

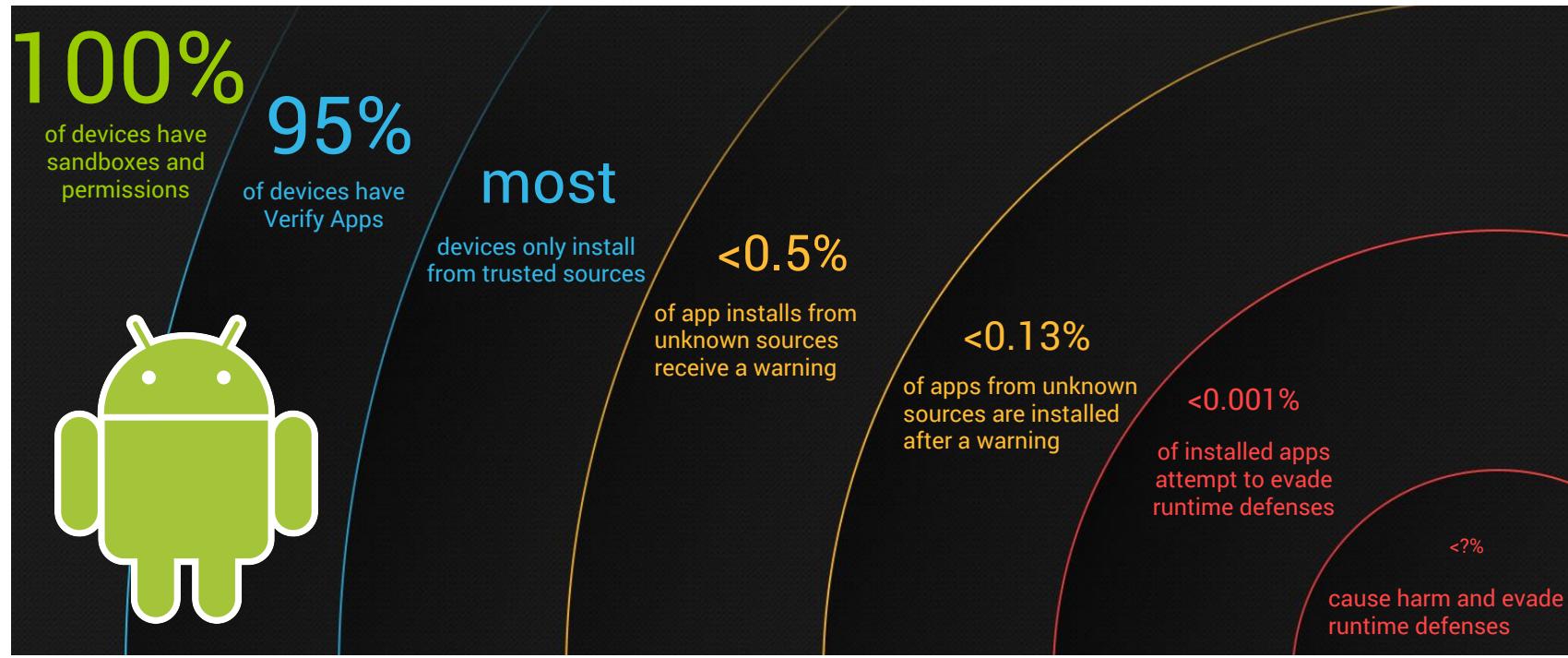
AndRadar: Fast Discovery of Android Applications in Alternative Markets



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Low infection rates?

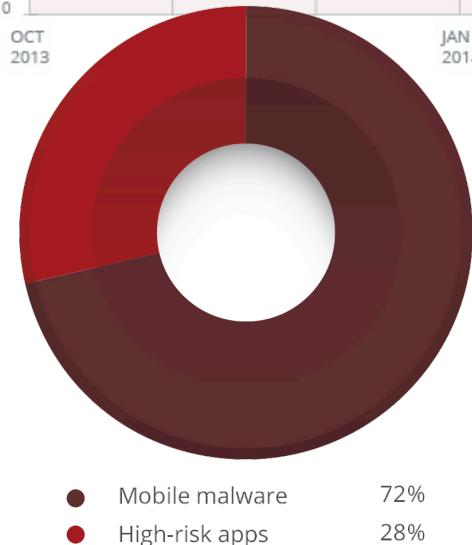


- The Core of the Matter (NDSS13) 0.0009%
- The Company You Keep (WWW14) 0.28%

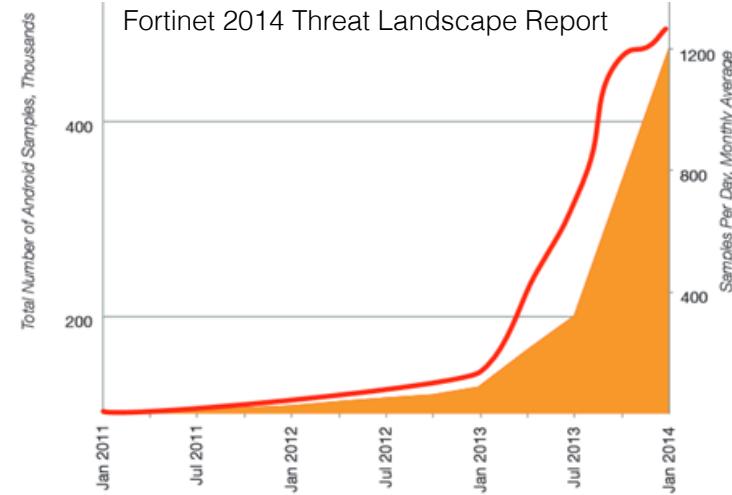
AV vendors paint a different picture...



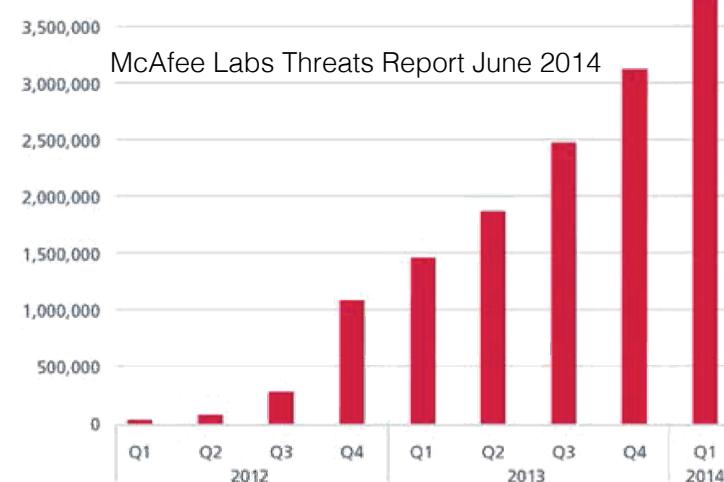
TrendMicro TrendLabs 1Q 2014 Security Roundup



Fortinet 2014 Threat Landscape Report



McAfee Labs Threats Report June 2014



Motivation



- How are malicious apps distributed?
 - Official Google Play Store
 - Torrents, One-Click Hosters
 - Websites, Blogs, ...
 - Alternative App Markets
- How wide-spread are malicious apps, how often are they downloaded?
- Do alternative markets employ security measures?
- Collect metadata for malware analysis
 - Andrubis, AndroTotal



Market Metadata: Google Play



Farting Panda – Android Apps on Google Play
https://play.google.com/store/apps/details?id=air.nl.bellpepper.fartingpanda

Google play

Apps

My apps

Shop

Games

Editors' Choice

Farting Panda

Bell Pepper Edutainment - 11 March 2014
Arcade

Install Add to wishlist

★ ★ ★ ★ ★ (1,733) 8+1 +1663 Recommend this on Google

The screenshot shows the Google Play store page for the "Farting Panda" app. The top section displays the app's icon (a panda farting), title, developer, category, and download/install buttons. Below this, four screenshots of the game are shown, illustrating the panda's movement and interaction with the environment. The bottom section contains the app's description, which includes a playful narrative about the panda's diet and the mechanics of the game, along with a bulleted list of controls.

