

# Data mining in the times of the GDPR

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# Disclaimer

I'm not a lawyer.

I don't have any  
formal training in law.

This is not legal advice.

Data mining &  
GDPR

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Gonzalez-Barahona

Should we worry?

What should we  
do?

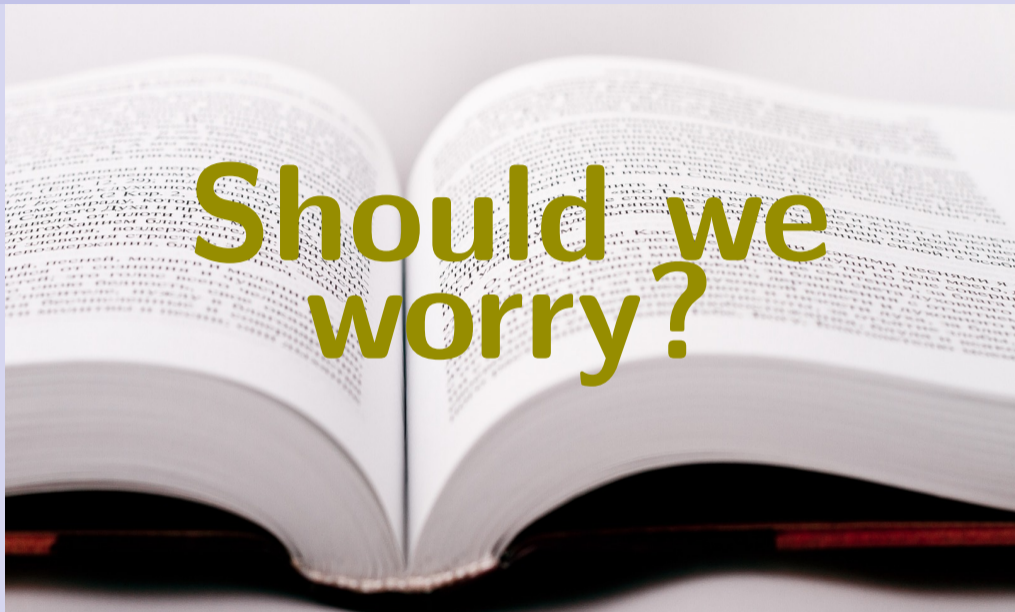
Some definitions

A case study

Important details

Call for action

To probe further



# Mining software repositories

*Should we worry  
when we research  
based on data  
extracted from  
software development repositories?*

Let's analyze from two (interrelated)  
points of view:

- legal requirements
- ethical requirements

### Data mining & GDPR

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While the EU's ethics review process is primarily concerned with ethics issues, your project must demonstrate compliance with the GDPR. However, the fact that your research is legally permissible does not necessarily mean that it will be deemed *ethical*.

Crucially, if your research proposal involves the processing of any personal data, whatever method is used, you – and all of your partners, collaborators and service providers – must, if called upon, be able to demonstrate compliance with both legal and ethical requirements. Such requests could come from data subjects, funding agencies or data protection supervisory authorities.

H2020 document on Ethics and Data Protection, by EC

# Applicable law

In the European Union (and elsewhere):

- **General Data Protection Regulation (GDPR)**  
Affects all of EU, and rights of EU citizens
- Specific law in member states
- Recommendations by national data protection agencies

Similar law in other jurisdictions:

- **California Consumer Privacy Act**

# Is research exempt?

Processing

Publication

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# Processing

Processing of personal data should be:

- lawful,
- fair,
- and transparent.

