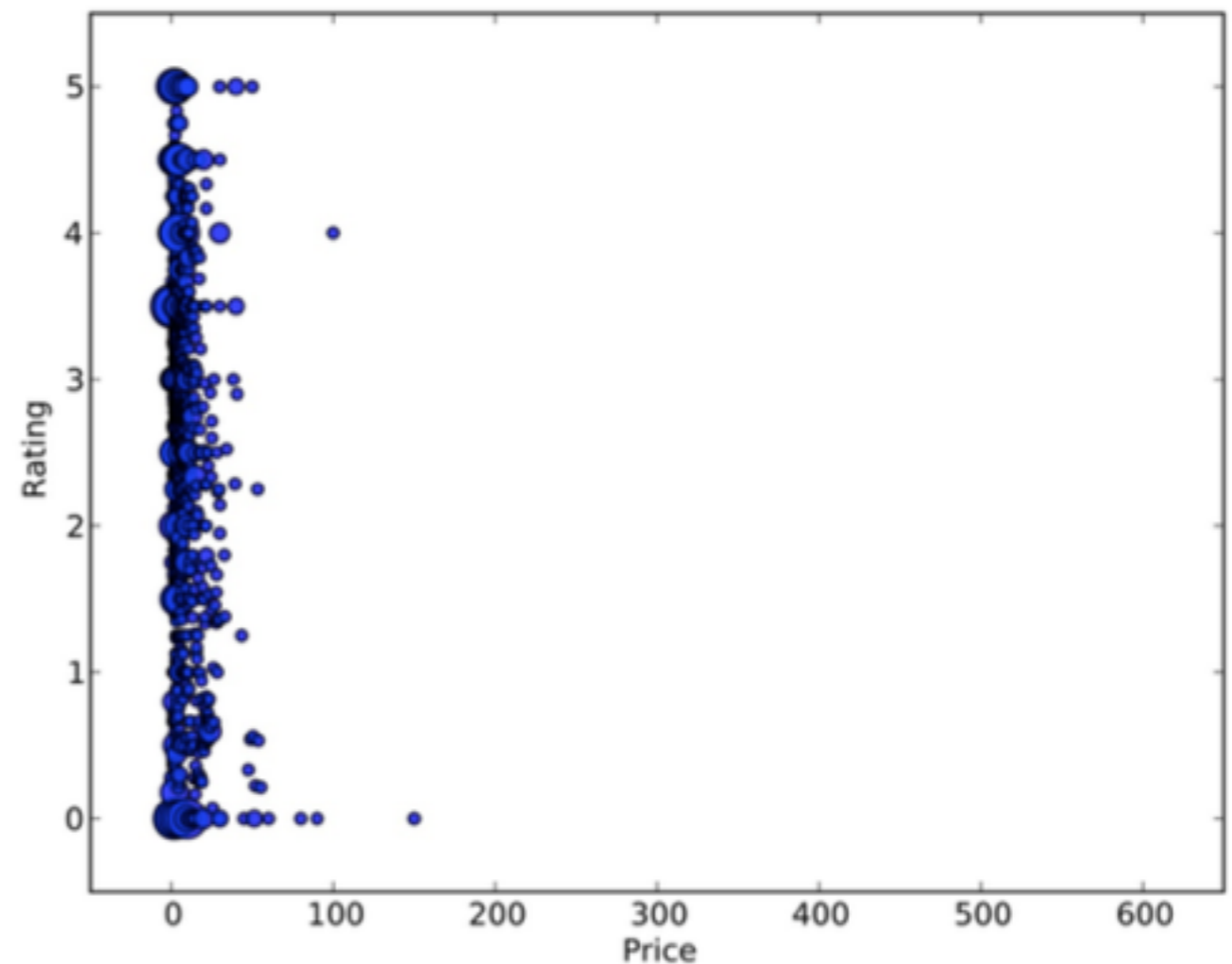
Yuanyuan Zhang
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RQ2:
Price/Popularity Correlation

(b) PD non-free apps
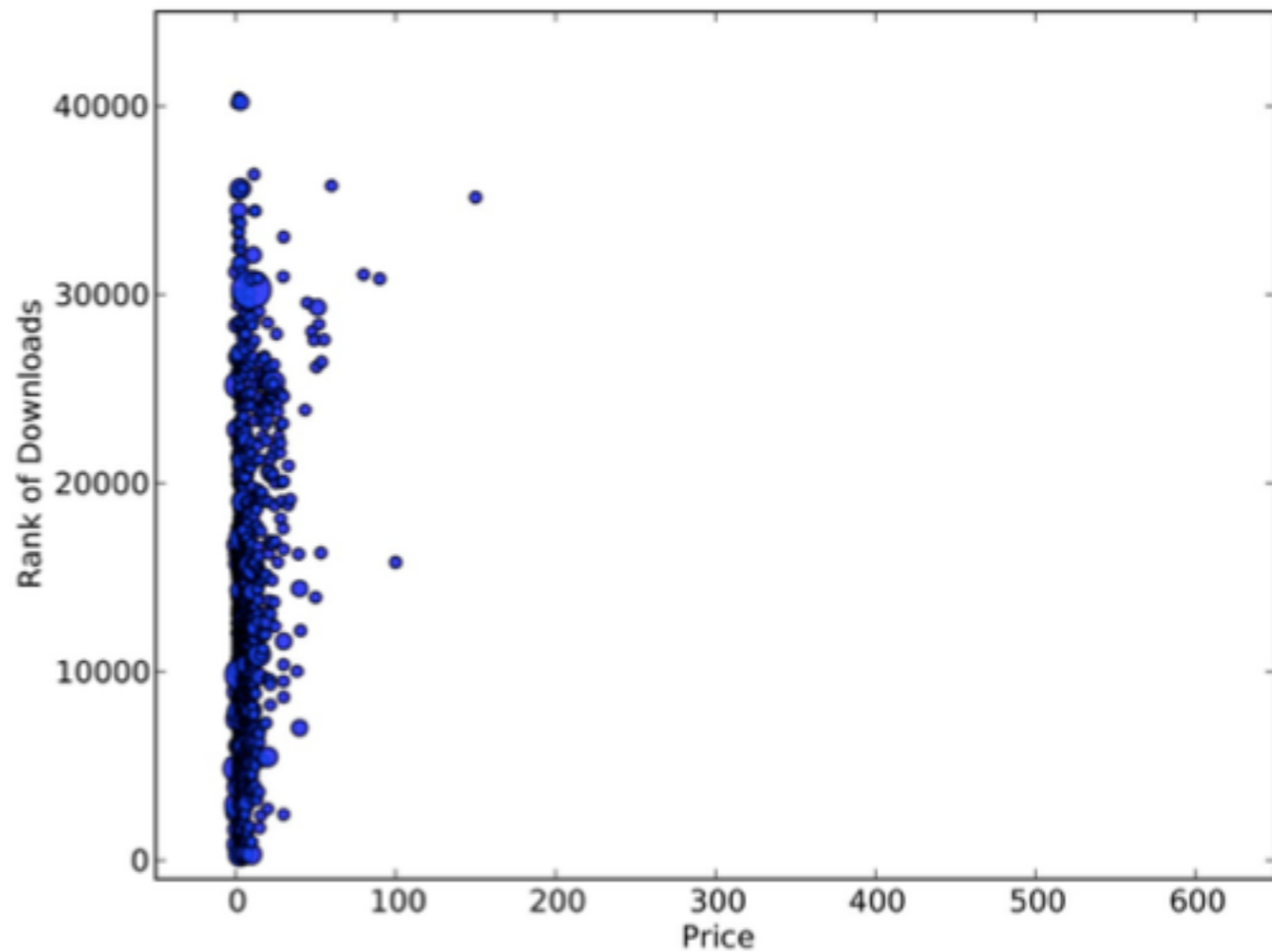
(j) PD non-free features