Are you up for the challenge?
Who needs a bird (even the flappy kind) if you can have a Panda?
Panda ate a splashy fish for breakfast, a flappy bird for lunch, and now his farts propel him high up in the air!
You know the drill:
• Tap!
• Fart!
• Avoid the bamboo!
• Get the hiscore! (mine is 15)

Market Metadata: Google Play



Farting Panda – Android Apps on Google Play
<https://play.google.com/store/apps/details?id=air.nl.bellpepper.fartingpanda>

Write a Review

Reviews

3.4

1,733 total

Rating	Count
★ 5	732
★ 4	215
★ 3	210
★ 2	171
★ 1	405

Jaxon Daoust ★★★★★
Addictive OK so I never played flappy bird. But this cute lil panda is addictive. Originally got it for my son ...

keishajo1973 ★★★★★
This is Awesome Zoos vu oversees Irene g deck vhf devilish cheese CIC faucets x Dudish v distends distrusts ...

What's New

- With music!
- With high quality graphics!
- More than 10 farting sounds!
- Play the game, or use the main menu as a musical instrument!
- Fart your way into the highscores!
- Made the collision check better.
- Performance tweaks.

Additional information

Updated	Size	Installs	Current Version	Requires Android
11 March 2014	11M	100,000 - 500,000	1.3.5	2.2 and up

Content Rating: Everyone | Contact Developer | Visit Developer's Website | Email Developer | Permissions | View details | Report | Flag as inappropriate

Similar

A row of five small thumbnail images showing various app interfaces, likely related to games or fun applications.

Outline



- **Market Characterization**
- Android Market Radar (AndRadar)
- Evaluation and Case Study
- Future Work and Conclusion

Market Characterization



- Alternative markets are popular because of ...
 - Country gaps (e.g. no paid apps in Google Play China)
 - Promotion
 - Specific needs and specialization
- Preliminary study on 8 alternative marketplaces
 - Crawled them entirely between July and Nov 2013
 - Downloaded 318,515 apps

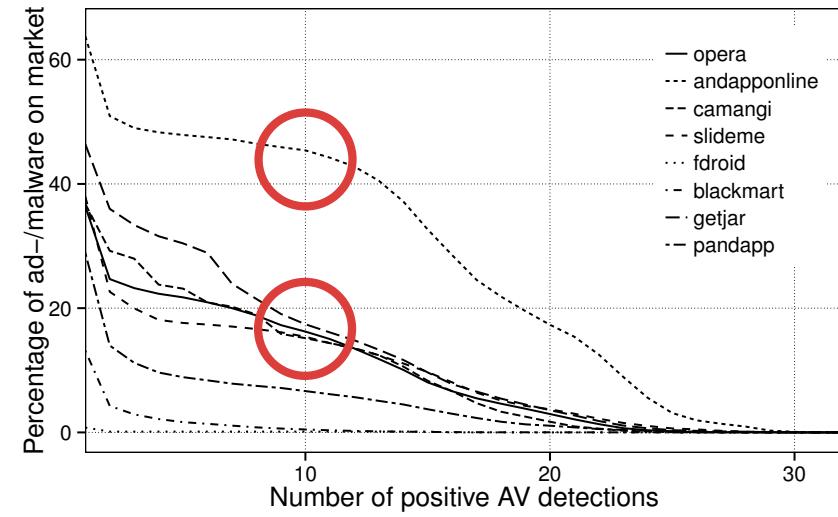
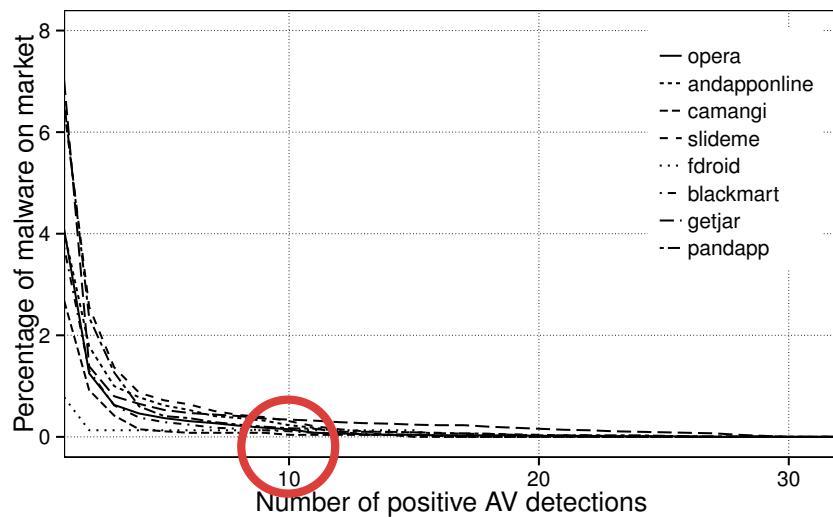


(1) Distribution of Unwanted Apps



Do markets distribute known, unwanted apps?

- Yes, they do!
- 5-8% malicious apps in whole dataset
10+ AV detections, excluding adware
- Some markets specialize in adware/"madware"

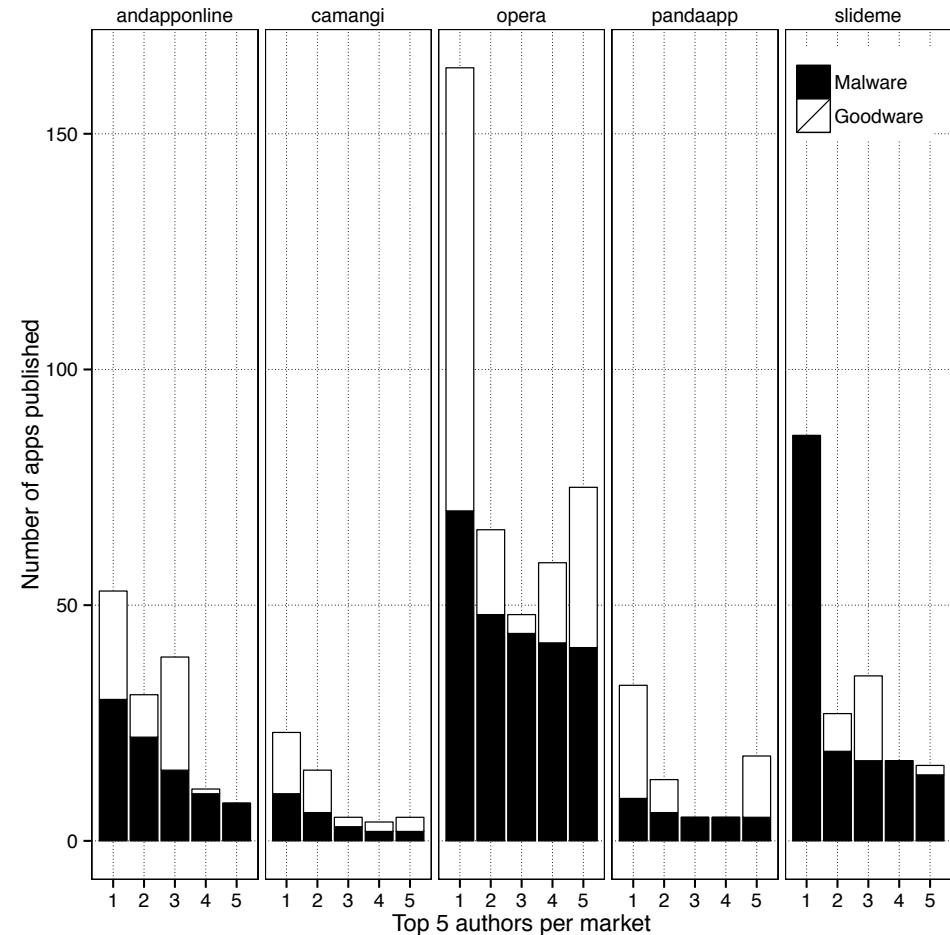


(2) Publication of malicious apps



Do markets allow the publication of malicious apps?