GDPR, Preface (39)

# Lawful?

- explicit consent: difficult when mining repositories
- task in the public interest (public institutions)
- legitimate interest (non-public institutions)

GDPR and Research: An Overview for  
Researchers, UK Research and Innovation

# Fair, transparent?

Fair, transparent:

*Processing for [...] research purposes, shall be subject to appropriate safeguards, in accordance with this Regulation, for the rights and freedoms of the data subject.*

GDPR, Article 89

*Those safeguards shall ensure that technical and organisational measures are in place in particular in order to ensure respect for the principle of data minimisation. Those measures may include pseudonymisation [...]. Where those purposes can be fulfilled by further processing which does not permit [...] the identification of data subjects, those purposes shall be fulfilled in that manner.*

GDPR, Article 89

# Publication

Publication of personal data:

*Sharing personal data should be through managed processes, with access and usage controls to protect from re-identification*

Potential problem for publication of results, when they involve personal data (eg: datasets)

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It is highly likely that if your project involves any data about identifiable persons, even if they are not directly participating in the research, you are processing personal data and must comply with EU and national law. Only data that have been fully and irreversibly anonymised are exempt from these requirements. Importantly, while **pseudonymisation** can provide individual data subjects with a degree of protection and anonymity, pseudonymised data still fall within the scope of personal data because it is possible to re-identify the data subject (see below).

Even if your project is using only **anonymised data**, the origin or acquisition of the data may still raise significant ethics issues.

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# “Higher risks” related to GDPR in research

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|   |  |
|---|--|
| <b>Types of personal data</b>                   | <ul style="list-style-type: none"> <li>* racial or ethnic origin</li> <li>* political opinions, religious or philosophical beliefs</li> <li>* genetic, biometric or health data</li> <li>* sex life or sexual orientation</li> <li>* trade union membership</li> </ul>   |
| <b>Data subjects</b>                            | <ul style="list-style-type: none"> <li>* children</li> <li>* vulnerable people</li> <li>* people who have not given their explicit consent to participate in the project</li> </ul>  |
| <b>Scale or complexity of data processing</b>   | <ul style="list-style-type: none"> <li>* large-scale processing of personal data</li> <li>* systematic monitoring of a publicly accessible area on a large scale</li> <li>* involvement of multiple datasets and/or service providers, or the combination and analysis of different datasets (i.e. big data)</li> </ul>  |
| <b>Data-collection or processing techniques</b> | <ul style="list-style-type: none"> <li>* privacy-invasive methods or technologies (e.g. the covert observation, surveillance, tracking or deception of individuals)</li> <li>* using camera systems to monitor behaviour or record sensitive information</li> <li>* data mining (including data collected from social media networks), ‘web crawling’ or social network analysis</li> <li>* profiling individuals or groups (particularly behavioural or psychological profiling)</li> <li>* using artificial intelligence to analyse personal data</li> <li>* using automated decision-making that has a significant impact on the data subject(s)</li> </ul> |
| <b>Involvement of non-EU countries</b>          | <ul style="list-style-type: none"> <li>* transfer of personal data to non-EU countries</li> <li>* collection of personal data outside the EU</li> </ul>  |

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## Should we worry?

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# Children & vulnerable people

Maybe we don't know...

...but they may be in our dataset

- they are subject to special protection
- even when we usually cannot tell who they are...
- ...others could

This situation is very difficult to deal with

# Privacy invasive methods

- Example: who is working off-hours
- Methodology: tracking individual activity in all available data sources
- Risk: tagging specific people

You can learn working hours, days off, vacation...

# Profiling individuals or groups

- Example: activities by newcomers
- Methodology: tracking individual activity in all available data sources
- Risk: tagging specific people

You can show specific activity of persons

# Using AI to analyze personal data

- Example: find out experts
- Methodology: analyze activity to find out experts in some languages, using AI
- Risk: singling out specific persons

# Large-scale

- Usually, several data sources
- The more data, the better
- If we can combine datasets, we do

The better the research, the riskier

# Data mining from social media

- Our data source are social media
- Of course we mine data from them

Data mining is the core of our business

# No explicit consent

- We collect data from services...
- ...which didn't get explicit consent for our cases
- Even if they got, they don't guarantee that for us
- In summary: usually, no explicit consent

Can we avoid this case?

# Transfer of data across EU border

- Collecting data from non EU data sources
- Sharing data with non-EU researchers

Can we avoid these scenarios?



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# What should we do?