RQ2

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RQ3:
Rating/Popularity Correlation
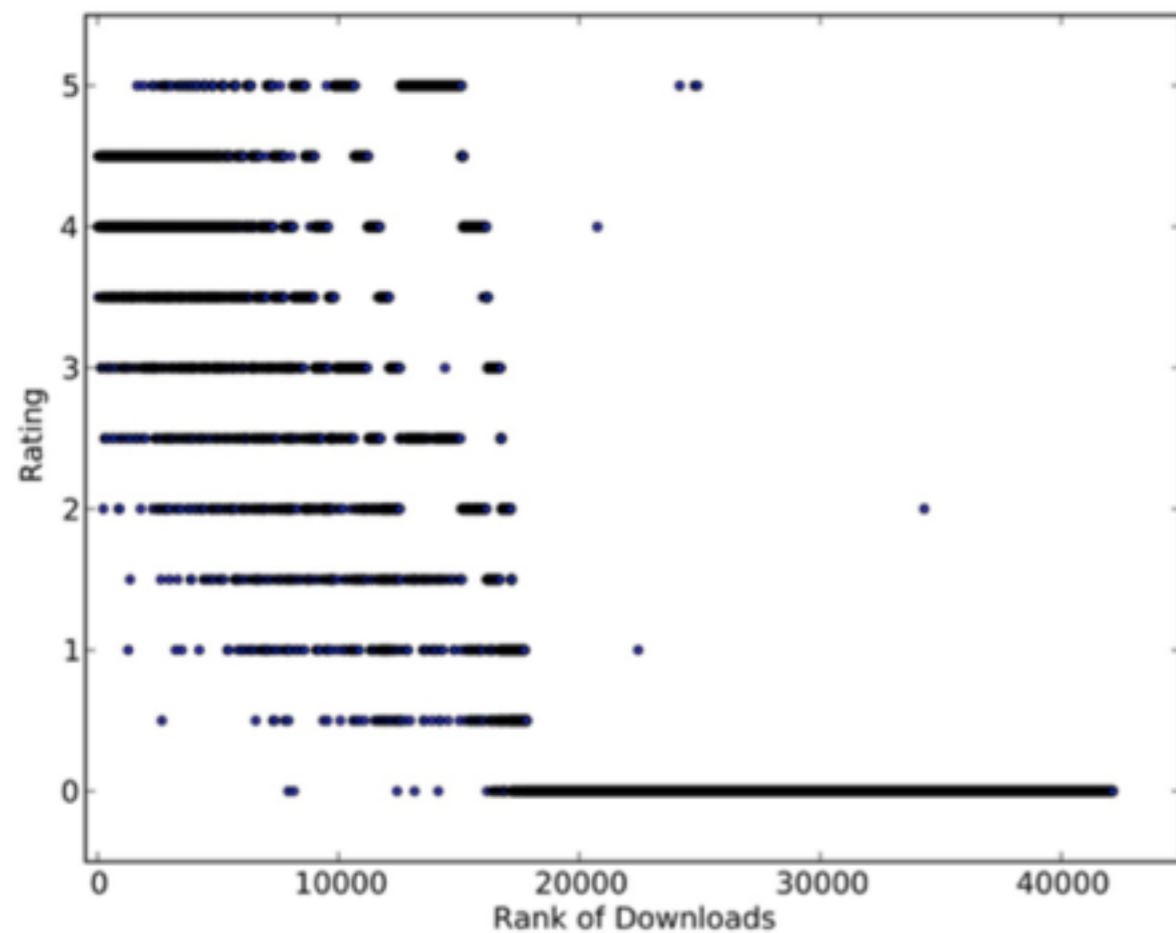
(c) RD non-free apps
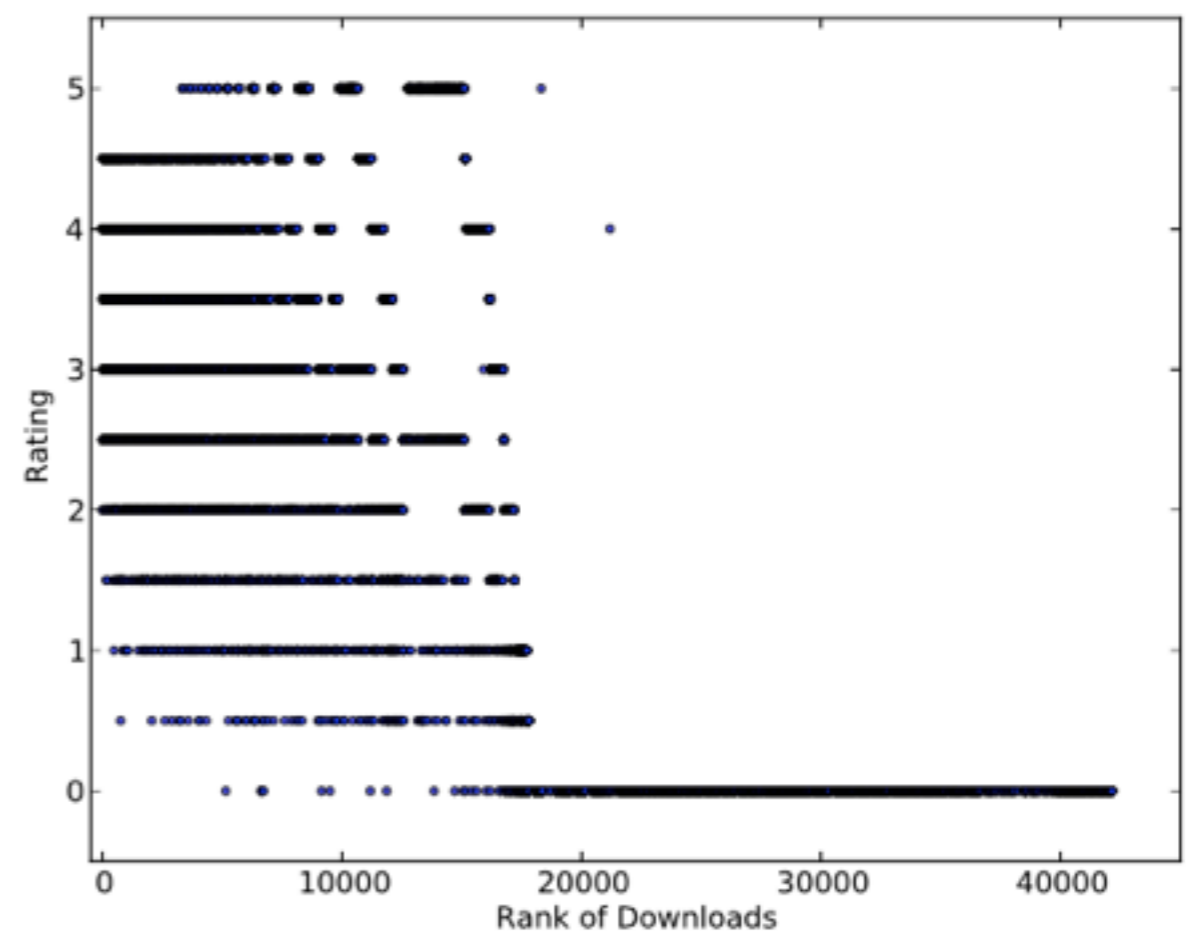
(d) RD free apps

RQ3

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RQ3:
Rating/Popularity Correlation

Non-free apps

Pearson correlation cofficient *rho = 0.78 (p = 0.004)*

Spearman correlation cofficient rho = 0.72 (p = 0.013)

Free apps

Pearson correlation cofficient *rho = 0.64 (p = 0.033)*

Spearman correlation coefficient rho = 0.65 (p = 0.037)
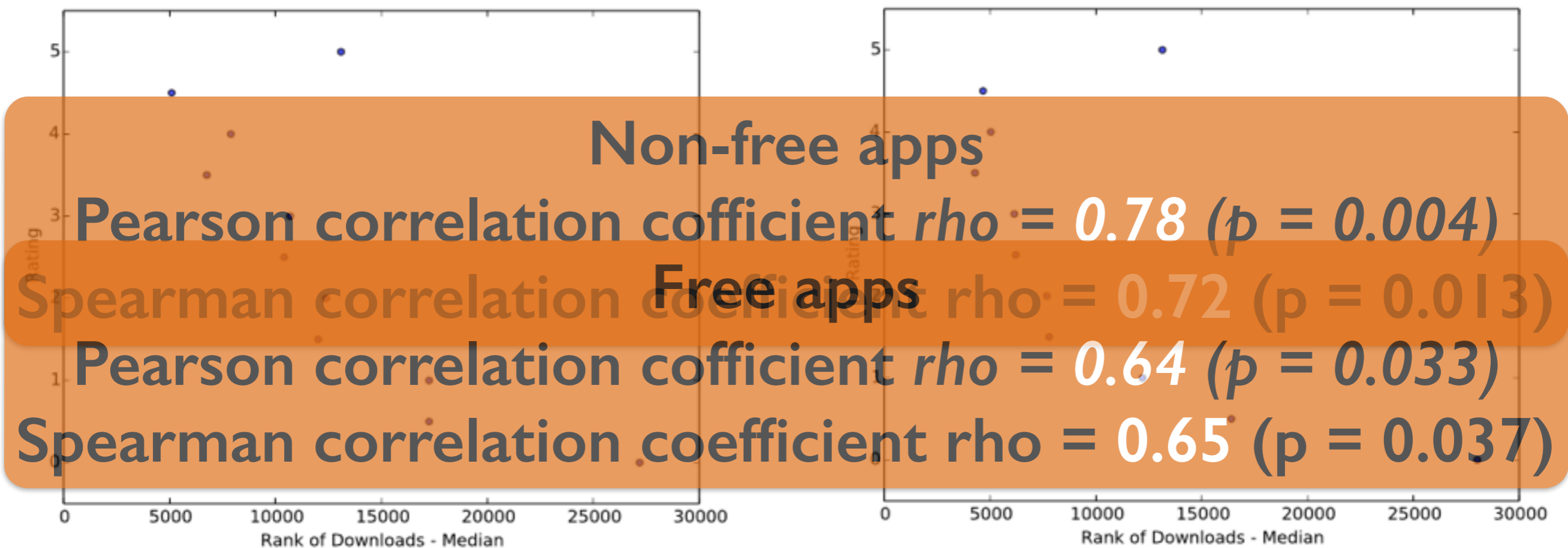
(e) MedianRD non-free apps