- Yes, they do!
- Ranking based on number of published apps
- Well visible and known to market operators
- Top authors publish both benign and malicious apps

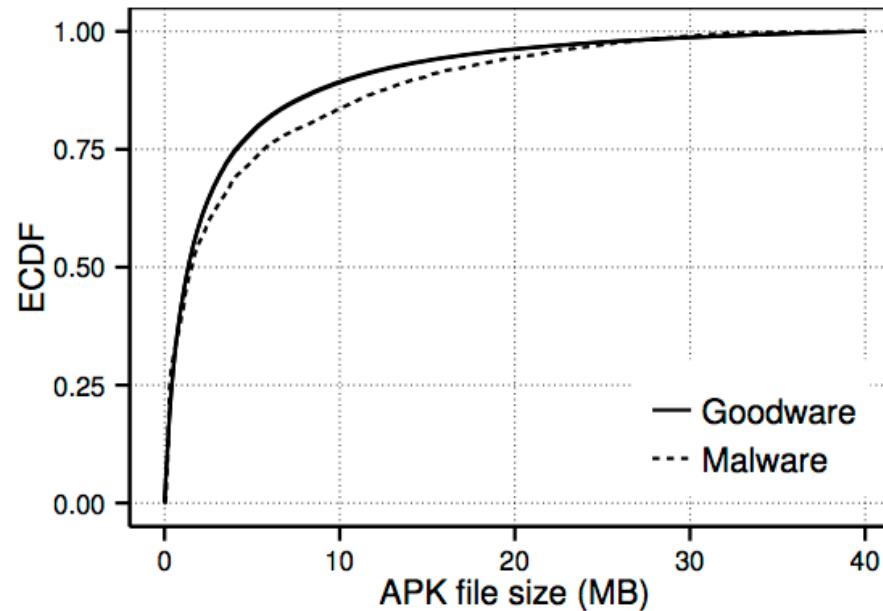


(3) Distinctive metadata



Do malicious apps have distinctive metadata?

- Yes, they do!
- Malicious apps slightly larger than goodware
→ Additional malicious code in repackaged apps
- Malicious apps are downloaded more often
→ Inflation of ranking with app rank boosting services

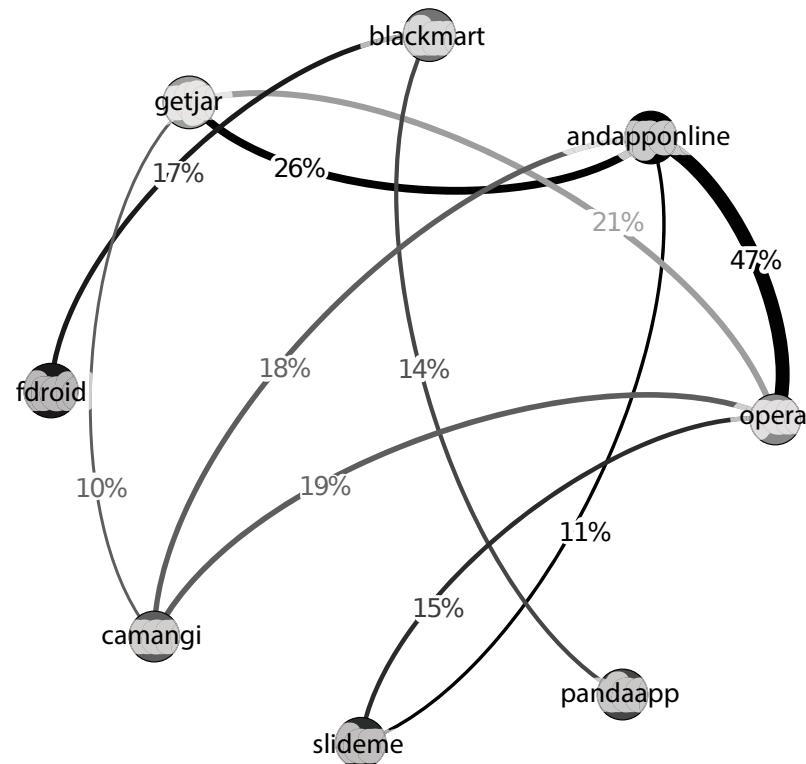


(4) Market Overlap

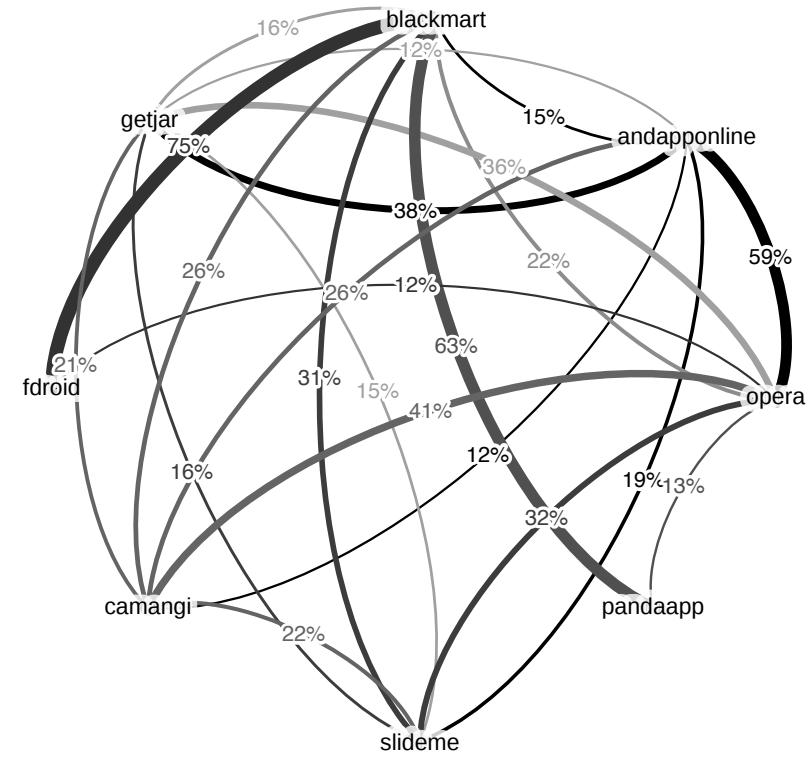


How are markets related to each other?

