



Automated Translation of Permission-Requiring Code to Privacy Statements

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Mobile Applications Violate Privacy!

- By recording audio without your permission (unauthorized).
- By sharing IP Address with 3rd parties for ads without properly informing users (unfair).
- By flashlight app collecting your location (illegitimate).

```
public void getInitCoords()
{
    this.mMap.setMyLocationEnabled(1);
    this.locmgr = ((android.location.LocationManager) this.getActivity().getSystemService(location));
    android.location.Criteria v0_1 = new android.location.Criteria();
    v0_1.setPowerRequirement(1);
    this.userLocation = this.locmgr.getLastKnownLocation(this.locmgr.getBestProvider(v0_1, 1));
    this.mMap.setOnCameraChangeListener(new com.qbiki.modules.nearbylocations.NearbyLocationFragment$2(this)
    if (this.userLocation != null) {
        this.mMap.moveCamera(com.google.android.gms.maps.CameraUpdateFactory.newLatLng(new com.google.android.gms.maps.LatLng(this.userLocation.getLatitude(), this.userLocation.getLongitude()));
        this.mMap.animateCamera(com.google.android.gms.maps.CameraUpdateFactory.zoomTo(1098907648));
    }
    this.mMap.setOnMyLocationChangeListener(new com.qbiki.modules.nearbylocations.NearbyLocationFragment$3(this)
    return;
}
```

```
"app_id": "com.apps.editblemishesphotos",
"title": "EditBlemishesPhotos",
"permissions_in_xml": [
    "android.permission.INTERNET",
    "android.permission.GET_ACCOUNTS",
    "android.permission.ACCESS_NETWORK_STATE",
    "com.apps.editblemishesphotos.permission.C2D_MESSAGE",
    "com.google.android.c2dm.permission.RECEIVE"
],
```

Creating privacy notices that match applications' behavior requires a lot of effort!

- Legal experts create privacy policy:
 - Long
 - Technical Jargon
 - College Level Reading
 - Inconsistent
- Constant update required.
- No domain knowledge.
- Use privacy policy generator:
 - Vague
 - Generic
 - Inconsistent

Privacy Recommender System I

- An end-to-end framework that identifies code segments processing personal information and translate it to privacy statements.

```
package com.qbiki.modules.nearbylocations;

public class NearbyocationFragment{

public NearbyLocationFragment() {
//
}

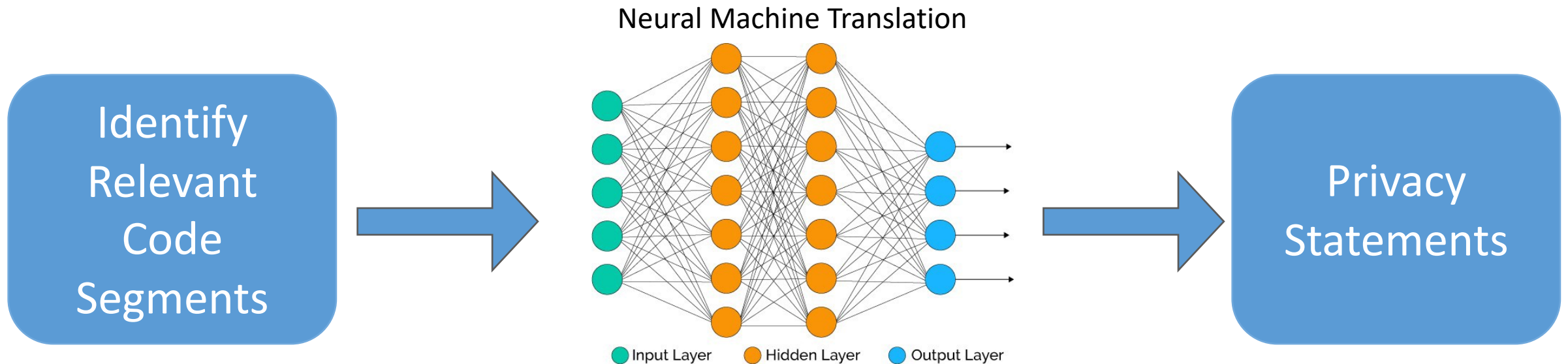
public void getInitCoords()
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this.mMap.setMyLocationEnabled(1);
this.locmgr = ((android.location.LocationManager) this.getActivity().getSystemService(location));
android.location.Criteria v0_1 = new android.location.Criteria();
v0_1.setPowerRequirement(1);
this.userLocation = this.locmgr.getLastKnownLocation(this.locmgr.getBestProvider(v0_1, 1));
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if (this.userLocation != null) {
this.mMap.moveCamera(com.google.android.gms.maps.CameraUpdateFactory.newLatLng(new com.google.am
this.mMap.animateCamera(com.google.android.gms.maps.CameraUpdateFactory.zoomTo(1098907648));
}
}
this.mMap.setOnMyLocationChangeListener(new com.qbiki.modules.nearbylocations.NearbyLocationFragment$
return;
}
```