(f) MedianRD free apps

RQ3

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RQ3:
Rating/Popularity Correlation

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RQ3:
Rating/Popularity Correlation

Median RD
free apps
Polynomial model

Rating

Rank of Downloads - Median

RQ3

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RQ3:
Rating/Popularity Correlation

Median RD
free apps (0 < R < 5)
Polynomial model

RQ3
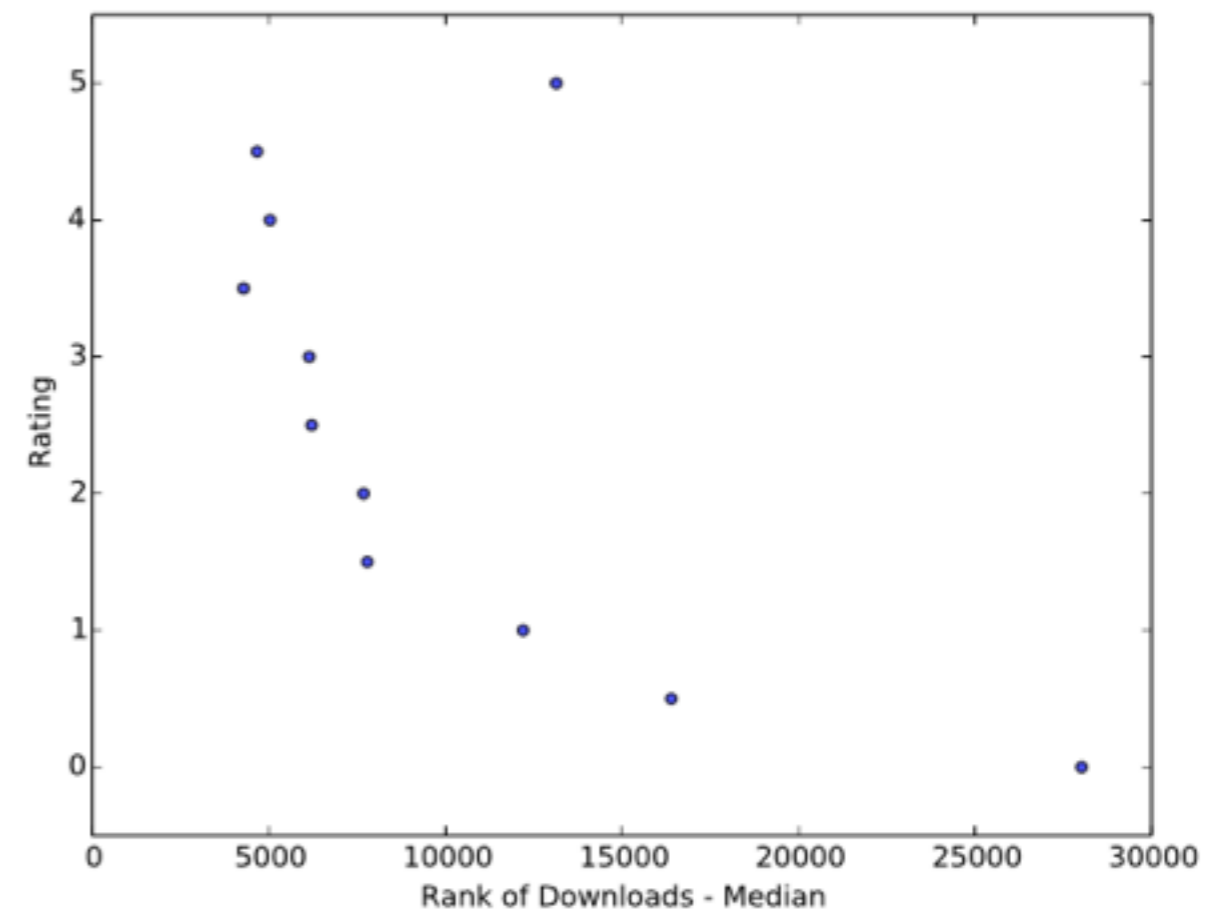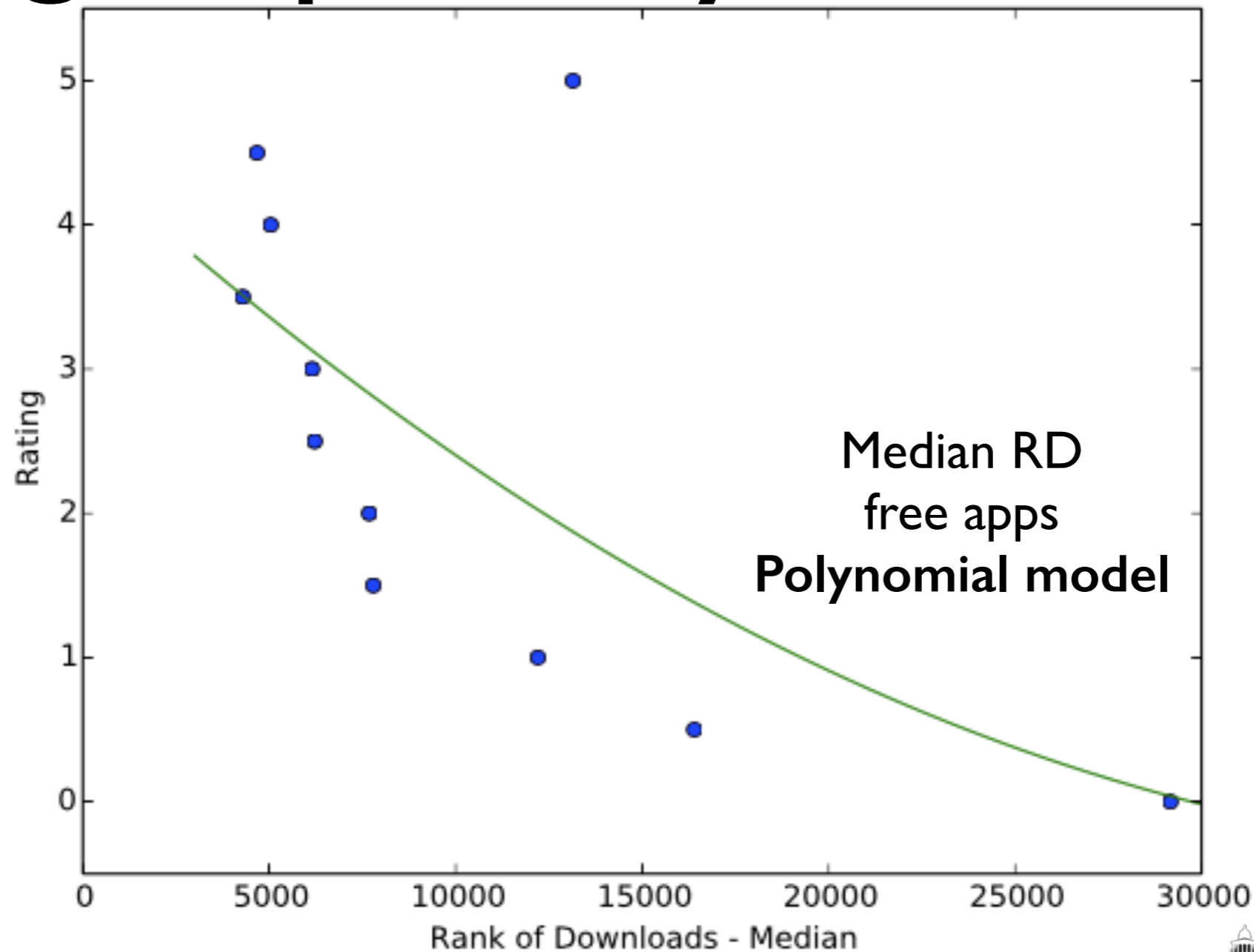
Yuanyuan Zhang
yuanyuan.zhang@ucl.ac.uk
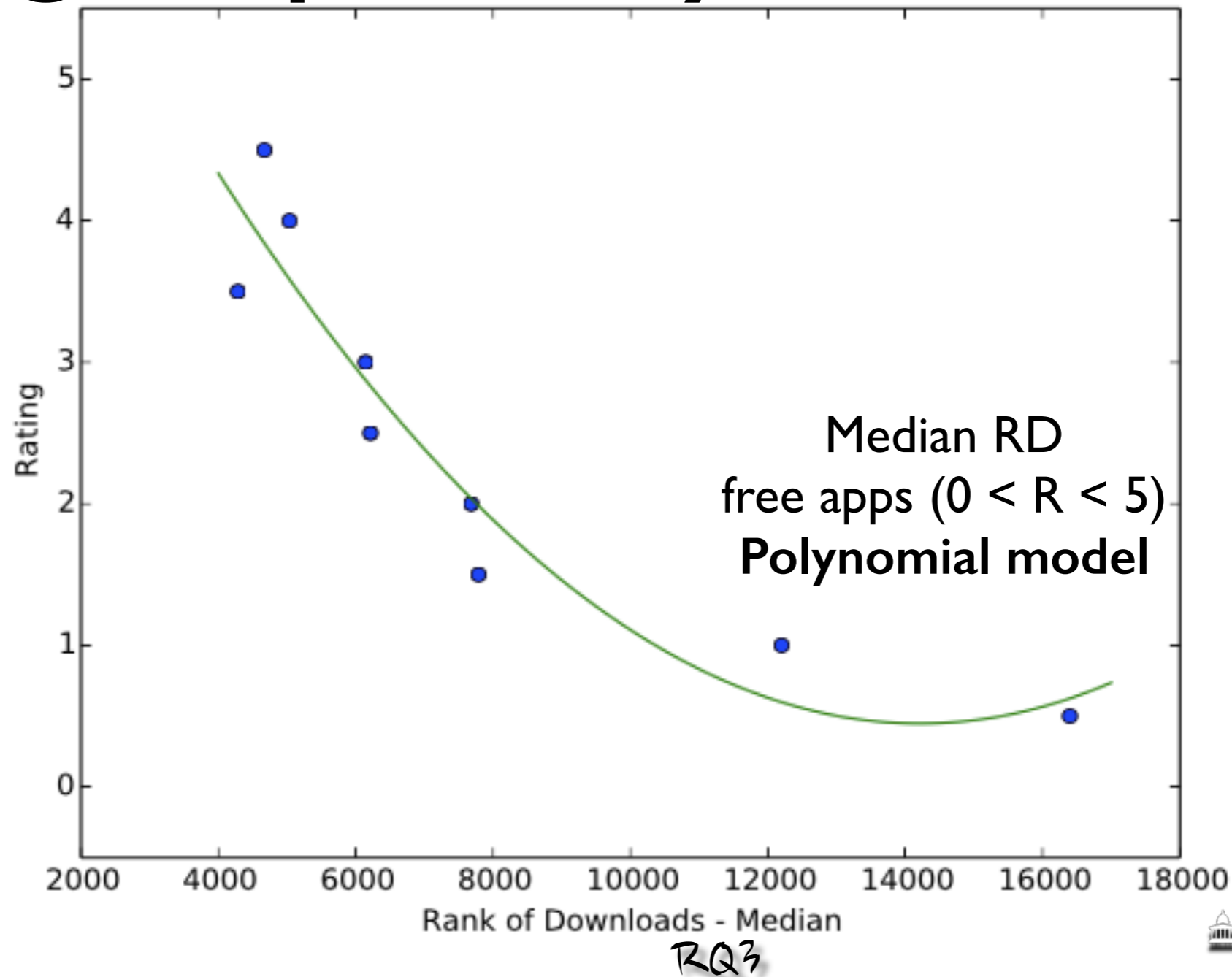
RQ3:
Rating/Popularity Correlation
over review subsets
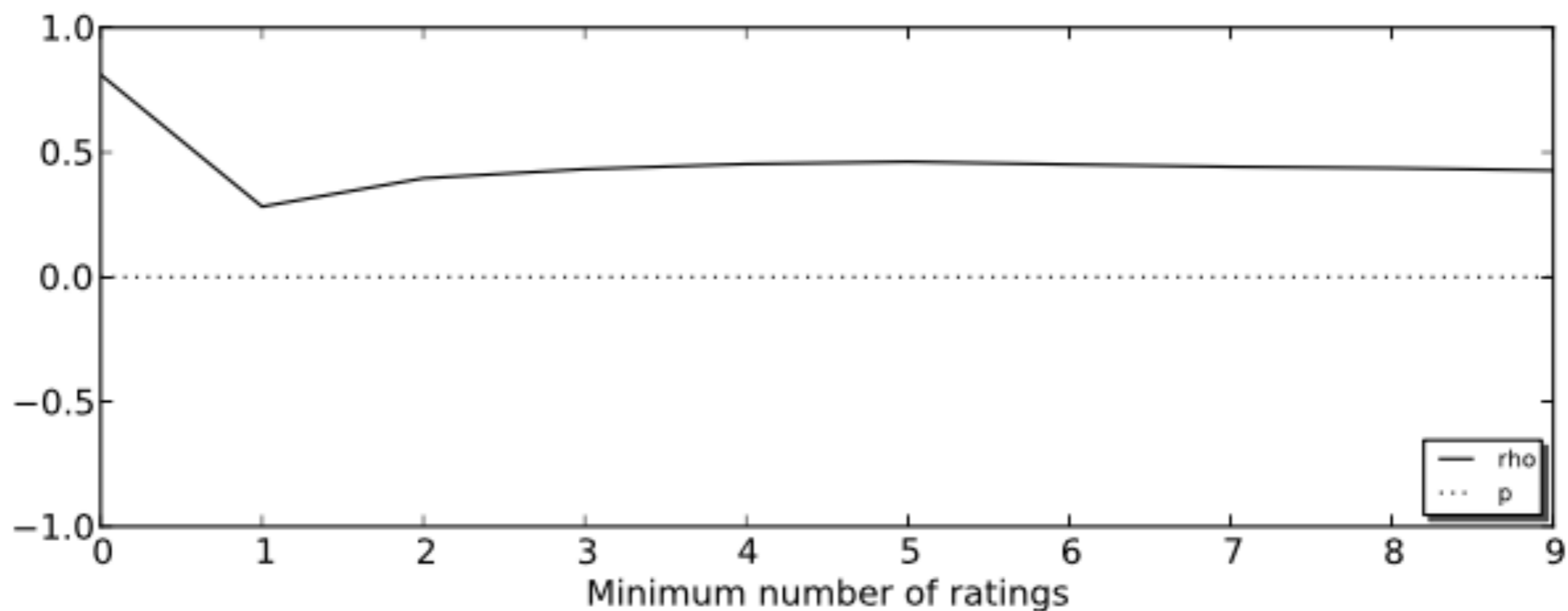
(c) Rating VS Rank of Downloads (non-free app)