- Markets share up to 47% MD5s, 75% package names



Intersection by MD5



Intersection by package name

Outline



- Market Characterization
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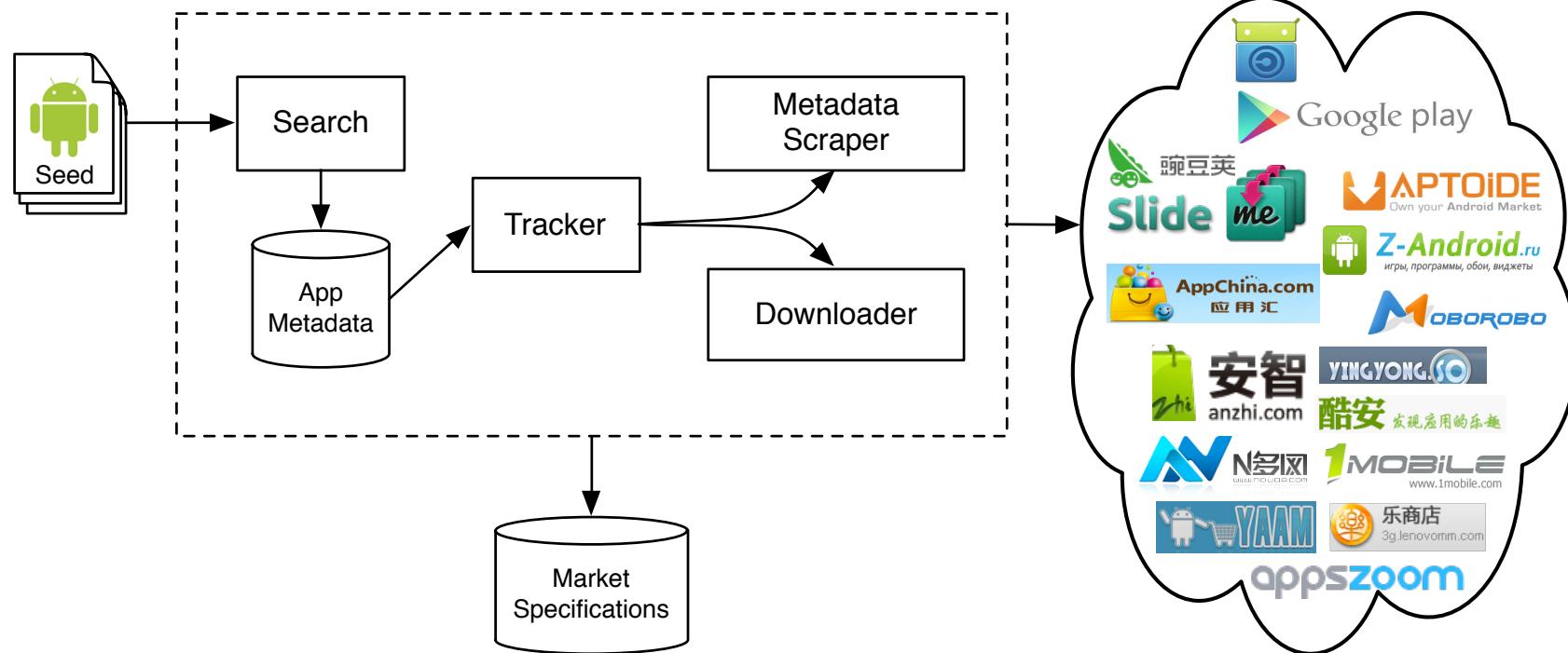
AndRadar Design Goals



- Discover apps in markets in real-time
- Distribution of apps across markets
- Increasing space and time requirements
- Meta information dynamic → regular crawling of apps

- Crawling of complete markets becomes infeasible
 - Plethora of alternative markets
 - ~ 196 in October 2011 (Vidas et al. CODASPY13)
 - ~ 500 in Juniper Threats Report March 2012/2013
 - ~ 89 in our market study in June 2013

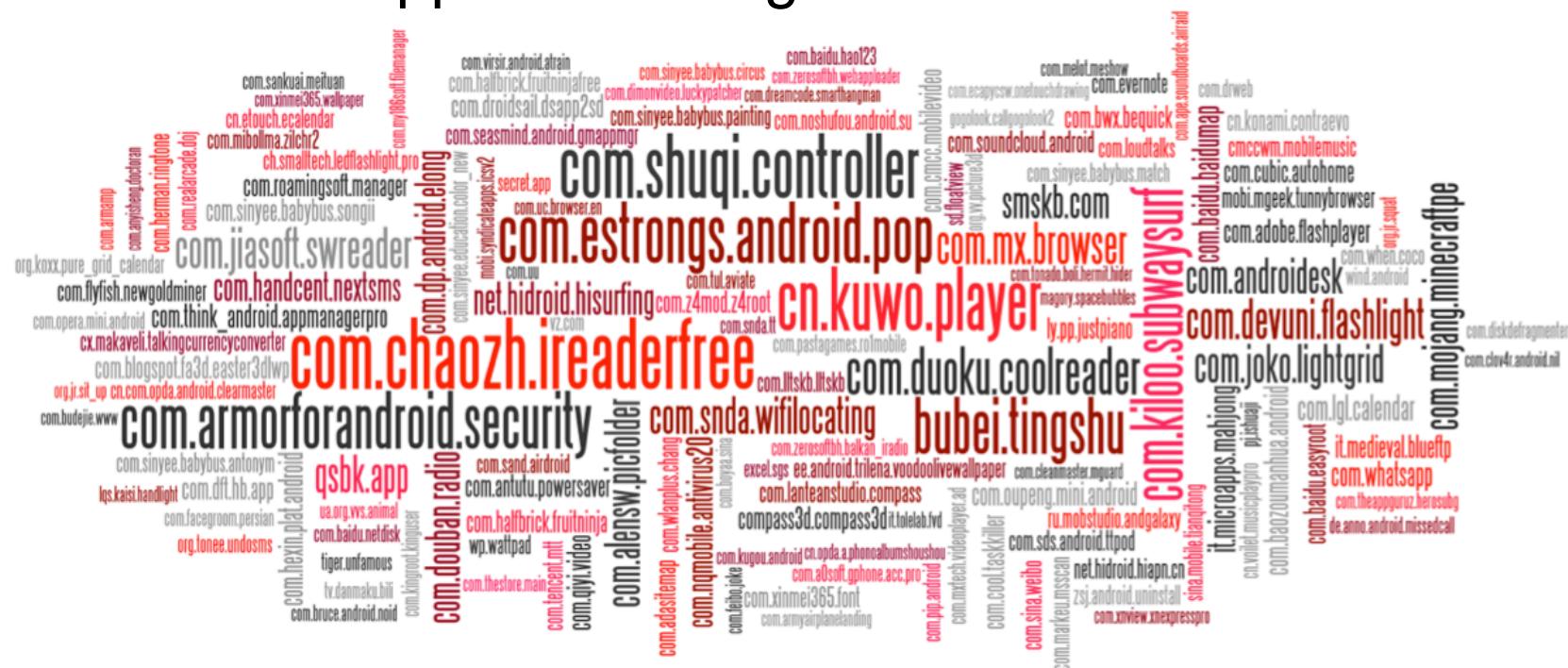
AndRadar Architecture



App Discovery



- Lightweight identifier to select target apps
 - Package name uniquely identifies app on device
 - Package name identifies app in markets
 - Part of an app's “Branding”



App Discover: AppChina



The screenshot shows the AppChina website interface. At the top, there's a navigation bar with links for '首页', '安卓软件', '安卓游戏', '排行榜', '开发者', '应用邦', and '论坛'. Below the navigation is a search bar with the placeholder '搜索软件/游戏' and a search button labeled '搜 索'. A red box highlights the URL in the address bar: 'www.appchina.com/app/com.Beltheva.DanceDance/'. The main content area displays the app details for '锅舞者' (PanDancer). The app icon features a cartoon bear dancing. The title '锅舞者' and its English name 'PanDancer' are prominently displayed. To the right of the title is a button labeled '免费下载' (Free Download) and a smaller button '点击查看二维码' (View QR code). Above the download button is a '1人喜欢' (1 person likes it) icon. The app's file size is listed as '12.5 MB', download count as '1000-5000次', category as '益智游戏', version as '1.0.1', and system requirements as 'Android 2.2 以上'. Below this information, there's a detailed description in both Chinese and Japanese. The Japanese text discusses updates and restrictions regarding advertisements. On the left, there's a section titled '“锅舞者”的介绍:' (Introduction to 'PanDancer') containing a short story about the bear's dance competition. To the right of the introduction are four screenshots of the game interface, showing the bear performing various dance moves like 'STEP', 'TURN', 'JUMP', and 'POSE'. At the bottom of the page, there's a feedback section with a button '您的意见' (Your Opinion), a footer with social media links for WeChat and Weibo, and a note indicating the app was updated on '2014-03-02'.

