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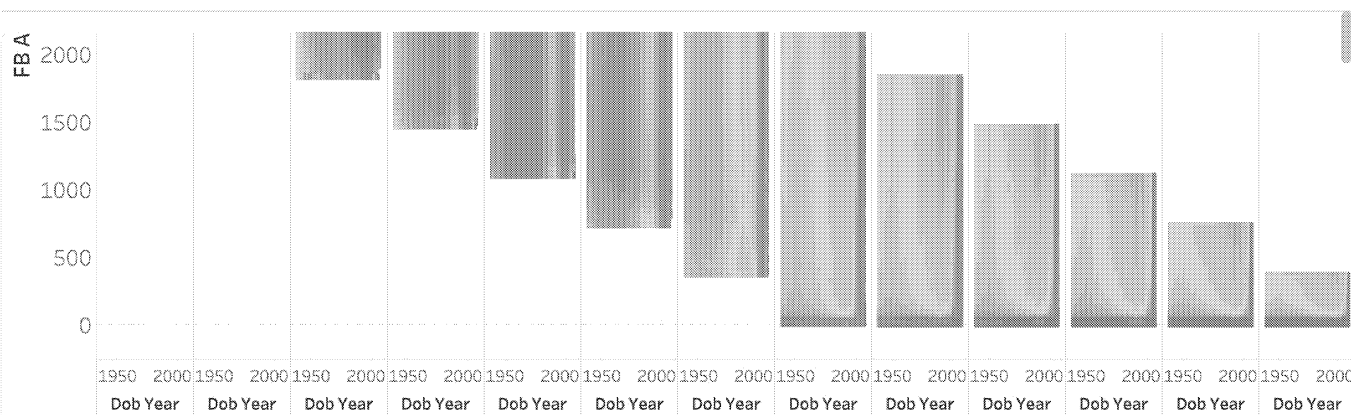
EXHIBIT 4

Long Term Retention: The Young Ones are the Best Ones and Ot...

Robert Chen (PM) · Last edited December 5, 2018 · 16 minute read

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Long Term Retention: The Young Ones are the Best Ones and Other Learnings

By Santosh Kumar Panda and Robert Chen

TL;DR

We observe very stark differences in **long term retention** in the United States depending on (1) **Age at which you join Facebook** and (2) **Year in which you join Facebook**.

One of our major objectives is to establish **long term retention** as a **standard metric** for Facebook to observe and analyze across our analytics and research teams, in addition to product teams more generally. We see that year-of-birth/age and confirmation year are important dimensions through which to understand how different people are using Facebook over time.

Our three major findings and associated implications are below.

1. **Tweens (approximate age 10-12) are special. People who join Facebook as tweens have the highest long term retention out of all age groups.**

a. Observations

- i. As an example, for people who joined Facebook in 2016, 12 year-olds (born in 2004) have long term retention (LTR) MAP_28 of 72% at an FB age of 365. 32 year-olds (born in 1984) have long term retention of 25% at the same FB age. This is a **3x difference** for a 12 y/o versus a 32 y/o! The difference is similar in magnitude across multiple confirmation years.
- ii. You can also see this very clearly in the Chart 2 below. There is a green band (indicating high retention) on the right in every confirmation year. The exceptions are in the very early days of Facebook (2004 and 2005) when high schoolers did not have access to Facebook.
- iii. Caveat: These findings rely on the Age Affinity model, and while it is the best we have for age, there are biases in the model which may influence the results.

b. Implications

- i. **ACTION:** Given that tweens have long term retention multiple times (~3X) more than adults, understand why this is the case.

i. Facebook as a whole should consider investing more heavily in bringing in larger volumes of tweens.

ii. For the Youth Team, **prioritize tweens over all other age groups.**

ii. **ACTION:** Track down the former tweens who have incredibly high retention on Facebook and find out why they joined Facebook when they did and what keeps them on Facebook till this day. Can we replicate some of those conditions so that we have a greater number of highly retentive tweens in our pipeline?