RQ3

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RQ1-3:
Price/Rating/Popularity Correlations

Our results show that there is **a correlation** between **customer rating and the rank of app downloads** for apps and the features extracted from them and for **both free and non-free apps and features**. However, there is **very little evidence for any correlation** between **price and either rating or popularity**.

RQ3

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RQ4:
Meaningful Features?

App Feature Questionnaire

We are carrying out an evaluation of our App feature mining technique, to see whether if the features extracted from App Store are meaningful to human. Thank you for taking the time to fill in this questionnaire; it should only take about 5 minutes.

Each feature is captured by a small set of collocated words describing a function shared by a set of Apps in the same category. **You will be given both feature tokens (in arbitrary order) generated by our technique and randomly selected tokens from app description. Please choose "Yes" if you think the set of tokens could represent a feature.**

Enter name   Start Questionnaire

RQ4

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RQ4:
Meaningful Features?

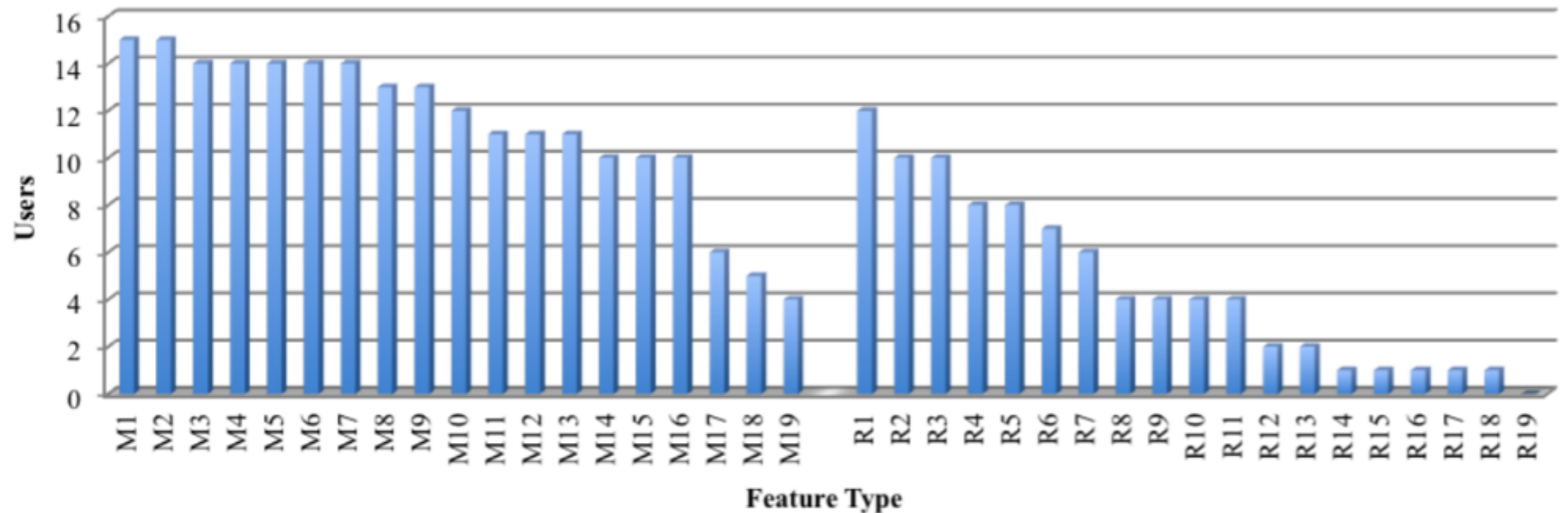| #	Feature Tokens	Categories	Could it be a feature?
Q1	['player', 'tweet', 'official']	Sports & Recreation	- Select -
Q2	['today', 'including', 'copyright']	News	- Select -
Q3	['press', 'songs']	Music & Audio	- Select -
Q4	['medical', 'expense']	Health & Wellness	- Select -
Q5	['activity', 'time']	Business	- Select -
Q6	['automatically', 'centered']	Maps & Navigation	✓ - Select - YES No

Next Page

RQ4

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RQ4:
Meaningful Features?