# Detailed analysis

Ethics issues raised by our methodology:

- data collection and processing operations
- ethics issues that these raise
- mitigation of these issues in practice.

Submission to the Research Ethics Committee.

# Detailed analysis

- Mandatory for EC-funded research proposals
- Important: involve the DPO  
(Data Protection Officer)
- Maybe: requirement to conduct a DPIA  
(Data Protection Impact Assessment)

# GDPR approach

Data protection by design (DPbD):

*Data controllers are required to implement appropriate technical and organisational measures to give effect to the core data-protection principles of GDPR.*

GDPR, Articles 5 and 25

# DPbD in research

## Data protection by design:

- Anonymization / pseudonymization
- data minimization
- cryptography (hashing, encrypting)
- data protection focused service providers & storage
- procedures for exercising fundamental rights (access, consent)

# Data minimization

*(1) Data processing must be lawful, fair and transparent. It should involve only data that are necessary and proportionate to achieve the specific task or purpose for which they were collected*

GDPR, Article 5

# Data minimization

- Collect minimal personal data
- Anonymize and pseudonymize
- Store data securely
- Dispose data when no longer needed
- Limit access to data

# Mitigation

Anonymization, pseudonymization

...but even in this case, ethics issues:

- origin of the data
- potential misuse of methodology or findings
- potential for deanonymization



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# Some definitions

# Data processing

*(2) Data processing [includes] any operation or set of operations which is performed on personal data or on sets of personal data, whether or not by automated means, such as collection, recording, organisation, structuring, storage, adaptation or alteration, retrieval, consultation, use, disclosure by transmission, dissemination or otherwise making available, alignment or combination, restriction, erasure or destruction.*

GDPR, Article 4.

# Actors subject to GDPR

- Data controller: determines the purposes and means of the processing of personal data
- Data processor: processes personal data on behalf of the controller

# Data protection office (DPO)

- Appointed by controllers and processors (eg: usually one in each University)
- Involved in all issues related to protection of personal data
- Data subjects may contact DPO directly
- Good, local point to seek advice for a researcher

# DPIA

## Data Protection Impact Assessment:

*Process designed to assess the data-protection impacts [...] and, [...] to ensure that remedial actions are taken as necessary to correct, avoid or minimise the potential negative impacts on the data subjects.*

# DPIA likely required

|   |   |
|---|---|
| <p>A company systematically monitoring its employees' activities, including the monitoring of the employees' work station, internet activity, <i>etc.</i></p> | <ul style="list-style-type: none"> <li>- Systematic monitoring</li> <li>- Data concerning vulnerable data subjects</li> </ul>   |
| <p>The gathering of public social media data for generating profiles.</p>   | <ul style="list-style-type: none"> <li>- Evaluation or scoring</li> <li>- Data processed on a large scale</li> <li>- Matching or combining of datasets</li> <li>- Sensitive data or data of a highly personal nature</li> </ul> |

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# A case study



# The problem

You have a collection of  
all commits fulfilling some properties  
from a large set of public repositories.

You analyze number of committers per time  
period.

How can you publish the dataset  
in a reproduction package?



# The problem

Let's assume we have  
a lawful basis  
for the data processing

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```
commit 491f9205c36fdf54b4bbb7f25ba83b6cb99874b9
Author: Jesus M. Gonzalez-Barahona <jgb@gsync.es>
Date:   Mon May 13 13:33:04 2019 +0200
```

Add notice about GNOME Extension needed  
for indications.

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Author: Jesus M. Gonzalez-Barahona <jgb@gsync.es>
Date:   Mon May 13 13:33:04 2019 +0200
```

Add notice about GNOME Extension needed  
for indications.

# Personal data?

# Personal data

*(1) 'personal data' means any information relating to an identified or identifiable natural person ('data subject'); an identifiable natural person is one who can be identified, directly or indirectly, in particular by reference to an identifier such as a name, an identification number, location data, an online identifier or to one or more factors specific to the physical, physiological, genetic, mental, economic, cultural or social identity of that natural person;*

GDPR, Art. 4

# Personal data

*Personal data include data such as internet protocol (IP) addresses (unique identifiers that can be used to identify the owner of devices connected to the internet) and data from 'smart meters' monitoring energy usage by addresses linked to identifiable persons.*

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Certainly, it includes names & email identifiers.