2. **The earlier the confirmation year (the year in which a user joined Facebook), the higher the long term retention.**

a. Observations

i. For example, for somebody who was born in 1953, this user's long term retention is markedly higher the earlier the user joined Facebook

i. Joined 2009: 76% at Day 1,800

ii. Joined 2011: 54% at Day 1,800

iii. Joined 2013: Projected ~47% at Day 1,800 (48% at Day 1,400)

iv. Joined 2015: Projected ~35% at Day 1,800 (42% at Day 700)

ii. You can also see this clearly in the Chart 2 below. The early confirmation years are much greener (LTR closer to 100%) than the latter confirmation years despite the early confirmation years despite having users who are of much greater Facebook age.

b. Implications

i. Facebook's long term retention deteriorates with each passing year. This is unsustainable, and we need to find out why it deteriorates.

i. Discovering why will lead to different product changes. Some hypotheses:

i. Competition: Other social services are better and better

ii. Nature of underlying population: The people who join Facebook later on are more marginal. Perhaps they have worse connectivity? Or perhaps they have negative sentiment toward Facebook?

iii. Changes in Facebook's product/the code and pixels: Our product has changed in a way that does not encourage strong long term retention.

iv. Changes in the friend graph on Facebook: People who joined earlier on have a different graph than those who joined later on. The graph of those who joined earlier on lends itself to better long term retention .

v. Changes in accounts created: There could be more secondary accounts (soon abandoned) or more fake accounts.

ii. **ACTION:** People who joined Facebook earlier on are fundamentally different from the people who join today. What makes them or their situation different? Can we replicate what we had before so that people who join Facebook today have higher retention?

3. **In a recent confirmation year, 2016, the higher the population penetration by year of birth, the lower the long term retention.**

a. Observations

i. **This is counterintuitive.** Conventional wisdom is that as population penetration increases, retention increases.

ii. Skip to the section "A Fascinating Relationship Between Long Term Retention and Population Penetration" towards the end to find analysis on this.

b. Implications

i. If the relationship is a causal one, then it suggests that we do not understand how social media products work. Even if it is only correlational, we should seek to understand the drivers.

i. Is it:

i. Users who are signing up for Facebook now are extremely marginal users?

ii. Why are they marginal? Don't like Facebook? Primarily use Snapchat? Have better uses of their time?

iii. Users who are signing up for Facebook now are already existing Facebook users but are signing up secondary accounts?

iv. Why doesn't our SUMA model detect this?

v. Users who are signing up are not real people

vi. Why doesn't our fake accounts team detect this?

ii. **ACTION:** This finding appears to challenge our understanding of how social media is supposed to work. It behooves us as Facebook to understand what is happening.

Context and Definitions

We initially looked into long term retention in order to calculate the lifetime value for teens. What we found was a dataset that was interesting in of itself.

We define **long term retention** as the continued use of Facebook over very long periods of time, hundreds or even thousands of days. For the purposes of this note, we looked the percent of users who were MAP_28 after n number of days.

Quick Primer on Charts

These LTR color charts are similar in format to triangle charts. You can skim this section if familiar.

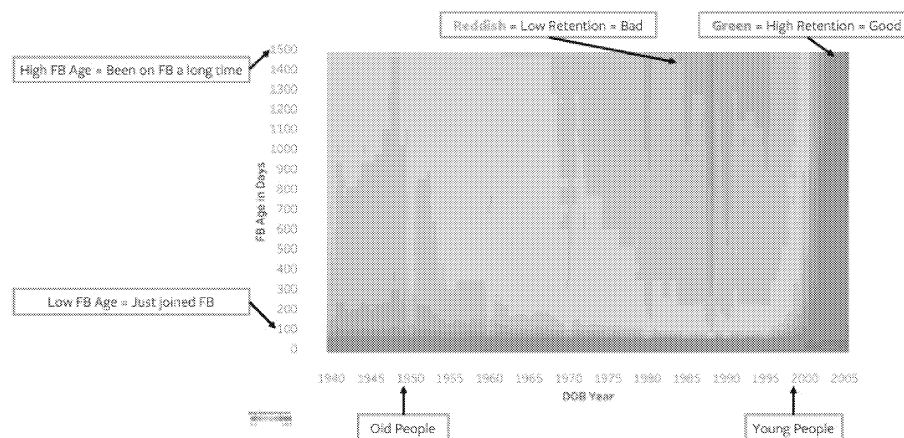


Chart 1: Sample Chart for Confirmed Year 2013

The color chart represents 3 dimensions of data.

- On the X Axis is the year the user was born, the date of birth (DOB) year
- On the Y Axis is the Facebook age—the number of days after the user joins Facebook
- On the "Z Axis" (the color of the data point) is the long term retention percent
 - 0%, the lower bound, is red; low retention is bad

- 50%, the midpoint, is yellow
- 100%, the upper bound, is green; high retention is good
- In some of the color charts, the data is blank for the earlier Facebook ages. This is because our current dataset does not go that far back in time. E.g., we didn't have dim_all_users in 2005.

Long Term Retention in the US since 2004 by Year of Birth

We will start by looking at the big picture, birth years 1940 to 2006 and confirmed years 2004 to 2016.