Application code segment

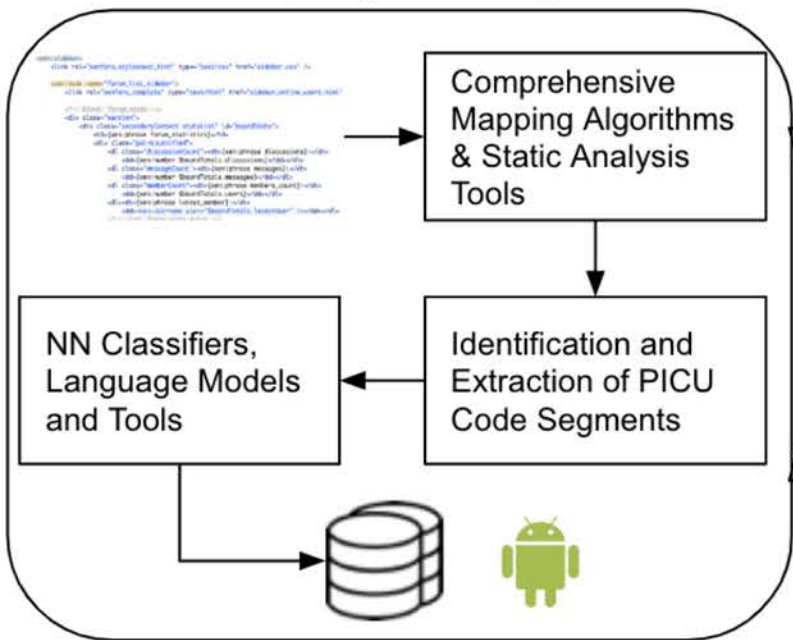


Edit Blemishes Photos collects location to identify near by attractions.

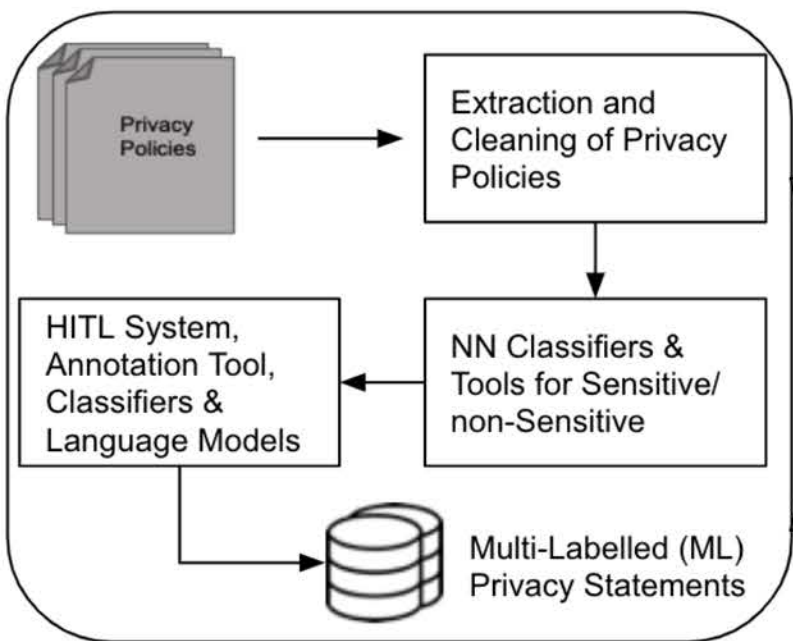
Privacy Recommender System II



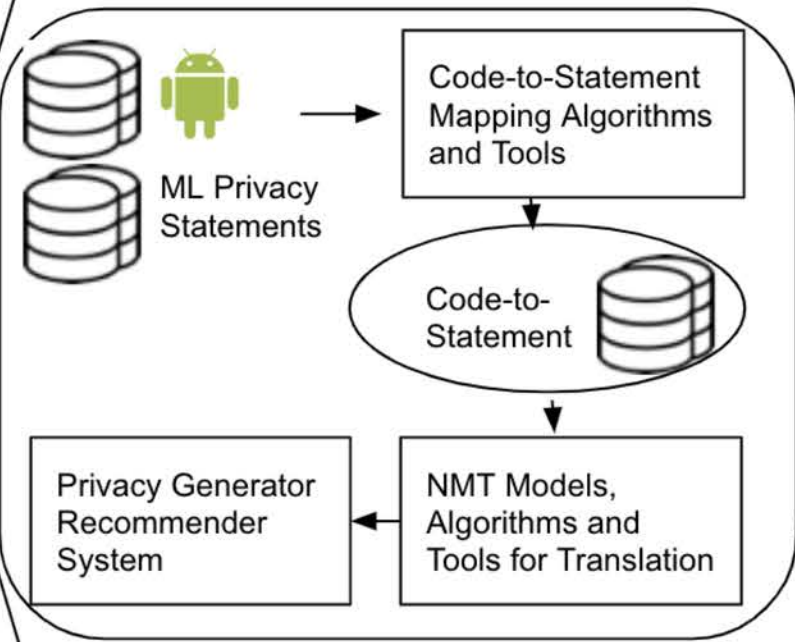
Phase One: Preparing Android Applications Dataset



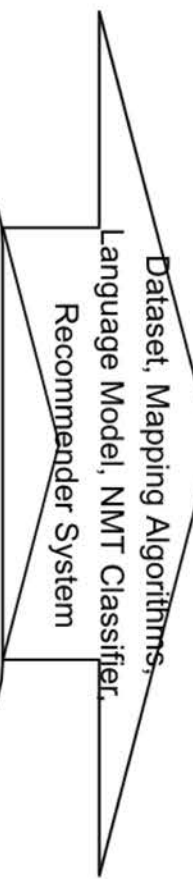
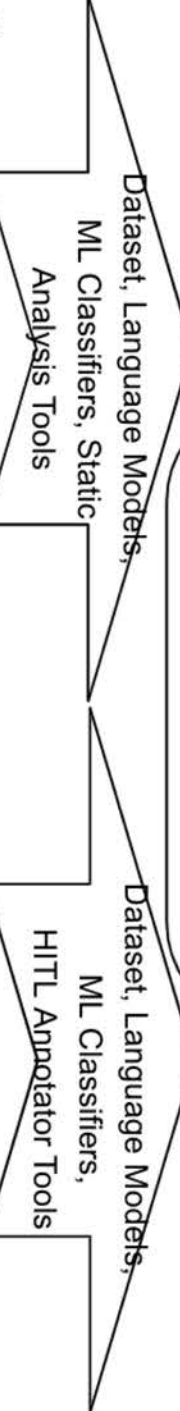
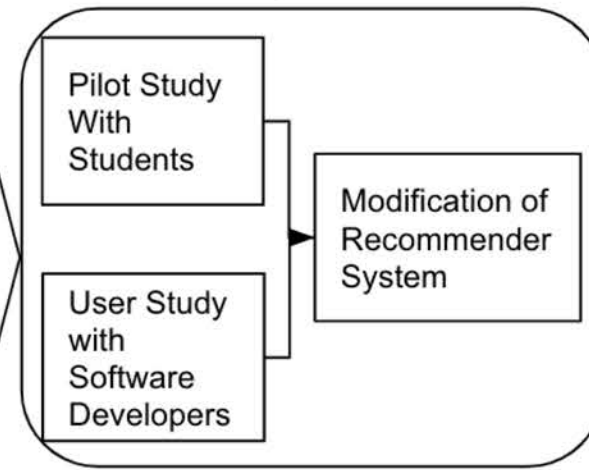
Phase Two: Preparing Privacy Policies Dataset



Phase Three: Mapping Code to Privacy Statements



Phase Four: Empirical User Evaluation



Privacy Recommender System – Phases

- Phase One – Developing mappings of API to personal information.
- Phase Two – Analyzing and understanding how privacy policies are written and annotating privacy segments.
- Phase Three – Mapping code segments with privacy statements
 - Train Neural Translation Model
- Phase Four – Evaluation and User Studies

Contributions

- End-to-end privacy framework
- Novel approach to resolve inconsistency
- Translation dataset
- Software tools
- Language models

Main Contributors

- Dr. Sepideh Ghanavati, **PI**, Department of Computer Science, University of Maine
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