App Discovery: Appszoom

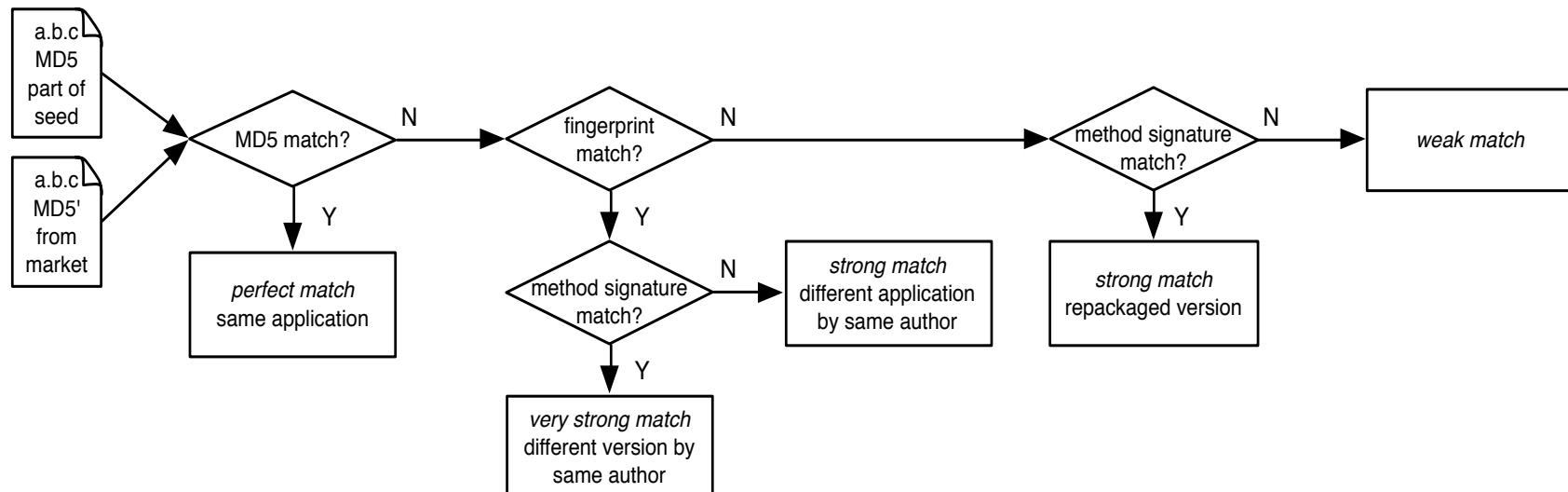


The screenshot shows the Appszoom website interface for the Android game "Rolling Panda". The top navigation bar includes links for "Categories", "Best Apps", "Today's Picks", "Downloaded", "Community", "Blog", "DEVELOPERS", and language selection ("EN"). A search bar is also present. The main content area displays the "Rolling Panda" app page. The app icon is a cartoon panda, labeled as "FREE" with a 4-star rating (2,097 reviews). Below the icon, there are download links for "Android" and "iPhone". The "Details" tab is selected, showing the app's name, developer ("KidsFun"), download count (500,000 - 1,000,000), and a list of "Pros" (fun, entertaining, colorful, addictive) and "Cons" (graphics' problem sometimes). There is also a section for "By KidsFun" listing other apps like "Caveman 2", "Dino Island", "Kids Memory Game", "Whack Zombies", and "Glow Jewels". The "Changelog and permissions" section is expanded, showing the package name "Package com.kidsfun.jump.panda" highlighted with a red box. The permissions listed include: - Know what access (wifi, 3G...) you have at every moment. - Send and receive internet info. - android.permission.READ_EXTERNAL_STORAGE - Read phone state. Used to know whether you're in a call or not. - Use the vibrator. - Write whatever to your SD card.

App Matching



- Match downloaded app to malicious app in seed
- Different levels of confidence based on
 - Package name
 - MD5 hash
 - Fingerprint of developer's certificate
 - Method signatures



Collected Metadata



- Continuous monitoring of discovered apps
- Harvest meta information from market listing
 - Upload date
 - Description
 - Screenshots
 - Number of downloads
 - User ratings
 - Reviews
 - Other apps by the same author
 - Delete date

Outline

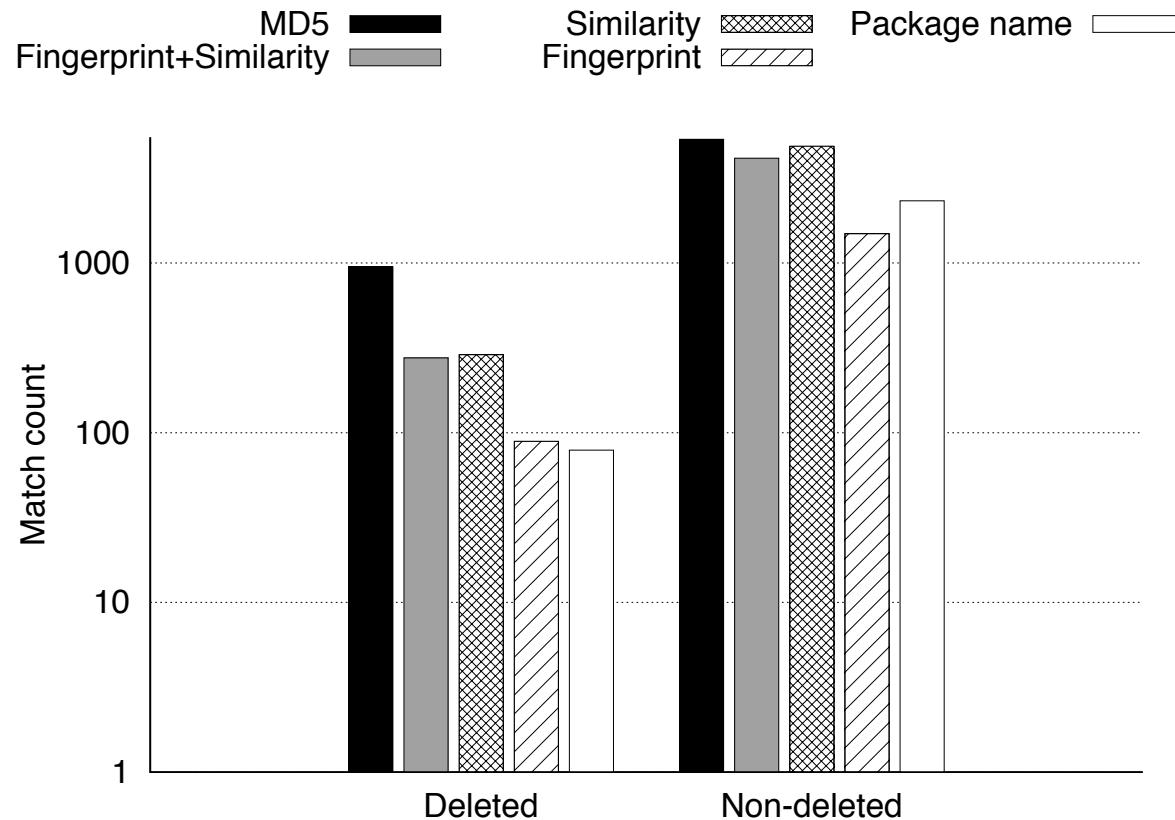


- Market Characterization
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- Future Work and Conclusion