# Personal data

Jesus M. Gonzalez-Barahona <jgb@gsyc.es>

# Personal data

But... wait!!!!

Our data is public data!!

# Open source data

## [Box 4] Using 'open source' data

The fact that some data are publicly available does not mean that there are no limits to their use.

On the contrary, **if you take 'open source' personal data about identifiable persons and create new records or files/profiles, you are processing personal data about them** and must have a lawful/legitimate basis for doing so.

**You must ensure that the data processing is fair to the data subject and that their fundamental rights are respected.**

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# Open source data

If your research project uses **data from social media networks** and you do not intend to seek the data subjects' explicit consent to the use of their data, you must assess whether those persons actually intended to make their information public (e.g. in the light of the privacy settings or limited audience to which the data were made available).

It is not enough that the data be accessible; they must have been made public to the extent that the data subjects do not have any **reasonable expectation of privacy**. **You must also ensure that your intended use of the data complies with any terms and conditions published by the data controller.**

If you are in any doubt as to what you can and cannot do with this kind of data, you should seek advice from your DPO or a suitably qualified expert and include their opinion in your proposal.

H2020 document on **Ethics and Data Protection**,  
by European Commission

# How to fix the problem

- Anonymize: Strip all personal data  
(but still... more on this later)
- Pseudonymize personal data  
(the dataset will be much richer, but still...)

# Pseudonymizing

*(5) 'pseudonymisation' means the processing of personal data in such a manner that the personal data can no longer be attributed to a specific data subject without the use of additional information, provided that such additional information is kept separately and is subject to technical and organisational measures to ensure that the personal data are not attributed to an identified or identifiable natural person;*

GDPR, Art. 4

# Pseudonymization

## [Box 2] Pseudonymisation and anonymisation: understanding the difference

**Pseudonymisation** entails substituting personally identifiable information (such as an individual's name) with a unique identifier that is not connected to their real-world identity, using techniques such as coding or hashing. However, if it is possible to re-identify the individual data subjects by reversing the pseudonymisation process, data protection obligations still apply. They cease to apply only when the data are fully and irreversibly anonymised.

**Anonymisation** involves techniques that can be used to convert personal data into anonymised data. Anonymisation is increasingly challenging because of the potential for re-identification.

**Re-identification** is the process of turning pseudonymised or anonymised data back into personal data by means of data matching or similar techniques.

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# Pseudonymizing 1

```
echo -n "<jgb@gsync.es>" | sha256sum  
3fdffb4a435cc3a5bab7d96b3cc2cefea90ca879f7fba0341
```

```
commit 491f9205c36fdf54b4bbb7f25ba83b6cb99874b9  
Author: 3fdffb4a435cc3a5bab7d96b3cc2cefea90ca879f7fba0341  
Date: Mon May 13 13:33:04 2019 +0200
```

```
Add notice about GNOME Extension needed...
```

# Pseudonymizing 1

Not good enough:

Data returned for an Email Append

| Input (Encrypted Email)                  | Recovered Email     | First Name | Last Name | Address          | City    | State | Zip   | Phone      |
|--|---------------------|------------|-----------|------------------|---------|-------|-------|------------|
| cbf05329de4e57e4cba09471448ddb98         | joe.smith@gmail.com |            |           |                  |         |       |       |            |
| 5469703a9c26d5e8be4e46bef4596e2f836088c0 | commonme@yahoo.com  | Don        | Johnson   | 478 19TH<br>PL W | Redmond | WA    | 98052 | 4255557892 |

In addition to reversing hashed email addresses, Datafinder also provides personal information including name, address and phone number associated with an email address.

Four cents to deanonymize: Companies reverse hashed  
email addresses, by Gunes Acar

# Pseudonymizing 1

For the curious:

- Estimated: 5 billion email addresses (2018)
- Amazon EC2: 450 billion hashes/sec.
- Lists of (targeted) email lists for sale
- Data breaches leaking billions of addresses

There is a whole business ecosystems around  
email addresses

Four cents to deanonymize: Companies reverse hashed

## Pseudonymizing 2

- Hash “name + address”

Better, but still subject to attack if you harvested addresses

- Salt the hash, use different algorithm
- Non-hash functions (eg, sequential code)
- Encryption instead of hash

Better, but you need to disclose details if you want others to merge with your dataset



# Pseudonymizing 3

A possibility emerges:

*“Encryption / coding*

*Datasets: public*

*Key / coding table:*

*only to researchers asking for it*

(variant: reference them in the paper)

Is this good enough for “legitimate use”?

# Pseudonymizing 3

```
commit 491f9205c36fdf54b4bbb7f25ba83b6cb99874b9
```

```
Author: 4334345
```

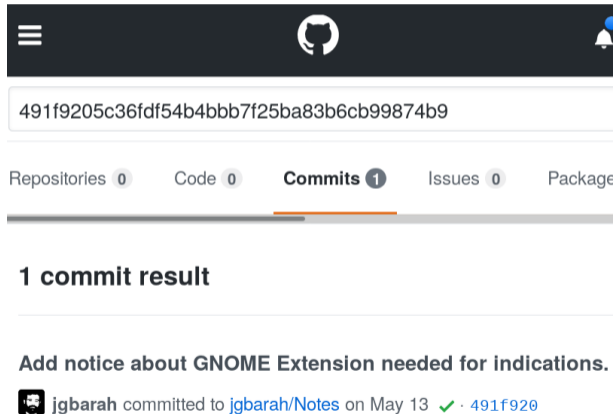
```
Date: Mon May 13 13:33:04 2019 +0200
```

```
Add notice about GNOME Extension needed...
```

Separate table:

```
4334345, Jesus M. Gonzalez-Barahona <jgb@gsync.es>
```

# We still have a problem



The screenshot shows a GitHub search results page. At the top, there is a navigation bar with a hamburger menu, the GitHub logo, and a notification bell. Below the navigation bar is a search input field containing the commit hash `491f9205c36fdf54b4bbb7f25ba83b6cb99874b9`. Underneath the search bar, there are tabs for "Repositories 0", "Code 0", "Commits 1", "Issues 0", and "Package". The "Commits" tab is selected, and a horizontal bar below it shows a progress indicator. The main content area displays "1 commit result". Below this, there is a message: "Add notice about GNOME Extension needed for indications." followed by a commit entry: "jgbarah committed to [jgbarah/Notes](#) on May 13 ✓ · [491f920](#)".

# We still have a problem

```
curl https://archive.softwareheritage.org/api/1/1/491f9205c36fdf54b4bbb7f25ba83b6cb99874b9/
```

```
{"author":  
  {"name": "Jesus M. Gonzalez-Barahona",  
    "fullname": "Jesus M. Gonzalez-Barahona <jgb@g",  
    "email": "jgb@gsyc.es"}  
}  
...  
}
```

# What can we do?

Pseudonymize the hash too:

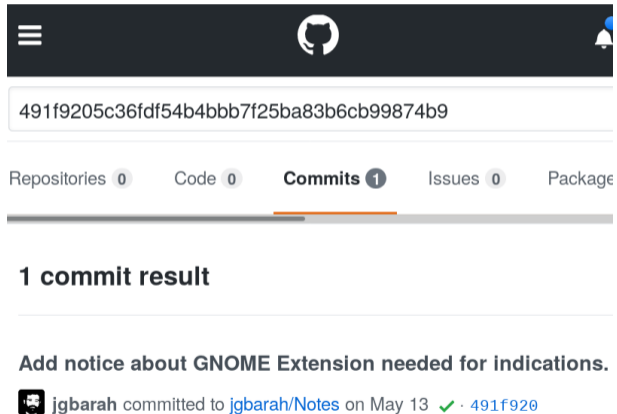
```
commit 6777888876876
```

```
Author: 4334345
```

```
Date: Mon May 13 13:33:04 2019 +0200
```

```
Add notice about GNOME Extension needed...
```

# We still have a problem (2)



The screenshot shows the GitHub search interface. At the top, there is a navigation bar with a hamburger menu, the GitHub logo, and a notification bell. Below this is a search bar containing the commit hash `491f9205c36fdf54b4bbb7f25ba83b6cb99874b9`. Underneath the search bar, there are tabs for "Repositories 0", "Code 0", "Commits 1", "Issues 0", and "Package". The "Commits" tab is selected, and a horizontal bar below it shows a progress indicator. The main content area displays "1 commit result". Below this, there is a message: "Add notice about GNOME Extension needed for indications." followed by a commit entry: "jgbarah committed to [jgbarah/Notes](#) on May 13 ✓ · [491f920](#)".

## We still have a problem (2)

- Commit comment can be used to deanonymize author.
- Date can be used to deanonymize author.

```
commit 6777888876876
```

```
Author: 4334345
```

```
Date: 5353453453
```

```
Comment: 4343434334
```

...and separate coding tables

# Why we need tables

- For reproduction: commits per time period
- for reuse: identity merging
- for reuse: relationship between message and time of the day
- for reuse: link to issues
- ...



# When data is public...

This is a problem for anyone  
having access to the data  
that allows deanonymization

But also for anyone letting others deanonymize

Big trouble if it is publicly available data

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# Important details

# Timing of anonymization

- Collection (no personal data is processed)  
Example: web form, no browser tracking  
Example: anonymous dataset from 3rd party
- Later than collection:  
Raw data is not anonymized  
(needs special protection)

## Informed consent

*Explain to participants what your research is about, what their participation in your project will entail and any risks that may be involved. When they have fully understood, see and obtain their express permission.*

GDPR, Article 4 (11), Article 7

# Managing consent

You need to document and archive consent

You need to be able of producing evidence

Consent management applications:

- ethically robust, secure
- model consent processes
- manage, document, evidence

# Secondary use

Usually, we perform secondary use  
(we don't collect data directly from persons)

Important: check original consent

Explain how data was obtained,  
justify use (legitimate use)  
ensure processing is fair to data subjects

## Secondary use

*(47) the legitimate interests of a controller [...] or of a third party, may provide a legal basis for processing, provided that the interests or the fundamental rights and freedoms of the data subject are not overriding, taking into consideration the reasonable expectations of data subjects based on their relationship with the controller*

# Data security

- Appropriate technical & organisational measures
- Level of security commensurate to risks faced by the data subjects
- Prevention of unauthorized access, disclosure, accidental deletion



# Data security

Do

- ✓ use GDPR-compliant tools to collect, process and store research subjects' personal data;
- ✓ take communications security seriously, and devise and implement dedicated protocols for your project as necessary;
- ✓ check the terms and conditions of all of the service providers you use (software, applications, storage, etc.) to process personal data within your project, in order to identify and mitigate risks to the data subjects;
- ✓ encrypt your research data and/or the devices on which they are stored, and ensure that keys/passwords are appropriately protected; and
- ✓ consult your DPO or a suitably qualified expert for advice on how to achieve a level of data security that is commensurate to the risks to your data subjects.

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# Data security

- ✘ collect data on a personal device such as a smartphone without ensuring that they are properly protected (e.g. consider the implications of automatic back-ups to the cloud, and the device's security features);
- ✘ use free services that may use your participants' data for their own purposes in lieu of payment, or collect data or communicate with research participants via social media platforms without first assessing the data protection implications;
- ✘ use unencrypted email, SMS or insecure 'voice over IP' platforms to communicate with vulnerable participants or those who may be subject to state surveillance;
- ✘ expose personal data to unauthorised access or use when accessing them remotely (e.g. by using insecure wifi connections) or travelling to countries where your devices may be inspected or seized; and
- ✘ assume that your research partners, collaborators or service providers have appropriate information security and data protection policies without checking that this is the case.

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# Transfer outside EU

Possible (GPDR, Chapter 5)::

- to countries with “adequacy determination”
- when explicit consent is obtained
- when compliant data-transfer agreements are in place

Beware of third-party services!!!

Non-EU countries with adequacy determination

# Transfer outside EU

- ✓ ensure that any international data transfers fulfil at least one of the relevant conditions in Chapter V GDPR;
- ✓ check that any third-party services you intend to use (e.g. survey tools, data analytics, cloud storage, etc.) are incorporated in an EU Member State or legally represented in the EU in accordance with the GDPR;
- ✓ adopt legally binding and enforceable agreements with partners or service providers prior to data transfers;
- ✓ prohibit the onward transfer of personal data by members of your consortium and any other recipients outside the framework of such agreements; and
- ✓ implement appropriate organisational and technical measures to ensure that personal data are transferred securely.

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# Archiving

Archive personal data  
only as needed for research purposes.

Delete it as soon as possible  
(define a maximum retention period).

Beware of backups and data in cloud storage.

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# Archiving

But you can keep personal data indefinitely if you ensure it is only for:

- archiving purposes in the public interest
- scientific or historical research purposes
- statistical purposes

# Archiving

## Open issue: archiving for reproduction

In principle, covered by research exemption,  
but it is not absolute

# Collection outside EU

Subject to GDPR  
even if data comes from outside EU  
if data controller is based in EU

Of course, compliance with  
the law of the country of collection



# Children

*If your research project involves collecting data from children, you must follow the “EC Guidance note on informed consent”, in particular the provisions on obtaining the consent of a parent/legal representative and, where appropriate, the assent of the child.*

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European Commission

*The GDPR establishes special safeguards for children in relation to “information society services”, a broad term covering all internet service providers, including social media platforms. These include a requirement for verified parental consent in respect of information society services offered directly to children aged under 16. Individual Member States may provide for this threshold to be lowered to 13.*

H2020 document on Ethics and Data Protection,  
European Commission

Data mining &  
GDPR

Jesus M.  
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Should we worry?

What should we  
do?

Some definitions

A case study

Important details

Call for action

To probe further



# Call for action

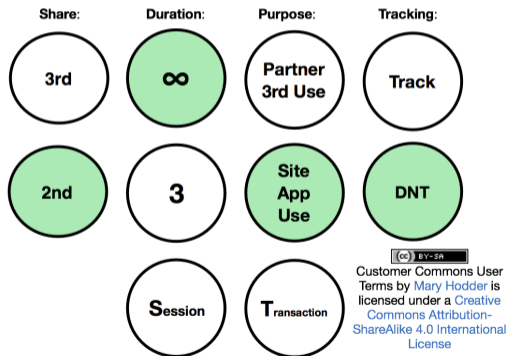
# Researchers & developers

Maybe we researchers need to work  
with developers  
to learn what is legitimate use for them?

Maybe developers should specify  
what is legitimate use for them,  
in their repositories?

# An inspiration

## MY TERMS: Icon format and structure



NOTE: I'm the first party. My terms are: 2nd-∞-SU-DNT

User Submitted Terms, by  
Mary Hooder  
Customer Commons and  
User Submitted Terms

# A related IEEE WG

## Working Group Details

**Working Group** MRPT\_WG - Machine Readable Privacy Terms Working Group

**Sponsor Committee** SSIT/SC - Social Implications of Technology Standards Committee

**Society** [SSIT - IEEE Society on Social Implications of Technology](#)

# Machine Readable Privacy Terms Working Group

# FOSS is open for a reason

Having the source code available  
is a conscious decision

It could be extended to all data  
related to software development  
(better understanding of the project)

Clarification of intent would help to define  
legitimate interest and prove ethics compliance

Data mining &  
GDPR

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# To probe further



# References

- **GDPR portal** by EC  
(includes full text of GDPR)
- **H2020 document on Ethics and Data Protection**, European Commission
- **GDPR and Research: An Overview for Researchers**, UK Research and Innovation

# Credits



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