RQ4

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RQ4:
Meaningful Features?

there is evidence that the bitri-grams of features extracted are meaningful to humans.

RQ4

Yuanyuan Zhang
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RQ5:
A Stronger Correlation involving Price?
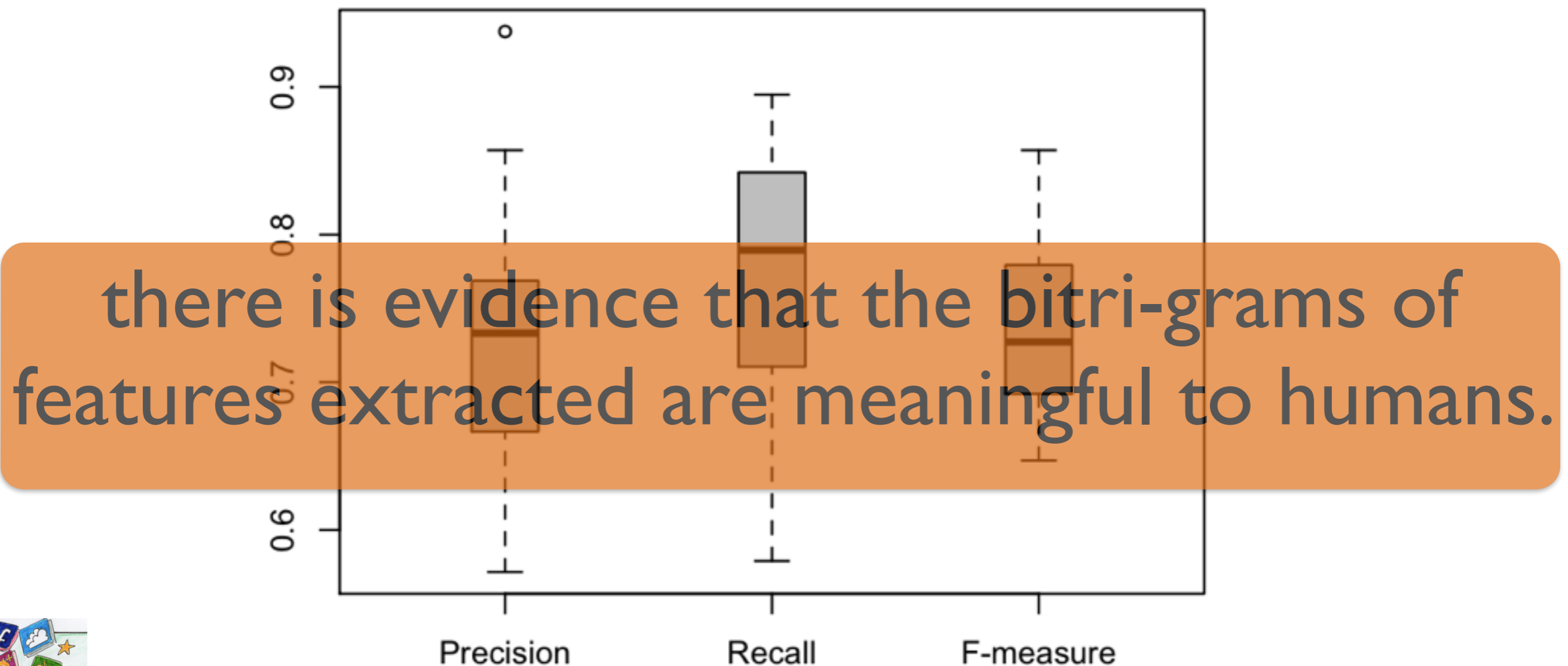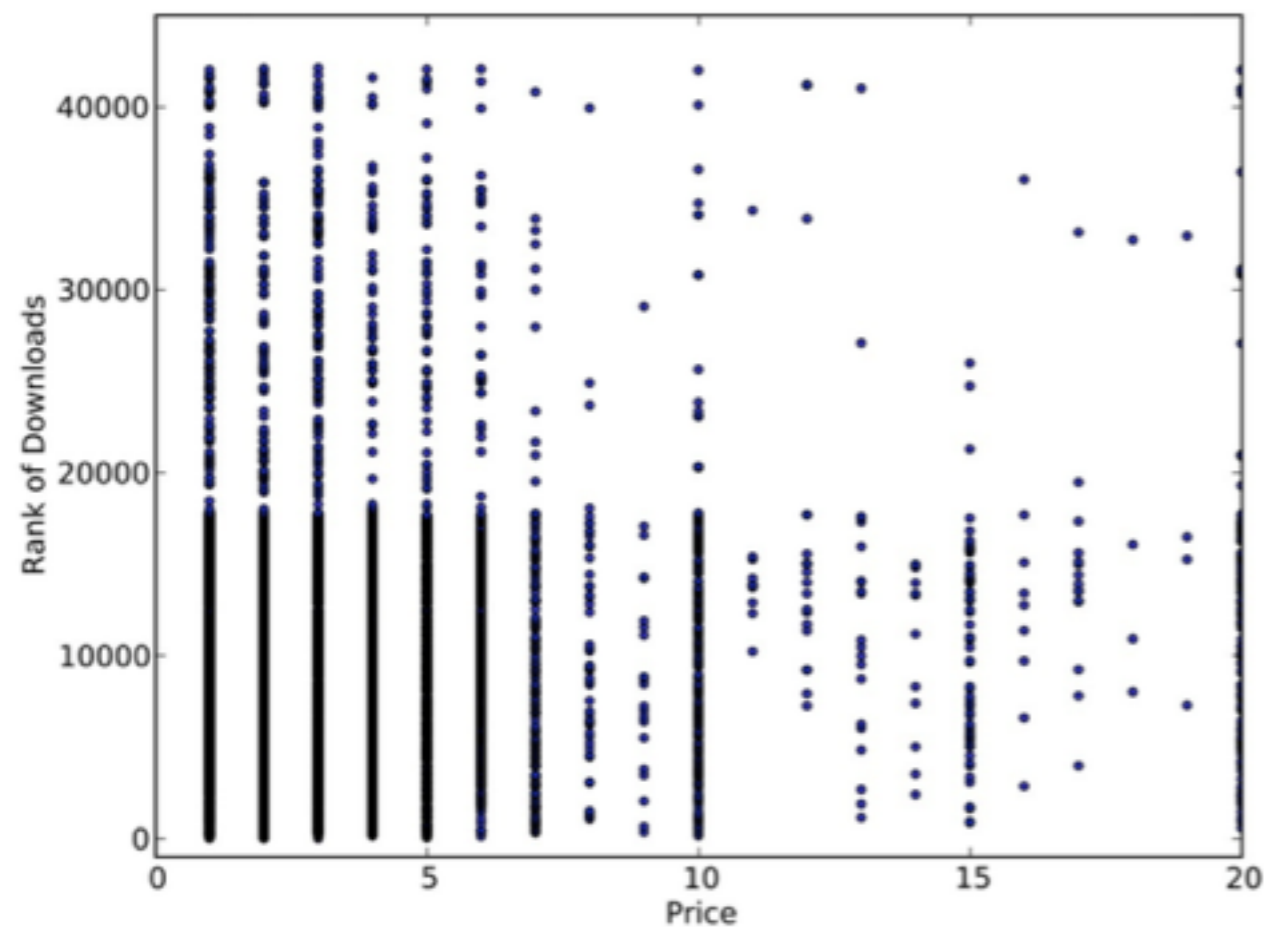