Overall performance



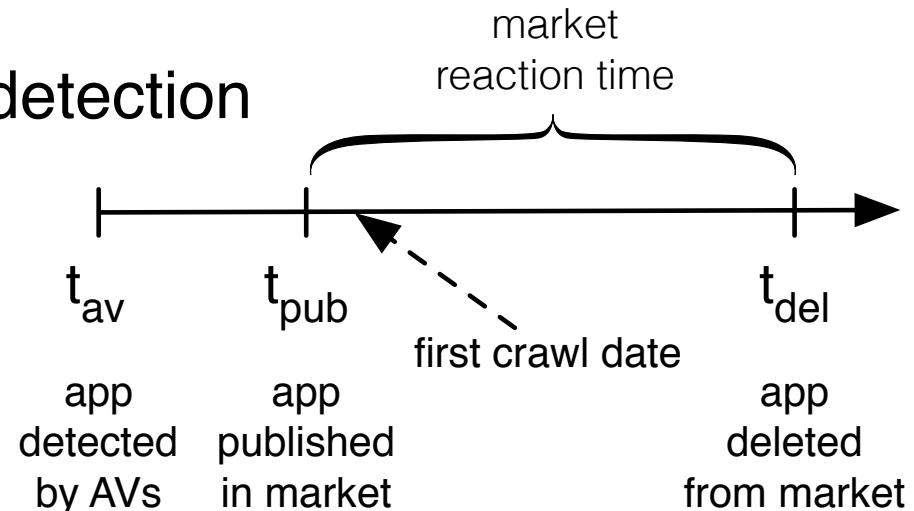
- Track tens of thousands of apps per market/day
- Tracked 20,000 apps/1,500 app deletions



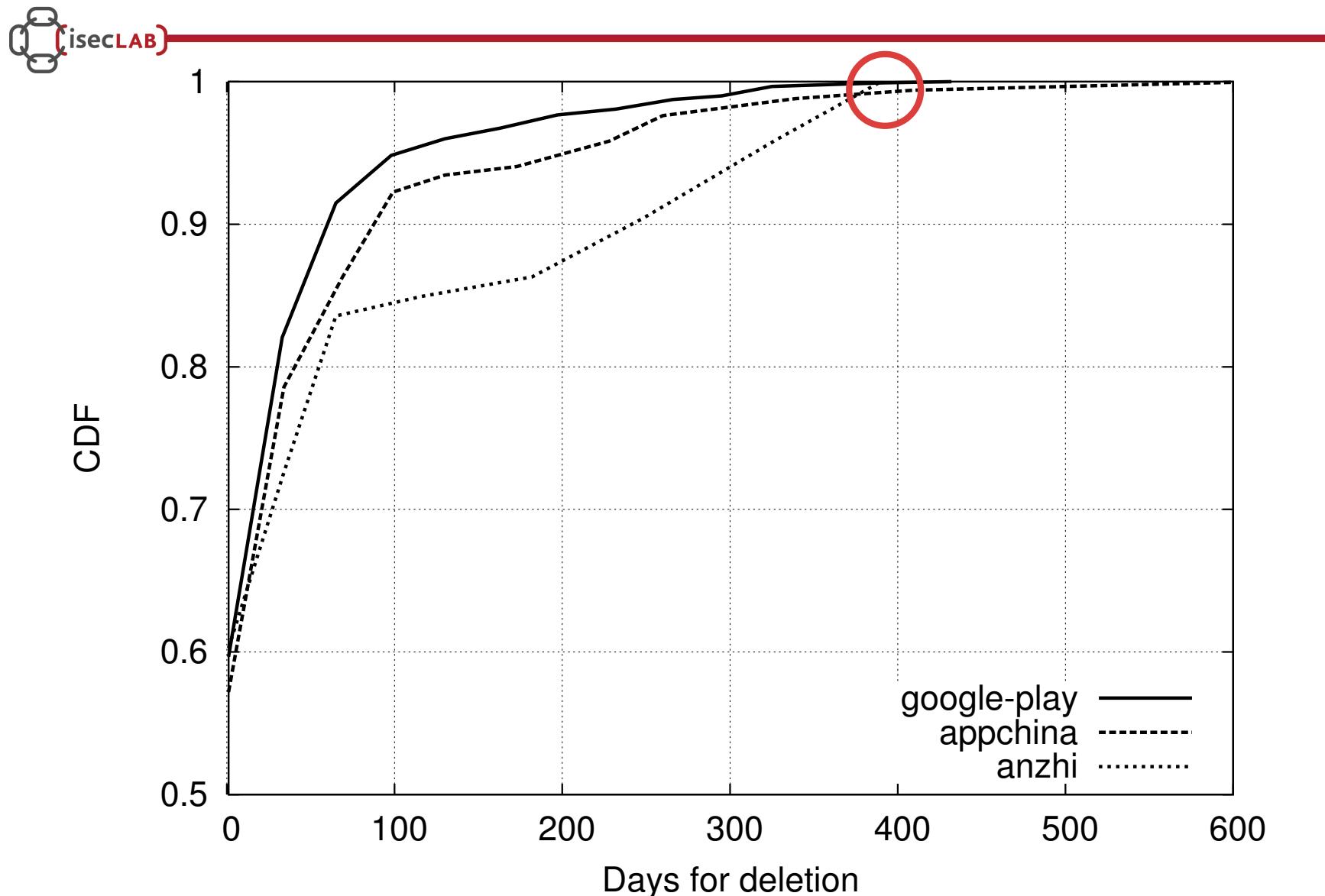
Application Lifecycles



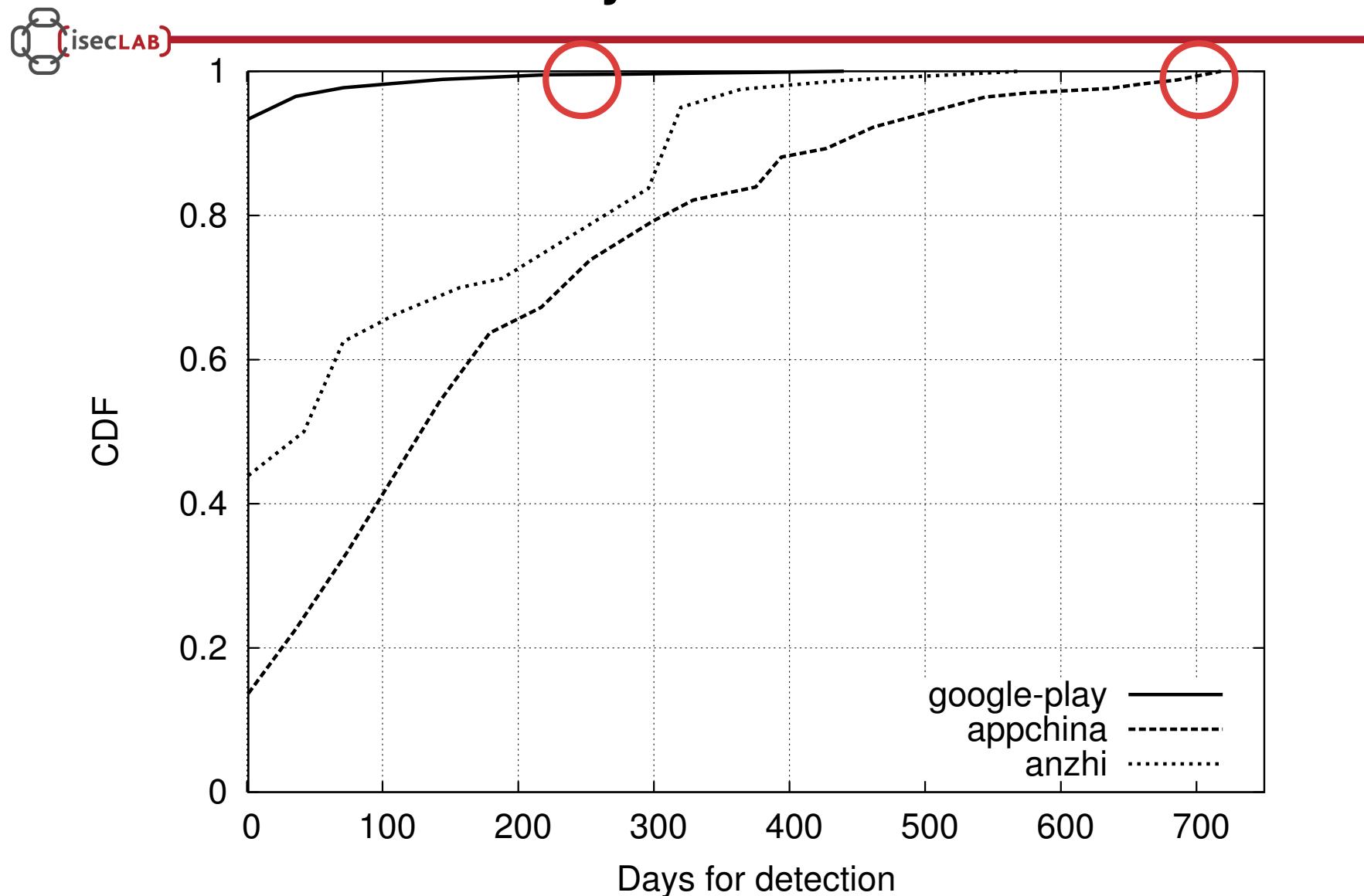
- **Normal Lifecycle:**
Market deletes app after it is detected by AVs
- **Market Self-Defense:**
Market deletes app before it is detected by AVs
- **Malware Hopping:**
App is republished after detection
“Failover” strategy