All Birth Years

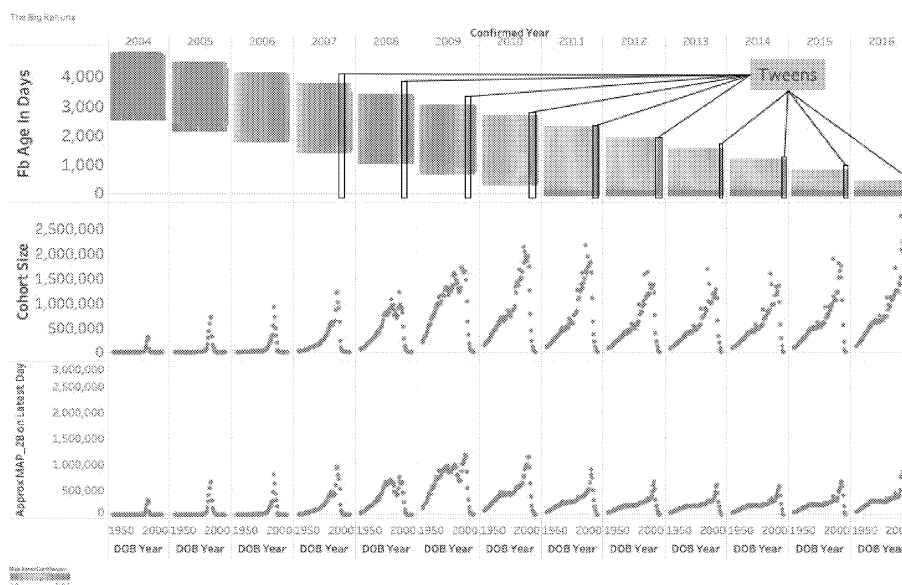


Chart 2: Long Term Retention, Cohort Size, and Approximate MAP_28 on Latest Day for All Birth Years and All Confirmed Years

Note on reading Chart 2 (as well as 4, 5, and 6):

- The tops charts in Chart 2 are what you saw in Chart 1 but instead of showing 1 confirmation year, we see all confirmation years
- The middle charts showing "Cohort Size" indicate the number of users on Day 0
 - The number of users that are MAP on Day X divided by the number of users on Day 0 = the retention %
- The bottoms charts show the "Approximate MAP_28 on Latest Day"
 - This shows the number of MAP_28 for each confirmation year x YOB on the latest DS
 - The # divide by cohort size gives the topmost color chart line for retention %

At a high level, we observe the following:

- The most retentive cohorts (the most green) are:
 - **Tweens (10-12 years old)**
 - Users from early confirmation years (2004 to 2009)
 - Further discussion in both the TL;DR and the 1981-2006 "zoom-in" section below
 - See Chart 3 below for an alternative view
- The least retentive cohorts (the most red) are:
 - **Late teens/young adults**—we see this pattern emerging as early as 2007!

- **Implication:** Social product for those joining as young adults are unlikely to be retentive
- Over time, the band of less retentive users expands in both directions
 - Younger and younger teens become less and less retentive. Hypothesis here is that people are joining social media earlier and earlier in life and habits are established early on
 - Older and older adults become less and less retentive. Hypothesis here is that most of the young and middle aged adults already joined a social media service earlier on so the people who are joining Facebook in recent years are more "marginal," either because they are already on an alternative service (e.g., Snapchat, Instagram) or because they naturally have less affinity toward social media
 - Another hypothesis, which we go into more detail at the "A Fascinating Relationship Between Long Term Retention and Population Penetration" section toward the bottom, is that retention goes down as we population penetration increases

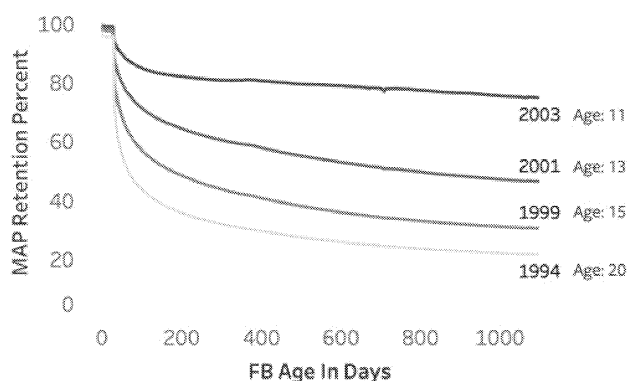


Chart 3: MAP Retention for Select YOB's in Confirmation Year 2014. The people who join as tweens do much better than people who join as teens or young adults. Note that the ages indicated are the age at which they joined Facebook. Lines do not start at exactly 100% due to deactivated accounts.

- MAP_28 long term retention tends to be stable (small negative slope) after a few hundred days
- Long term retention can be very high despite small cohort sizes
 - This is the case with the early cohorts from 2004-2005 as well as the small cohorts for the very old and very young in almost all the confirmed years
- Facebook's largest influx of users (cohort size) occurred in 2009, 2016, 2010, 2015, and 2011
 - However, the users from earlier confirmed years are much more retentive
 - Therefore, the biggest confirmations years by proportion of current MAP are 2009 (22%), 2010 (14%), and 2008 (11%)
 - For the large number of confirmed users in the more recent years, we wonder if a significant portion of those are spam/fake accounts
- Difference in the shape of the curve between the Cohort Size (middle charts) versus Approx MAP_28 on Latest Day (bottom charts) shows you which cohorts are relatively more retentive
 - Conventional wisdom is that Facebook does poorly with older people—however, our long term retention data seems to say that older people who join Facebook, whether in the earlier years (e.g., 2009) or even more recently (e.g., 2016), tend to continue using Facebook

Next we zoom in on particular birth years. We start with 1981 to 2006. Then 1961 to 1980 and finally 1940 to 1960.

Year of Birth 1981 to 2006

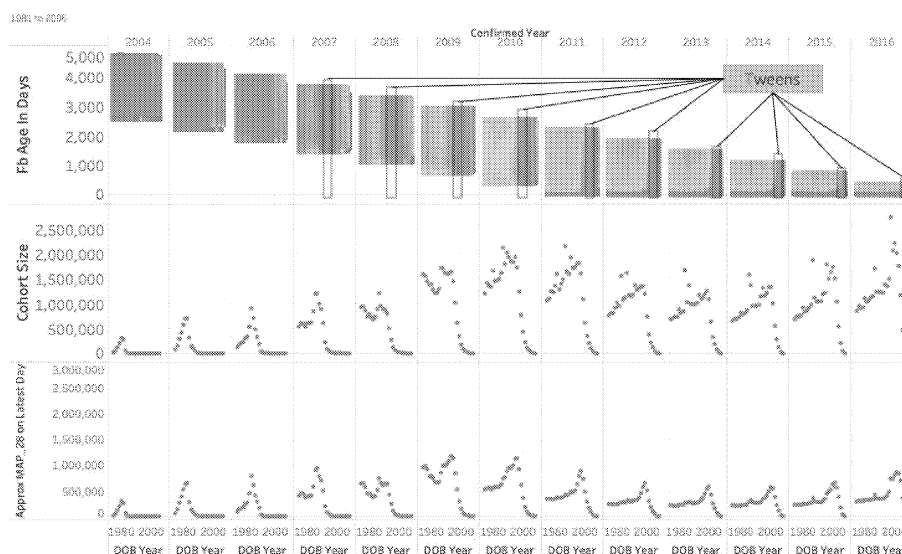


Chart 4: Long Term Retention, Cohort Size, and Approximate MAP_28 on Latest Day for Birth Years 1981 to 2006 and All Confirmed Years

- About 51% of MAP is represented by birth years 1981 to 2006
- As early as confirmation year 2007 (Facebook was opened up to all users in September 2006), we see that people who joined FB as **twens** have the **highest long term retention**. This is true from confirmation year 2007 to 2016.
 - E.g., people born in 1995 and confirmed in 2007, approximately 12 y/o at confirmation, have 92% MAP retention on Day 3,652!
 - E.g., people born in 2005 and confirmed in 2016, approximately 11 y/o at confirmation, have 87% MAP retention on Day 365
- Users joining as young teens used to have high LTR, but that has declined drastically in more recent confirmation years
 - E.g., people born in 1996 and confirmed in 2010 (approx 14 y/o at confirmation), have 58% MAP retention at Day 2,000
 - But for people born in 1997 and confirmed in 2011 (approx 14 y/o at confirmation) have dropped to 41% at Day 2,000. Even on the same date (Day 1,635), for those born in 1997 and confirmed in 2011, their MAP retention was 42%
 - And even more recently, for people born in 2002 and confirmed in 2016 (approx 14 y/o at confirmation) have dropped to 40% as early as Day 365 and projected to drop to around 25% by Day 2,000
- In recent years, **people who join as young adults (19-29) have the worst long term retention** of all ages
 - However, this group is also fully penetrated on a MAP/population basis. So that leads us to ask:
 - Who is creating new accounts if it seems like almost all people in the age range are already FB MAP?
 - And even more recently, for people born in 2002 and confirmed in 2016 (approx. 14 y/o at confirmation) have dropped to 40% as early as Day 365 and projected to drop to around 25% by Day 2,000. In 2011, their MAP retention was 42%

- How many of these are fake/spam accounts? (We used the fake accounts classifier to remove fake accounts, but perhaps we not sufficiently detecting fake accounts.)

Year of Birth 1961 to 1980

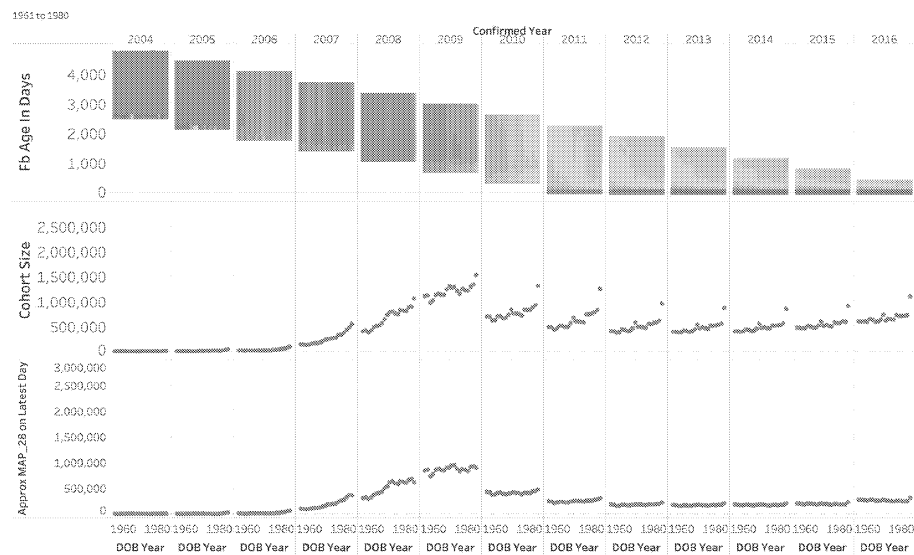


Chart 5: Long Term Retention, Cohort Size, and Approximate MAP_28 on Latest Day for Birth Years 1961 to 1980 and All Confirmed Years

- About 32% of MAP is represented by birth years 1961 to 1980
- During the first few years of Facebook, this group had very high long term retention
- However, this group's long term retention has dropped considerably
- In contrast to the younger ages, the number of recent account confirmations is considerably lower

Year of Birth 1940 to 1960

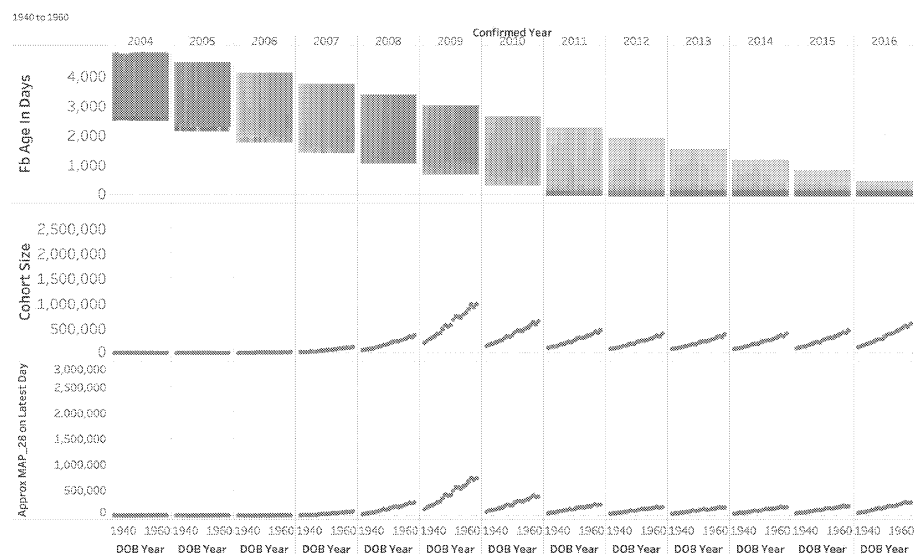


Chart 6: Long Term Retention, Cohort Size, and Approximate MAP_28 on Latest Day for Birth Years 1940 to 1960 and All Confirmed Years

- About 17% of MAP is represented by birth years 1940 to 1960
- Separate from those who join as tweens (10-12 y/o), those who join in old age have the highest long term retention

- We see this in the yellow-green coloring for those in this age group
- People who join Facebook at older ages do better than people who join as young adults
 - Conventional wisdom is that Facebook does poorly with older people—however, our long term retention data seems to say that older people who join Facebook, whether in the earlier years (e.g., 2009) or even more recently (e.g., 2016), tend to continue using Facebook
 - These people do worse than people who join as tweens

A Fascinating Relationship Between Long Term Retention and Population Penetration

The MAP_28 population penetration (MAP_28 / total population for that year of birth) is eerily an inverse of the long term retention chart in recent confirmation years. This leads to an unexpected result. The higher the MAP_28 population penetration, the lower the long term retention of new cohorts. We would expect the opposite effect. A simple linear regression (with population penetration as the independent variable and LTR as the dependent variable) has an $r\text{-squared} = 0.84$. For confirmation year 2016, **the relationship is that the higher the population penetration, the lower the long term retention**. This runs counter to our expectation that as population penetration increases, the value of the social service goes up because more people you know are on the service. It seems like the countervailing forces such as differences in the underlying population (e.g., type of users who join later), fake accounts, secondary accounts, and/or other factors may be more important than the increased value from the greater % of people from your year of birth being on the service. Perhaps making the world more open and connected, beyond a certain point, is not that valuable.

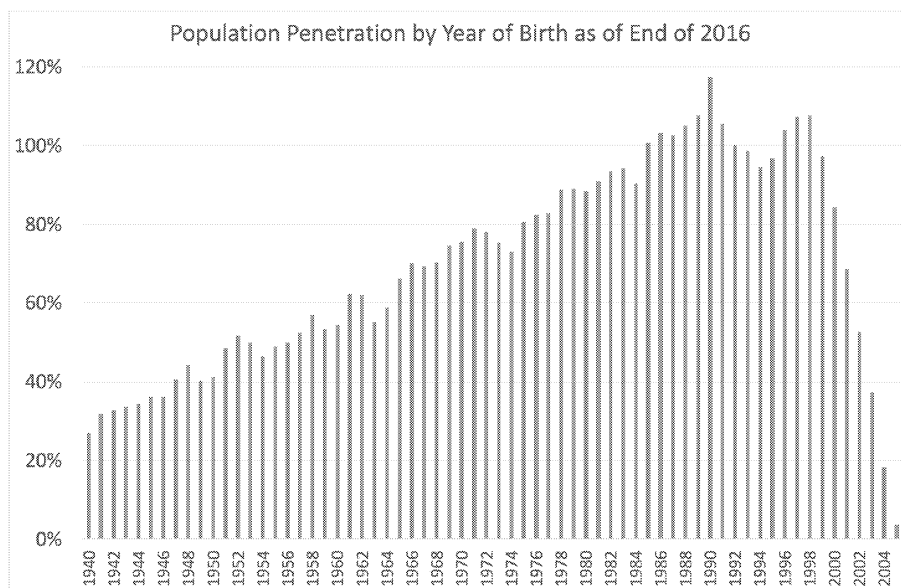


Chart 7: Population Penetration by Year of Birth as of End of 2016

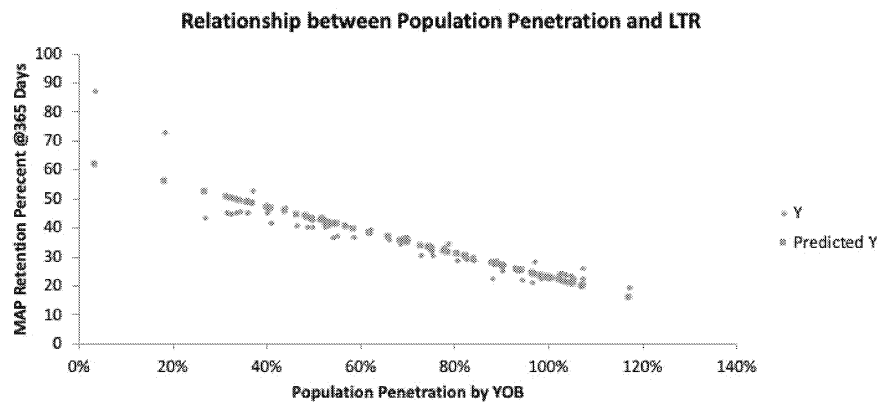


Chart 8: Relationship between Population Penetration and Long Term Retention. $r\text{-squared} = 0.84$

Recommendations and Concluding Thoughts

Product Recommendations

Who precisely are we building for?

- Given the extremely high long term retention of tweens, what can we do to safely and appropriately onboard high volumes of tweens onto Facebook?
 - And can we push those growth while maintaining high retention?
- When we launch new products, do we intend for these new products for high-tenure or low-tenure people?
 - Because the LTR for high-tenure people continues to be high, we could have greater focus on building for low-tenure people
 - However, we would want to monitor our high-tenured people in case their retention drops
- Can we replicate the earlier days of Facebook and recreate the very high long term retention that Facebook used to have?

Research and Analytics Recommendations

Let's understand long term retention and these Confirmation Year x YOB cohorts much more deeply.

- Who are the users in the different confirmation year X YOB cohorts and what makes them the same or different?
 - By confirmation year:
 - If they are the same as the users today, is it the environment (e.g., competition) or product that has changed?
 - If early confirmation year users are different from those joining today, in what ways are they different and what can we build for them?
 - By age:
 - What is it about people who join as tweens make them have such high long term retention?
 - Why do we do the poorest with those who join as young adults?
 - Why do we do better with people who join when they are old compared to young adults?
- Operationalize confirmation year into Deltoid
 - The differences in usage are starkly different by confirmation year so it makes sense to monitor metrics by confirmation year

Because of the difficulty in assessing long term retention, nobody has done it until now. With this dataset, we can understand Facebook and other family apps more deeply than before.

What's Next

We are planning to look at long term retention outside the United States and also for Instagram. We also hope this work spurs others to look into long term retention themselves as the breadth of this data across time and products lends itself to further analysis.

Methodology

The long term retention dataset provides statistics and analyses on retention of users on facebook over time. The primary retention metric for the current dataset is overall FB xAP and it is limited to the users in US only. The dataset is populated all the way from Jan 2012 till March 2018. The dataset provides a wide variety of dimensions such as the Age, Year of Birth and Registration Date among other things. The dataset also tracks the Facebook Age as well as the age of the user though time which are aimed at providing generational insights into user retention.

Data Derivations

Almost all of the data including most of the dimensions and all of the xAP metrics are derived from dim_all_users. It is one of the most trusted and well monitored datasets which is critical for data quality. Age related attributes are derived from Dim Age Affinity (see below). Accounts that are deactivated are included in the cohort until the day of de-activation. Accounts which are marked as SUMA or Fake are excluded from any all calculations.

Age Calculations

The Teen/Non-Teen and the age of a user are determined using Age Affinity. Instead of using the Point Estimates - we estimate the distribution of the sample mean of the user being in a certain age/age-group using the bootstraps. For example to determine if the user is a Teen - we use the following 3 step formula

1. Calculate Age for a bootstrap n being calculated as $A(n) = @DATEDIFF(CURRENT_DS, AA_DOB(n))$
2. $P(n) = \{A(n) \leq 18\}$ - then 1 else 0.
3. $P(\text{teen}) = (\sum P(n))/100$

The same is extended onto age specific calculations.

We also froze the Age Affinity partition to the 07/01/2018 partition to avoid inconsistencies in the dataset due to predictions changing over time. Since this analysis is primarily for long term retention - the impact of AA not having accurate predictions for new users is minimal.

SUMA

One of the key assumptions in the dataset is that the rate of SUMA has been fairly constant over time. Based on the results of the high level analysis - the current SUMA model only flags about 10% of accounts as SUMA. For example in for YoB 2012 - there were 12M accounts created on FB for US users but only 4M people born in US.

Dataset Details

Primary Summary Table - ytg_cohort_user_metrics_summary_agg

Dash -

https://our.intern.facebook.com/intern/unidash/dashboard/youth_growth/cohort_analysis_by_dob/

Sample Query - For people born on 1999 who were between the age of 10 and 30 - how is their retention across time?

```
SELECT
    fb_age_in_days,
    age_at_registration as dim,
    SUM(map_28) as metric_val,
    SUM(total_users) AS cohort_size,
    (SUM(1.0 * map_28) / SUM(total_users))*100 AS retention_percent
FROM
    ytg_cohort_user_metrics_summary_agg
WHERE
    ds between '2012-01-04' AND '2017-12-31'
    AND age_at_registration BETWEEN 10 AND 30
    AND fb_age_in_days IS NOT NULL
    AND dob_year = '1999'
    AND confirmed_year IS NULL
    AND age_in_years IS NULL
    AND age_in_years_months IS NULL
GROUP BY
    1,
    2
ORDER BY
    1, 2
```

Thanks

Thank you to those who shared feedback on earlier versions of this work: Danny Ferrante, [REDACTED]

[REDACTED] Tom Cunningham

Thanks to our respective managers [REDACTED] and [REDACTED] who gave us the time to pursue a novel type of metric and analysis.

Appendix

Previous presentation on the topic: Youth Leads Review

👍👍👍 34

10 comments 12 shares

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Robert Chen (PM) 🌐

[REDACTED] Shared some of this earlier on and here's a more in-depth look

6y Like Reply



[REDACTED] 🌐

Audience selection while sharing is still very limited; which prevents me from sharing stuff all the time. This could be a problem with other older joiners too.

Over the past 8 years, I have accumulated a lot of friends and many of them I no longer communicate or keep in touch. Hence, when sharing something, I feel a bit queasy to share something with all my friends. I would rather like a quick selective sharing in composer 😊

6y Like Reply



Hi Robert! We have done A LOT of research with tweens to understand how they use social media, why they use Facebook, and what they need in a product. Based on that research, we do not recommend onboarding them onto Facebook because it is not an engaging product for them. The reason tweens sign up for Facebook today as the 1st social media platform is because parents ask them to or they need a FB login for games etc. It is not the platform they desire or enjoy to be on unless we make major changes. Here is work from multiple studies over the past 1.5 years on tweens and their social media needs:

1/ Why do tweens sign up for Facebook but not use it?

<https://our.intern.facebook.com/.../research/p/jmmwq39kgx/>

2/ What do tweens look for in social media apps?

<https://our.intern.facebook.com/.../research/p/jrtd9fpv9i/>

3/ What do tweens want from messaging?

<https://our.intern.facebook.com/.../research/p/86u2imcp6/>

Instead of onboarding them onto FB, we recommend onboarding them via a messaging play. Please find that research here:

<https://our.intern.facebook.com/.../research/p/86u2imcp6/>



6y Like Reply

Robert Chen (PM) ④

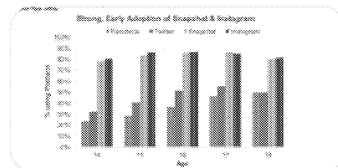
Thanks [redacted] for the detailed response! How would you square the data we see for people who join as tweens? They have had the **highest long term retention** (by far...several times larger than others) of any age at confirmation since 2007.

I think we'd want to track down the people who joined as tweens (and are teens or adults now) and understand why their Facebook experience has been so good.

6y Like Reply

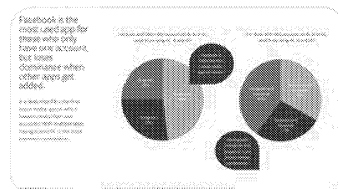
Robert Chen (PM) ④

Regarding whether a messaging play for tweens is the right one, there is early evidence that Instagram does better than Snapchat for early teens (and this is something we should understand more deeply for sure). Given that kids are more consumption oriented (e.g., popularity of YouTube with that demographic) and that high levels of communication with peers seems to increase with age (e.g., making Snapchat better for older teens), my read is that a more full-fledged "social media" experience such as Instagram or Facebook would be better than a messaging-first experience for tweens.



6y Like Reply

Yes, I think that young teens are a focus area for IG, cc [redacted] so it will be great to onboard them to IG for IG. Our research shows that instead of SC > IG or IG > SC, we see that those two are used as a complementary play. One is for connecting with close friends, one is for connecting with interests and public content. Tweens need both. If you look at what tweens do on the platforms and who they connect with, we see that for FB and IG, it's not about close friends whereas on SC 80% of experiences on the platform are about connecting with close friends (in the same deck as linked above).



6y Like Reply

Robert Chen (PM) 
Agree that IG and SC are very complementary! One of the 5 global clusters of teens is the SC/IG cluster. My point was just that for tweens, it seems like their affinity for non-messaging based social media may be higher than for messaging. But that's just an initial read based on the limited information we have right now.

Anyway, the above is a minor point relative to the data showing how compelling Facebook can be for people who join as tweens.

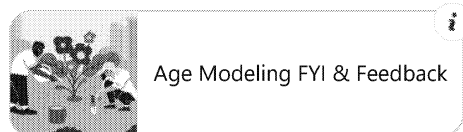
6y Like Reply

 Write a reply...

[REDACTED] 
Great post! Are you establishing age from the DOB they put at sign up?

6y Like Reply

Robert Chen (PM) 
Thanks! We use the Age Affinity model, which is the best model we have (and a product of years of work by our analytics and core data science teams). This <https://fb.facebook.com/groups/1339841902719382/> is probably the best group to learn more.



6y Like Reply 

 Write a reply...

[REDACTED] 
[REDACTED]

3y Like Reply

 Write a comment...