(a) Price VS Rank of Downloads

(b) Price VS Rank of Downloads

RQ5

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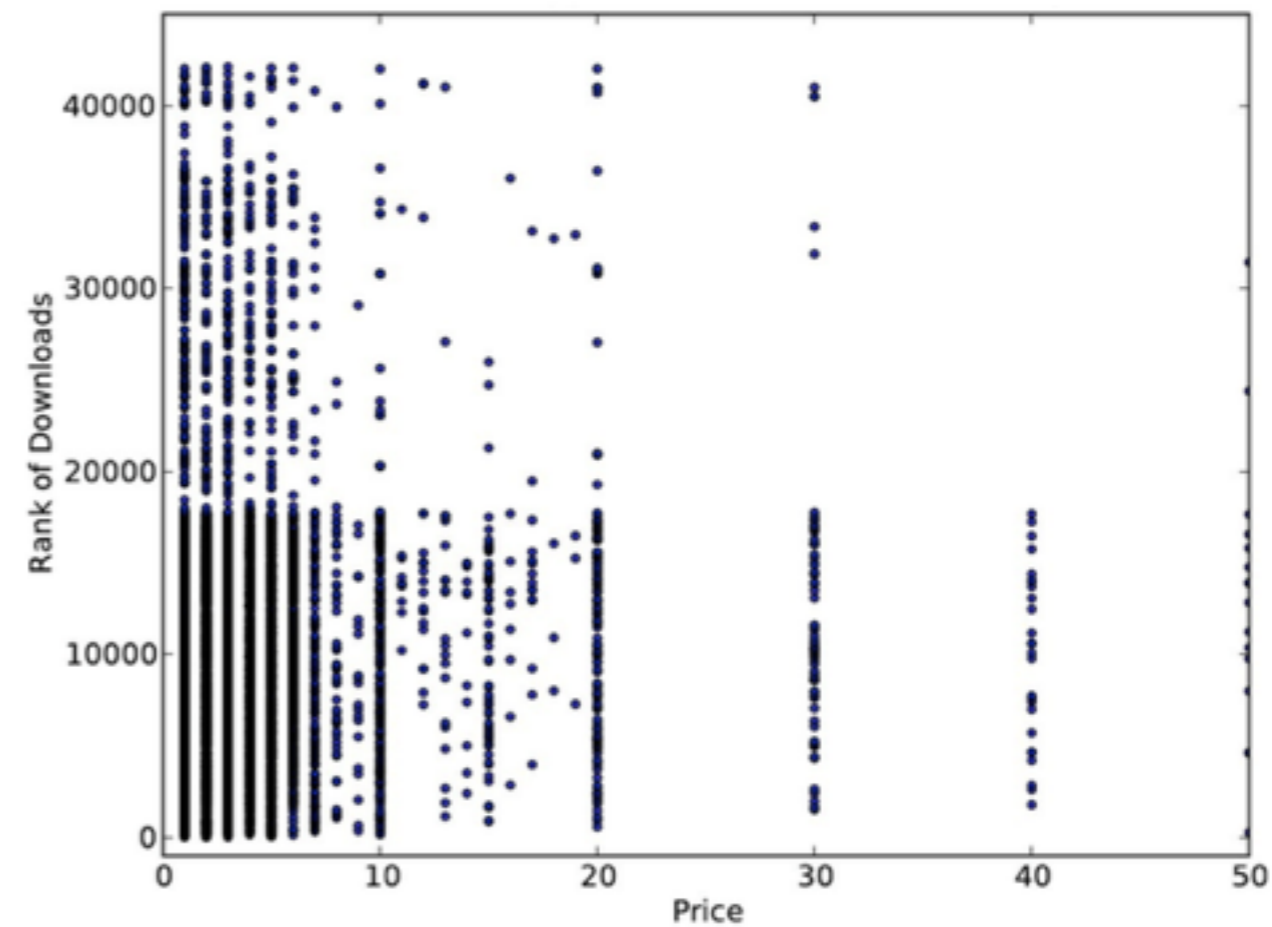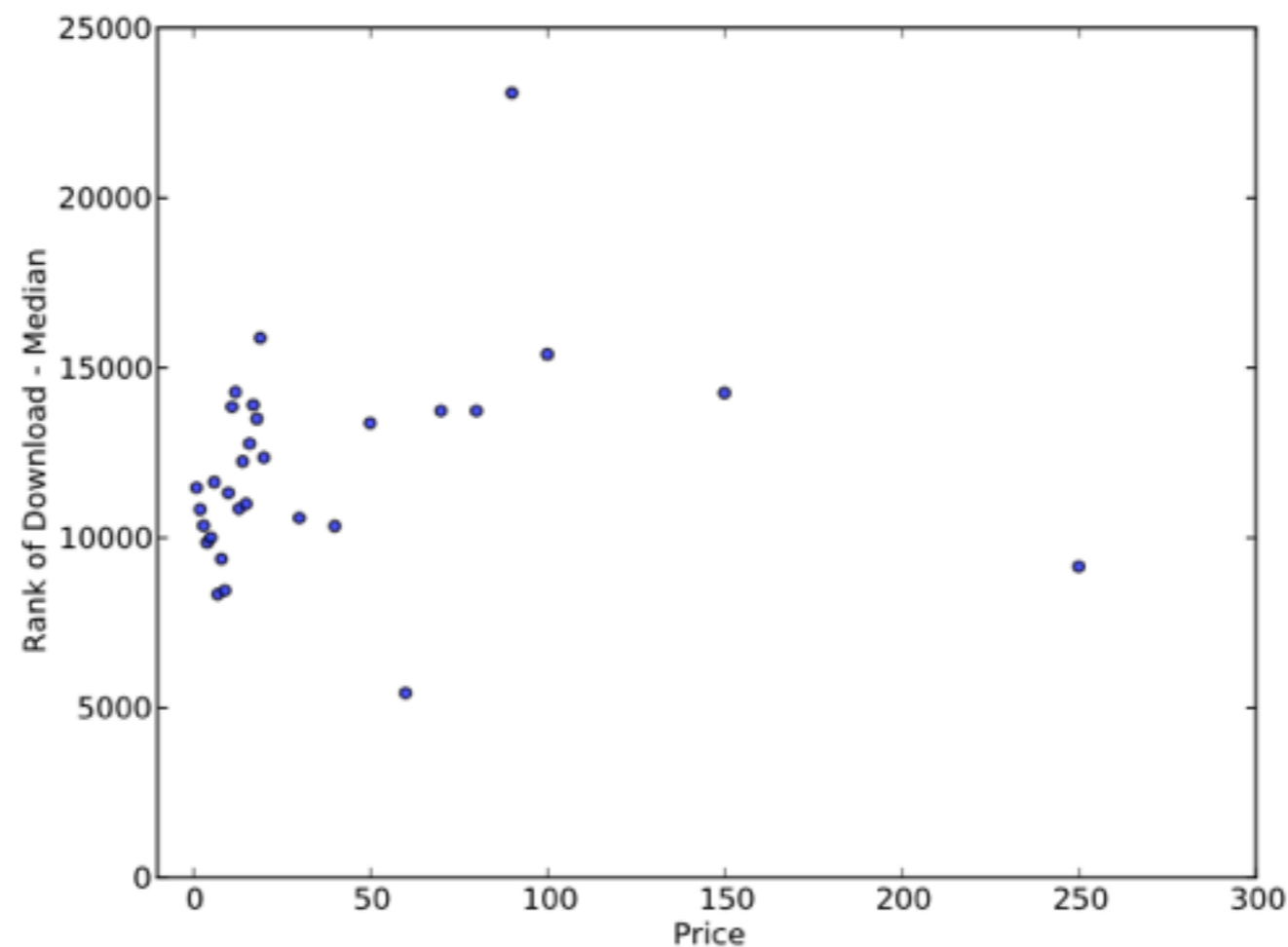# RQ5:
A Stronger Correlation involving Price?

(c) Price VS Rank of Downloads (median)

RQ5

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RQ5:
A Stronger Correlation involving Price?
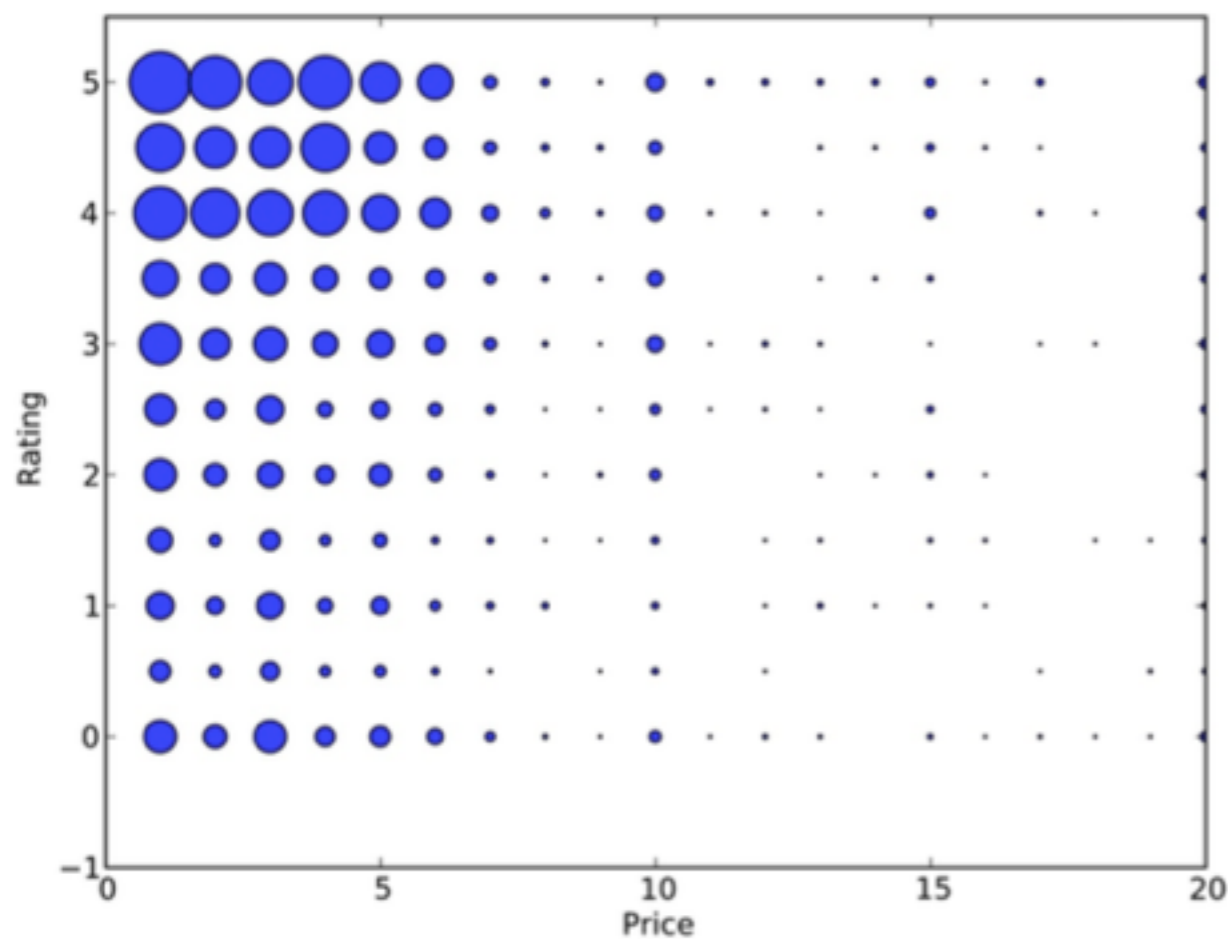
(d) Price VS Rating
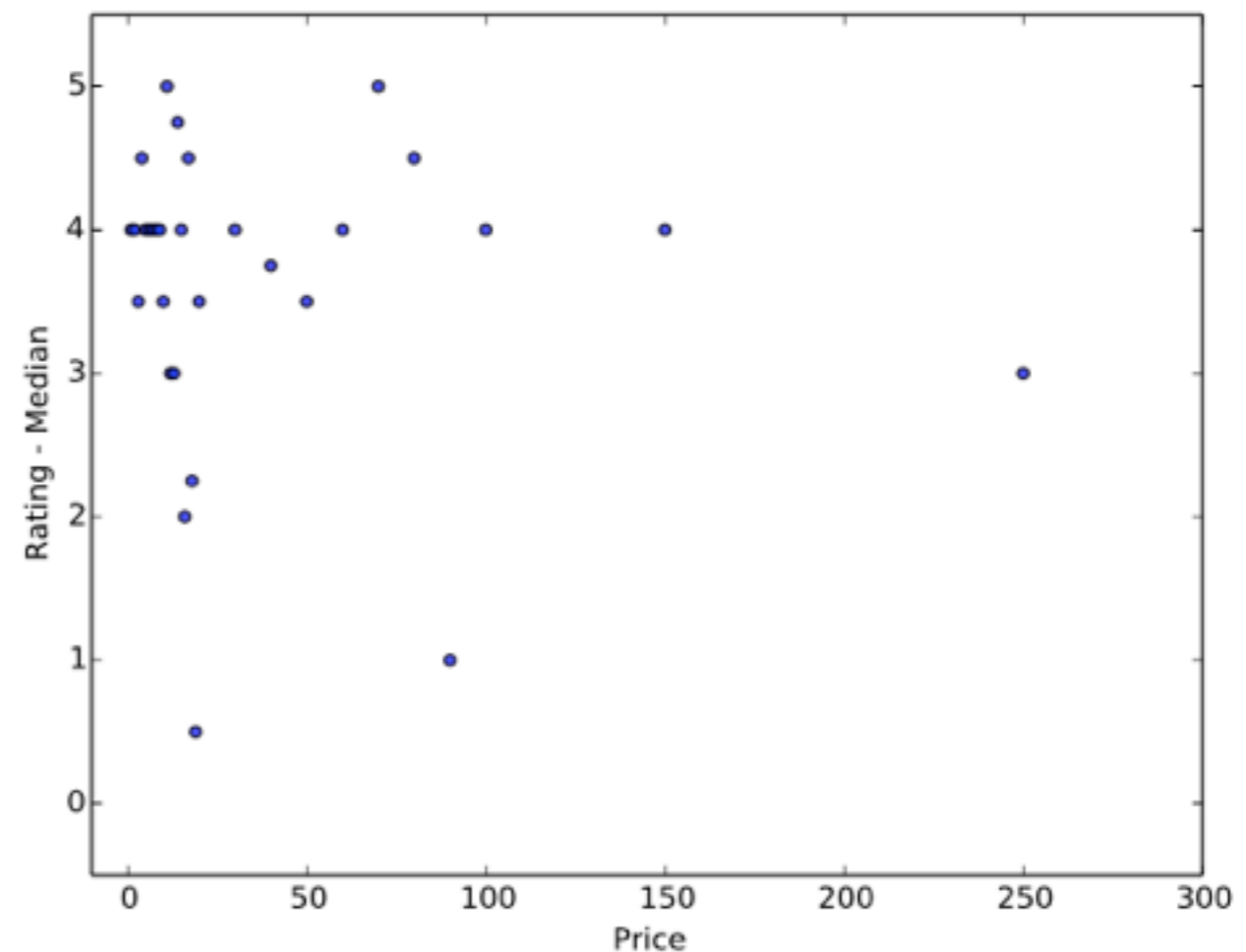
(f) Price VS Rating (median)
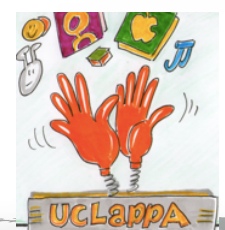
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Pearson correlation cofficient *rho = 0.46 (p = 0.007)*

Spearman correlation coefficient rho = 0.46 (p = 0.006)

There is a moderate correlation between price and median number of features. That is, more expensive apps tend to have more features.
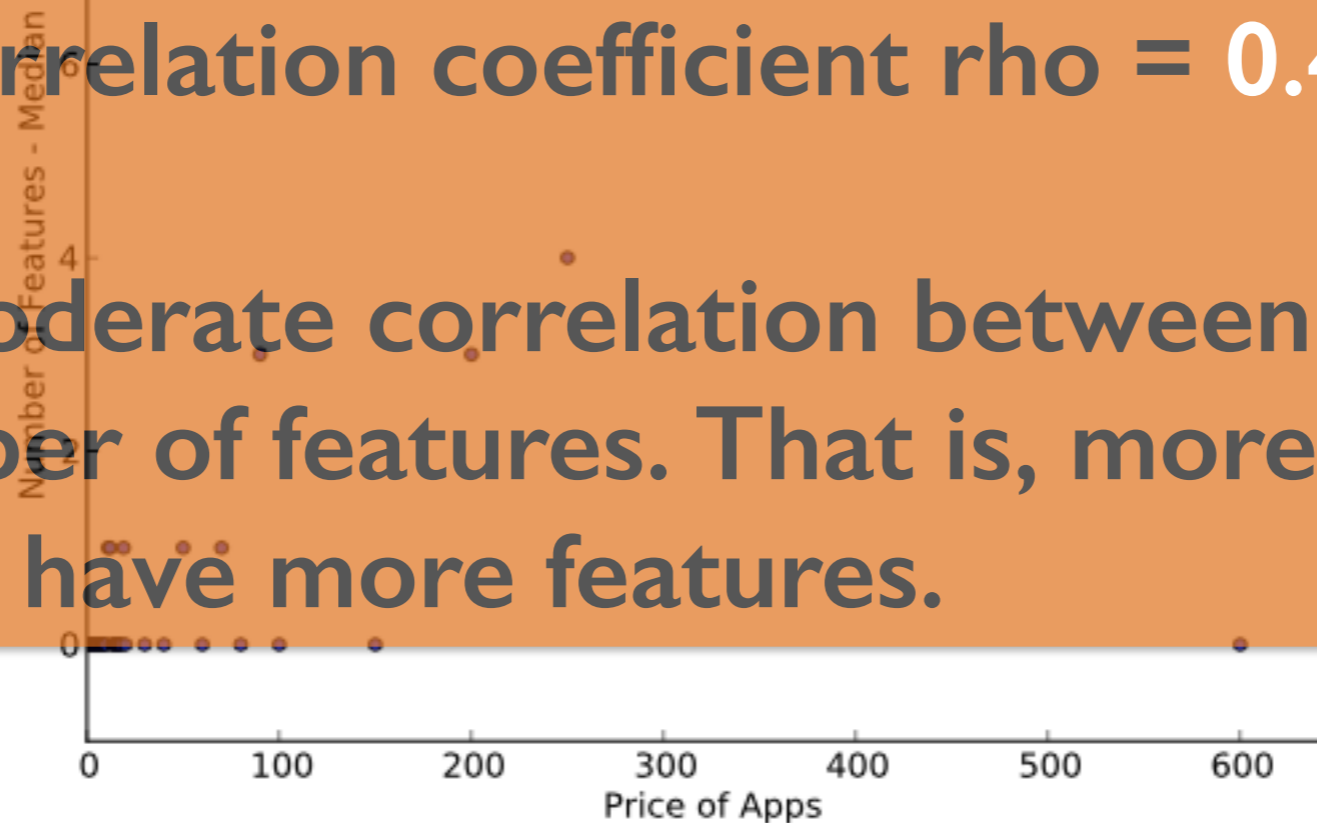
(g) Price VS Feature (median), $f \geq 0$

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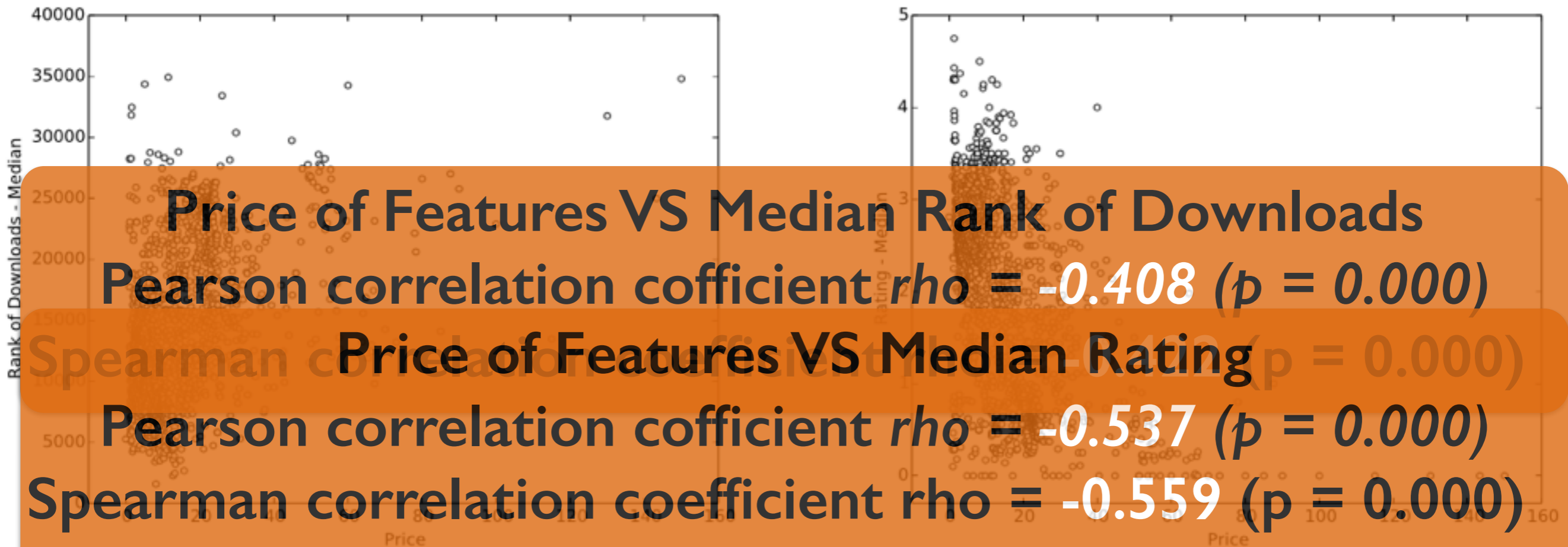
RQ5:
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Price of Features VS Median Rank of Downloads
Pearson correlation cofficient *rho = -0.408 (p = 0.000)*
Spearman correlation cofficient *rho* = *-0.463 (p = 0.000)*

Price of Features VS Median Rating
Pearson correlation cofficient *rho = -0.537 (p = 0.000)*
Spearman correlation coefficient rho = **-0.559** (p = 0.000)

There is an inverse correlation between the feature price and rating. That is, more expensive features tend to be less highly ranked.

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There is a moderate correlation between apps price and median number of features. The higher the price, the more features are claimed to be provided.

However, the answer for features provides stronger evidence of an inverse correlation between the price and rating; more expensive features tend to be less highly ranked.

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RQ5.1:
A Stronger Correlation involving Price?

Is there any difference in Rating and Popularity for free apps compared to non-free apps?

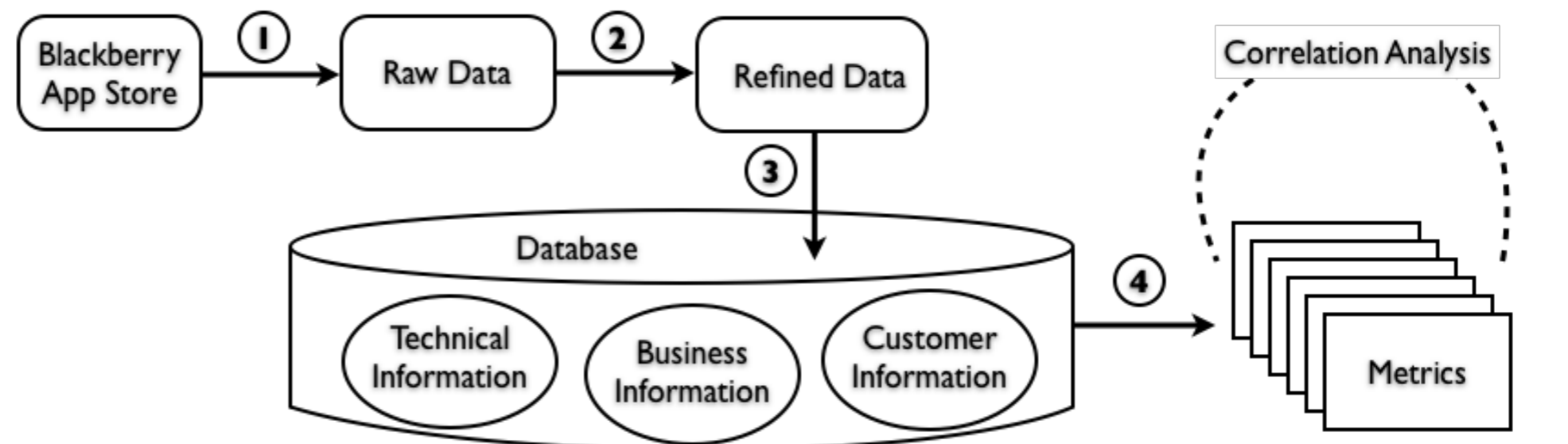Non-parametric Mann-Whitney Test & Vargha-Delaney effect size

There is strong evidence that the free apps are, in general, more popular than non-free apps and they also enjoy higher ratings.

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Technical — Features

Customer — Ratings / Popularity

Business — Price

(a) Price distribution over apps
(b) Price distribution over features
(c) Rating distribution over apps
(d) Rating distribution over apps - zoom in

UCLappA

Blackberry App Store →① **Raw Data** →② **Refined Data**

③

Database: Technical Information | Business Information | Customer Information

④ → **Metrics**

Correlation Analysis

RQ1-3:
Price/Rating/Popularity Correlations

Our results show that there is **a correlation** between **customer rating and the rank of app downloads** for apps and the features extracted from them and for **both free and non-free apps and features**. However, there is **very little evidence for any correlation** between **price and either rating or popularity**.

$$\frac{C(\blacksquare)+C(\blacksquare)+C(\blacksquare)}{3}$$

$$F(f,d) = \frac{\sum_{a_i \in S(f,d)} A(a_i, d)}{\sharp(S(f,d))}$$

RQ4:
Meaningful Features?

#	Feature Tokens	Categories	Could it be a feature?
Q1	['player', 'tweet', 'official']	Sports & Recreation	- Select -
Q2	['today', 'including', 'copyright']	News	- Select -
Q3	['press', 'songs']	Music & Audio	- Select -
Q4	['medical', 'expense']	Health & Wellness	- Select -
Q5	['activity', 'time']	Business	- Select -
Q6	['automatically', 'centered']	Maps & Navigation	- Select - / YES / No

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There is a moderate correlation between apps price and median number of features. The higher the price, the more features are claimed to be provided.

However, the answer for features provides stronger evidence of an inverse correlation between the price rating; more expensive features tend to be less highly ranked.