Market Reaction Time



Community Reaction Time



Outline



- Market Characterization
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- Evaluation and Case Study
- **Future Work and Conclusion**

Future Work



- Automated notification system for markets
- Extend app discovery in markets based on
 - Application name
 - Image characteristics (icon, screenshots)
 - Description of functionality
- Versioning of malicious apps
- Identify fraud in markets (“App rank boosting”)
 - Inflated download numbers
 - Fake ratings and reviews

Conclusion



- In-depth measurement on 8 alternative markets
- AndRadar to discover malicious apps in real-time
- Tracking of app distribution across markets
- Collect metadata about apps
 - Branding
 - Updates
 - Download numbers
 - Ratings & reviews
- Expose publishing patterns of malware authors
 - “Failover” strategies to migrate between markets



Questions?

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mlindorfer@iseclab.org

<http://www.iseclab.org/people/mlindorfer>

Malicious App Seed



- Feed of known malware or unwanted apps
- Continuous stream of apps from ...
 - Manually vetted malware repository (VirusShare)
 - Submission feed from VirusTotal based on # of AV signatures
 - Submissions to Andrubis based on dynamic analysis result
- Seed format: APK files
<Package name, Certificate, Method signatures, MD5>

1Mobile



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www.1mobile.com/1mobile-market-79873.html

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1Mobile Market 4.0.2.2

1Mobile Market 4.0.2.2's Description

ChangeLog for 4.0.2.2

- 1.Redesigned User Interface, easier to use
- 2.Provide the most extraordinary using experience
- 3.Support personalized recommendations
- 4.Improve performance and stability

Over 500,000 free apps;

- Direct downloads to your phone or computer;
- All safe, all secure, virus and malware clean;
- Stable, high speed downloads supported by 80,000 servers...

...More

1Mobile Market 4.0.2.2's Screenshots

Download 1Mobile Market 4.0.2.2

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DOWNLOAD QR CODE

1Mobile Market
Bigger size, Easy Browsing.
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- my NPR
- MPP Mouse

Anzhi



Dr. Panda 餐厅_策略经营_游戏_安卓安智市场

登录 注册 新浪微博 腾讯微博

搜索应用/游戏

首页 安卓应用 安卓游戏 专题 开发者 安智论坛 电信精品

游戏 > 策略经营

Dr. Panda 餐厅 (1.2)

★★★★★ 安全认证 有广告

软件分类: 策略经营 下载: 1000+
时间: 2014年02月28日 大小: 44.6M
系统支持: Android 4.0及以上 资费: 免费
作者: Skai

安装到手机 二维码扫描下载 一键举报

下载到电脑 云推送到手机

简介:

《Dr. Panda餐厅》重新开业啦！这次一切由你做主！制作你梦想中的美味比萨、让人赞不绝口的通心粉或是辣到让人喷火的香辣汤。甜还是咸？辣还是苦？你说了算！在Dr. Panda餐厅2中，孩子们将掌管厨房里的一切！未来的大厨们将自由地选择食材，选择如何制作料理！切，拌，煎，炖多达20种食材，制作完美

展开 ↓

软件截图:

联系我们

Aptoide



Search "panda" | Aptoide – Android Apps Store
www.aptoide.com/search/view?search=panda

Search application... English New user Login

APTOIDE Own your Android Market

HOME APPS STORES PARTNERS PUBLISHERS

SEARCH

SEARCH RESULTS FOR APP: PANDA Found 559 APPS

The screenshot shows a grid of 559 app results for 'panda'. Each result includes the app icon, name, download count, last update, and download links. Many apps feature the Aptoide shield icon. The results are organized into several rows:

- Row 1: Panda Run (64), Dr. Panda's Restaurant - ... (15,380), Talking Lily Panda Free (2,586)
- Row 2: Dr. Panda's Daycare - Free (4,373), Dr. Panda's Veggie Garden (4,190), Dr. Panda's Hospital - Free (4,161)
- Row 3: Dr. Panda's Veggie Garde... (1,647), Pandas vs Ninjas Christmas (536), foodpanda Order Food D... (374)
- Row 4: Talking Panda (135), Dr. Panda's Handyman - ... (103), Panda Super Run (13)
- Row 5: Sleepy Panda Wallpaper (10), Keyboard Cute Panda (7), Flying Panda (0)
- Row 6: Dr Panda's Handyman (7,328), Dr. Panda's Restaurant (6,224), Dr. Panda's Beauty Salon (5,596)
- Row 7: Dr. Panda's Home (1,060), Dr. Panda's Airport (12,245), Dr. Panda's Supermarket (11,379)
- Row 8: Dr. Panda's Bus Driver, Market पारा, 91PandaHome

CoolAPK



The screenshot shows the CoolAPK website interface for the app '愤怒的熊猫:Pandas vs Ninjas Premium'. The page includes the following elements:

- Header:** Includes the CoolAPK logo, navigation links (首页, 应用, 游戏, 发现频道, 应用集, 酷市场), user account links (我叫MT, 登录, 注册), and search bar.
- App Information:** Title '愤怒的熊猫:Pandas vs Ninjas Premium 1.5', download count (5人关注, 8000+次下载), rating (20个评论, 4个权限), file size (8.09 MB), supported versions (支持1.6及更高版本), and update date (2011-08-16).
- Downloads and Interactions:** Download button, Follow button, Cloud installation to mobile, QR code, Add to application set, and More options.
- Review and Rating:** CoolAn点评: '如果玩腻了愤怒的小鸟, 这款愤怒的熊猫Pandas vs Ninjas确实可以作为一款替代品, 而且对于rom和屏幕的支持比小鸟更好, 不过在市场的评价还是明显不如小鸟, 正宗的就是正宗, 这款熊猫还是可以把玩一下的, 市场售价0.99美金'. Below it is the Application Rating section with a score of 4, 2 reviews, and a 5-star rating scale.
- Game Preview:** Two screenshots showing the game's interface and levels.
- Comments:** A section titled '评论 (共20条评论) ...' with a comment input field, smiley face icon, image icon, and a green '提交评论' (Submit Comment) button.
- Comment Examples:** A sample comment by 'sunnyshigou' from 2011-08-14, version 1.3, with a reply from '非直男' on 2012-12-28, and two more replies from 'sunnyshigou' on 2012-12-21 and 2012-12-19.
- Bottom Navigation:** Buttons for '应用评分', '应用详情', and '权限(4)'.
- Footer:** Classification tags (休闲游戏, 熊猫, 小鸟), '应用简介 ...', 'v1.5更新内容:', '版本历史 ...', and footer links.

F-Droid



The screenshot shows the F-Droid repository page for the app "Pocket Bandit".

Pocket Bandit
Slot-machine game

A comic style slot machine game. The game is modelled after the classic, three reel, ten stops slot machines, made popular by Mills Novelty. Unlike its mechanical cousins, Pocket Bandit is not entirely luck based, but also offers elements of skill and strategy game play. Pull the lever to spin the reels and push it up to stop them spinning.

License: Apache2

Website: <http://www.onyxbits.de/pocketbandit>
Issue Tracker: <https://github.com/onyxbits/pocketbandit/issues>
Source Code: <https://github.com/onyxbits/pocketbandit>
Donate: <http://www.onyxbits.de/pocketbandit>

For full details and additional technical information, see [this application's page](#) on the F-Droid wiki.

Packages

Although APK downloads are available below to give you the choice, you should be aware that by installing that way you will not receive update notifications, and it's a less secure way to download. We recommend that you install the F-Droid client and use that.

Download F-Droid

Version 1.1 - Added on 2013-03-09

This version requires Android 1.6 or newer.

This version uses native code and will only run on: armeabi armeabi-v7a

This version is built and signed by F-Droid, and guaranteed to correspond to the source tarball.

Latest Apps

RMLL/LSM GPLv3	
GreenAddress.it LGPLv2.1	
WikiOff GPLv3	
Moon Phase GPLv3	
Quasselidroid GPLv3	
ChessWatch GPLv2	
Lightning MPLv2	
Calculate! GPLv3	
...	

Lenovo



The screenshot shows a web browser displaying the Lenovo App Store at app.lenovo.com/app/13825097.html. The page is for the app "Panda DIY". The interface includes a header with the Lenovo logo, a search bar, and navigation links for "首页", "安卓软件", "安卓游戏", "排行榜", "微博热搜", and "我要吐槽". A large green banner features the text "乐助手 | 用电脑深度管理手机可以很简单！" and a "立即下载" button. The main content area shows the app's details: "Panda DIY" by "乐商店", version 1.2.1, size 3.26MB, and developer "cathy123cathy12". It also shows a QR code for download. Below the details are two screenshots: one of a messaging interface and another of a cartoon panda face. To the right, there are sections for "乐商店手机版", "乐商店平板版", and "乐助手-乐商店PC版". A "相关推荐" sidebar lists several other apps like Youku, QIYI, and Baidu Video.

Moborobo



The screenshot shows a web browser displaying the [Moborobo app store](http://store.moborobo.com/SoftDetail.aspx?f_id=4297930). The URL in the address bar is `store.moborobo.com/SoftDetail.aspx?f_id=4297930`. The page header includes the Moborobo logo, navigation links for **Store**, **Mobo Products**, **Help Center**, **News**, and **Reviews**, and a **Forum** link. The breadcrumb navigation shows the user is at **Home >> Store >> Apps >> Education**.

The main content area features a large banner for the **PhotoWonder** app. The banner includes a photo of a smiling person holding a camera, the **PhotoWonder** logo, and text encouraging users to visit their Facebook page. It also shows two smartphones displaying the app's interface. To the right of the banner, there is a partial view of another app's promotional image with the word **Sold** visible.

On the left side, there is a sidebar titled **Categories** with a list of app categories: **Networking**, **Tool**, **Reference**, **Office**, **Rich Media**, **Reading**, and **Others**. Each category has a small arrow indicating it can be expanded.

The central content area displays the details for the **Let's Spot by BabyBus** app. The app icon features a cartoon panda. The details include:

- Version: 4.24
- Size: 21.04MB
- Updated: 2014-03-25
- Category: Education
- Developer: BabyBus
- Requires: Android1.6+
- Download: 4629

The app has a rating of **★★★★★ (0)**. Below the rating are social sharing buttons for **Like**, **Tweet**, and **G+**. A blue button labeled **Install with Moborobo** is located at the bottom of the app's detail card.

A brief description of the app states: "Let's Spot is an educational enlightening game which improves the kids' observation skills. Let's follow the Panda into the wonderful world and find out the different points between pictures. Spot 5 different points in each pair of pictures to pass one level. Come on!"

Game rules: It has 20 levels. Each level has 5 different points. Player should find the different points and click on them.

Nduoa



The screenshot shows the Nduoa website interface. At the top, there's a navigation bar with links like 'N多网', '安卓游戏', '安卓软件', etc. Below the navigation is a search bar with the placeholder '大家都在搜: 刀塔传奇' and a '搜索' button. A banner at the top right says '登录 | 新人注册'. The main content area features a large image of a panda-themed mobile home screen. To the left of the image, there's a detailed product listing for '可爱Panda--桌面主题 (1.0)'. The listing includes a small icon of a panda, a 5-star rating, and the text '1,069次下载'. It also lists the file size as '6.45 MB' and the compatibility as '2.0及其以上'. Below the listing is a section for 'N多市场' with download links for '电脑版' and '手机版'. At the bottom of the page is a QR code.

SlideME



Guess the Painting | SlideME
slideme.org/application/guess-painting

Slide me

Application search:

[Homepage](#) [Applications](#) [Community](#) EN | FR

[View](#) [Reviews](#) [Discussion](#)

Guess the Painting v4.26

By [babibus](#). Updated July 8, 2014

★★★★★ 169 0 0 Education > Early Childhood

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跑酷熊猫 Running Panda 信息
大小 8.96M
分类 跑酷竞速 | 跑酷 | 射击冒险 | 熊猫 | 道具 | 奔跑
更新 2012年8月11日
版本 1.2.0
要求 Android 2.2.x 以上
查看权限要求
网站 杭州君道网络科技有限公司
来自 Google Play提供

跑酷熊猫 Running Panda 描述
看我如何飞闪腾挪！
跑酷熊猫是一款生动有趣的奔跑类游戏。您需要操作一只武艺高强的熊猫，利用不同的技能和道具不断的跃过各种障碍，打破自己的最佳成绩。游戏中熊猫拥有二次弹跳，翻越及短暂腾空的能力（需要消耗能量），还能购买道具用物品攻击障碍物。
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跑酷熊猫 Running Panda 更新内容
新版变化
V1.2新增加了成就系统，完成全部6个成就是具有挑战性的。修复了游戏跳出问题及其他运行bug。
了解更多

Z-Android



Panda Run - Скачать на андроид
z-android.ru/595-panda-run.html

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Panda Run

Rating: ★ ★ ★ ★ (votes: 3)

Version game: 1.2.1 Version Android: 2.0 and higher

Size: 3.7 MB Published: 01.05.2014

Developer: sagego Google Play: [Go to](#)

Interest from players to banners has not faded, despite the lack of releases. We note: interest does not fade from interesting banners. Panda Run - one of them, whose number of fans approaches fifty million.

Developers successfully connected the runner with a multi-level platformer, so that now the main hero is not just running through the jungle, trying to get home in time, but also risks falling into a abyss, jumping from one platform to another.

Thus, the Panda must collect as many coins as possible, laid out in golden bands along the road and above it. To the same, however, the developers have added many more creatures, which the Panda eats with pleasure, and gets additional points for this.

In general, if she stops at a collection of coins - she will not find the way home, and if she ignores the despised metal, she will not be able to collect the required amount of points to pass to the next level.

Thus, to win, you need to balance interests between the desire to leave the jungle as quickly as possible, and the desire to collect as many coins as possible in her stomach.

Screenshots: