Diffix: Enabling (Aggregate) Data Markets with Anonymization

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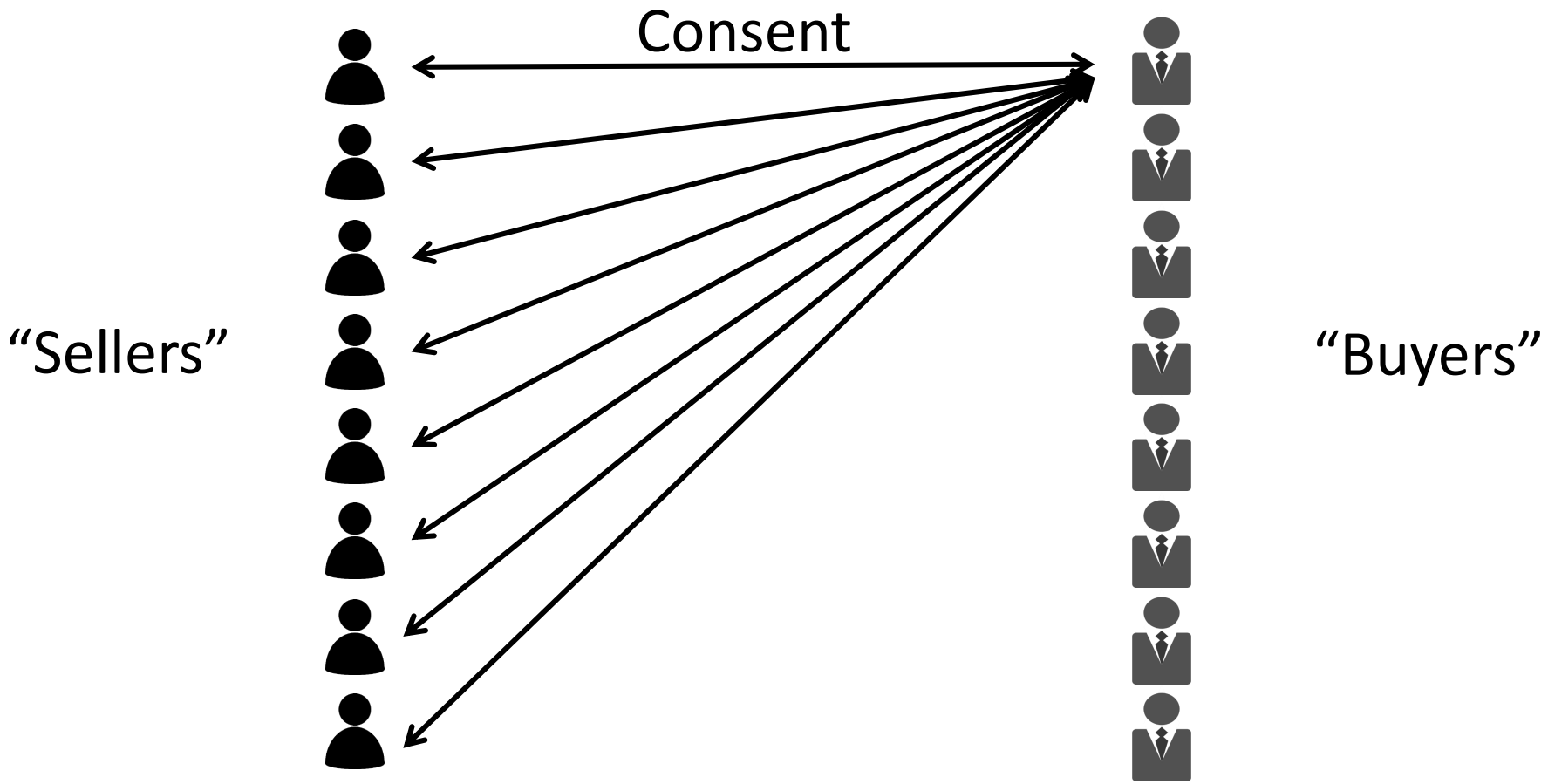
MyData 2017 Session:
Roadmap for Personal Data Markets

Markets and Scale

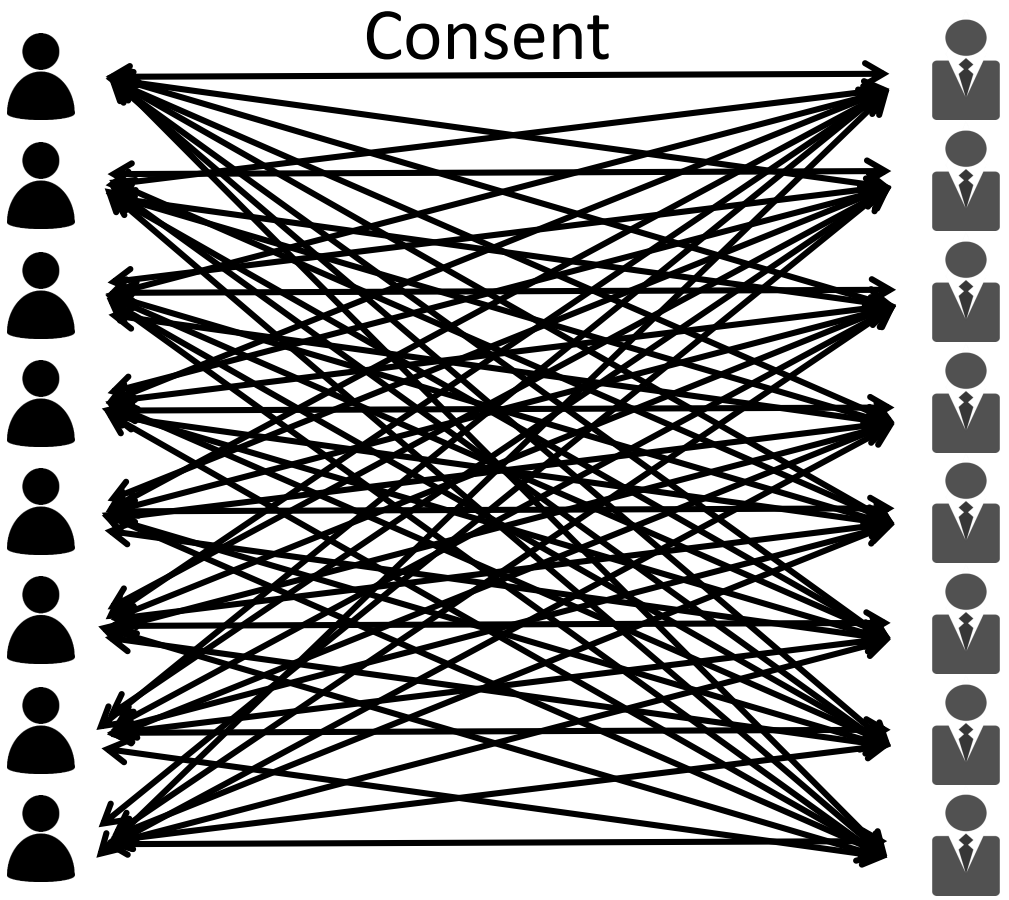
- Market: *“a regular gathering of people for the purchase and sale of provisions, livestock, and other commodities.”*

- Markets don’t scale without “middlemen” of various sorts
- A “middleman” is antithetical to the MyData concept of individual control over data
- To scale a *data market*, individual needs to give broad consent to middleman
  - Individual cannot be expected to give consent every transaction, or even track every transaction

Data Market Without Middleman



Data Market Without Middleman



“Sellers”

“Buyers”

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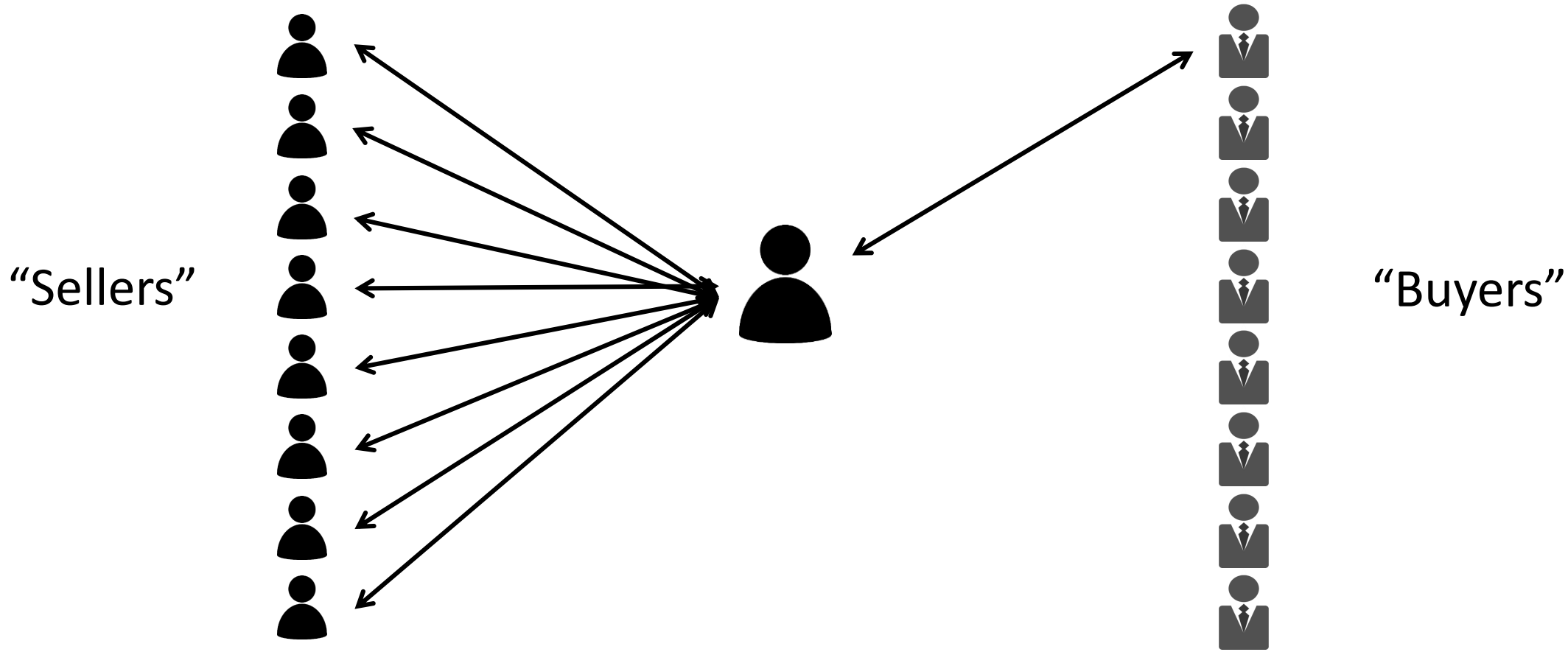
Middleman, but per-transaction consent:

- Still doesn't scale for seller

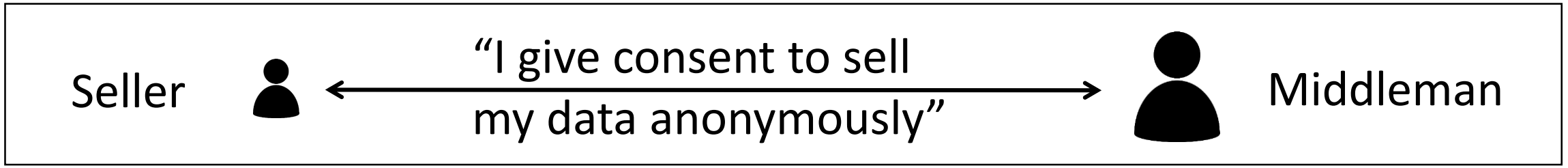


MyData Enables and Hinders Data Markets

- MyData *enables* data markets in many ways:
  - Diverse types of data joined together through identity management
  - Diverse data leads to much better analytics
    - Knowledge of diet ***and*** exercise together more valuable than knowledge of diet or exercise separately
- But MyData concept of individual control of data *hinders* data markets

Anonymization is key enabler

- Most often, data “buyer” is interested in *aggregate* data, not *individual* data
- If aggregate data is *anonymous*, then consent is much simpler:



- Because anonymous data is not “personal” data
- Safe to distribute

Conclusions from GDPR-track session in Tallinn

- People don’t trust claims of anonymity
  - Too many failures in the past

- People don’t even trust DPA “certifications” of anonymity
  - Too much expertise required, too complex

Synopsis

- Buyers in a data market may be interested in only *aggregate data*
- Historically GDPR-level anonymity very hard to achieve
- *Diffix* is a technical breakthrough in anonymity
  - GDPR-level anonymity
  - Minimal data distortion
  - Simple configuration
  - Rich query semantics

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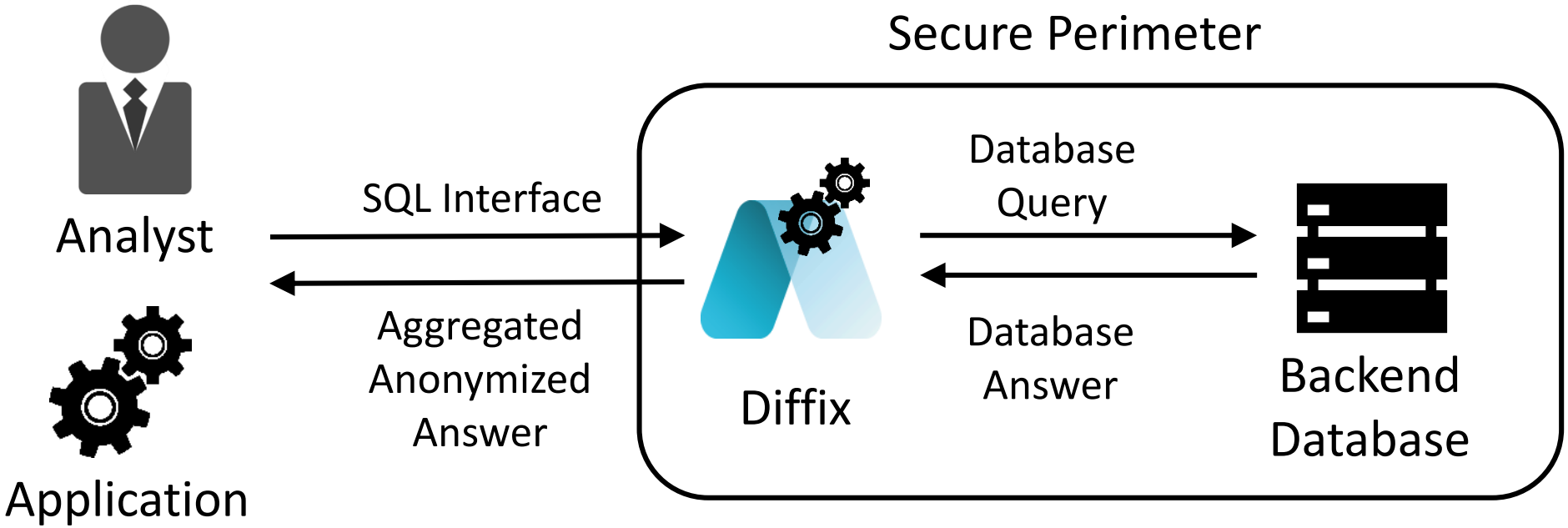
- Need transparency to build confidence

Strong anonymization (has been) very hard

- Requires substantial expertise
  - For example, ARX:
    - classify data as identifying, quasi-identifying, sensitive, and insensitive;
    - create masking-based, interval-based, or order-based generalization hierarchies;
    - understand and configure privacy models such as δ-presence, l-diversity, t-closeness, δ-disclosure, k-Anonymity, k-Map, (ϵ,δ)-differential privacy;
    - risk-based privacy models for prosecutor, journalist and marketer risks
- Re-think for each new use case
- *Often not possible,* even for a single data set with single use case!
- *Definately not possible* if goal is to join diverse data in a market

Diffix: Breakthrough in anonymity



Deployed as a “box” in front of an unmodified (raw) database

Diffix Configuration is Simple

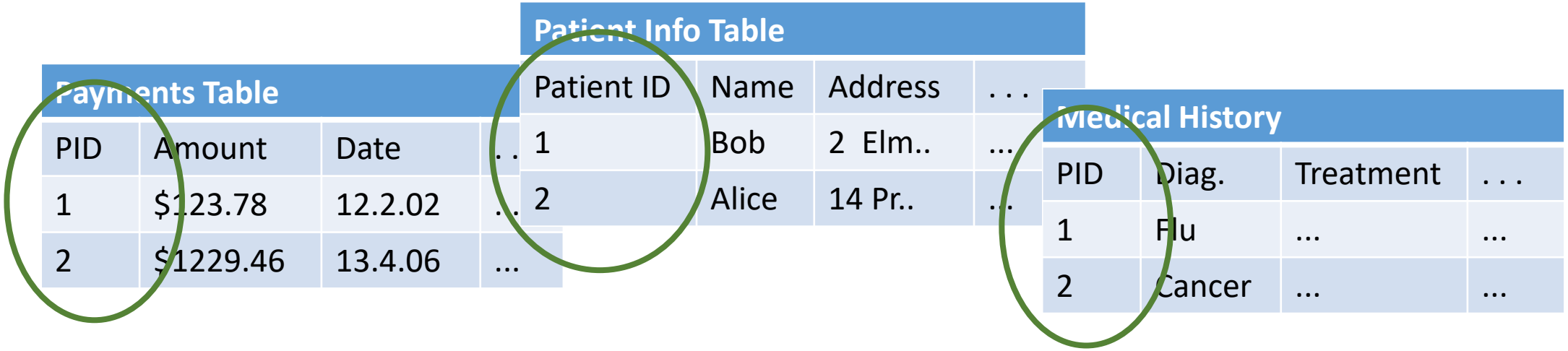
Payments Table			
PID	Amount	Date	. .
1	$123.78	12.2.02	...
2	$1229.46	13.4.06	...

Patient Info Table			
Patient ID	Name	Address	. . .
1	Bob	2 Elm..	...
2	Alice	14 Pr..	...

Medical History			
PID	Diag.	Treatment	. . .
1	Flu	...	...
2	Cancer	...	...

Diffix Configuration is Simple

- No change to database
- Simply identify and configure key fields that identify users and link user tables
- Example: 30 minutes to configure clinical database with 120 distinct user tables



Payments Table

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Patient ID	Name	Address	. . .
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PID	Diag.	Treatment	. . .
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```
SELECT [DISTINCT]
  field_expression [, ...]
  FROM from_expression [, ...]
  [ WHERE where_expression [AND ...] ]
  [ GROUP BY column_expression | position [, ...] ]
  [ HAVING having_expression [AND ...] ]
  [ ORDER BY column_name [ASC | DESC] | position [, ...] [ LIMIT
amount ] [ OFFSET amount ] ]

field_expression :=
  * | table_name.* | column_expression [AS alias]

column_expression :=
  [table_name.]column_name |
  aggregation_function([DISTINCT] column_name) |
  function(column_expression) |
  column_expression binary_operator column_expression |
  column_expression::data_type

binary_operator :=
  + | - | * | / | ^ | %

data_type :=
  integer | real | text | boolean | datetime | date | time

from_expression :=
  table | join

table :=
  table_name [[AS] alias] | (select_expression) [AS] alias
```

```
join :=
  table CROSS JOIN table |
  table { [INNER] | { LEFT | RIGHT } [OUTER] } JOIN table ON where_expression

aggregation_function :=
  COUNT | SUM | AVG | MIN | MAX | STDDEV | MEDIAN

where_expression :=
  column_expression equality_operator (value | column_expression) |
  column_expression inequality_operator (numerical_value | datetime_value) |
  column_expression BETWEEN value AND value |
  column_expression IS [NOT] NULL |
  column_expression [NOT] IN (constant [, ...])
  column_expression [NOT] LIKE | ILIKE string_pattern [ESCAPE escape_string]

having_expression :=
    column_expression comparison_operator (value | column_expression)

comparison_operator :=
    equality_operator | inequality_operator

equality_operator :=
    = | <>

inequality_operator :=
    > | >= | < | <=
```

Much of SQL

banking Online

```
1 SELECT left(birth_number, 2) AS birth_year, count(*), count_noise(*)
2 FROM accounts
3 GROUP BY 1
```

Run or Ctrl + Enter

```
1 SELECT left(birth_number, 2) AS birth_year, count(*), count_noise(*)
2 FROM accounts
3 GROUP BY 1
```

birth_year	count	count_noise
*	22	1.4
38	73	1.4
60	80	1.4
19	48	1.4
80	93	1.4
49	85	1.4
20	57	1.4
72	86	1.4

Tables and views New view

Filter columns

− accounts

Column	Type
account_id	integer
acct_district_id	integer
frequency	text
acct_date	integer
client_id	integer
disp_type	text
birth_number	text
cli_district_id	integer
lastname	text

+ cards

+ clients

+ disp

+ loans

+ orders

banking Online

```
1 SELECT operation, count(*), count_noise(*)
2 FROM transactions
3 GROUP BY 1
```

Run or Ctrl + Enter

```
1 SELECT operation, count(*), count_noise(*)
2 FROM transactions
3 GROUP BY 1
```

operation	count	count_noise
	218210	100
PREVOD NA UCET	254653	190
PREVOD Z UCTU	81705	58
VKLAD	182005	120
VYBER	517162	210
VYBER KARTOU	9275	34

Download as CSV | Show chart

6 rows.

Tables and views New view

Filter columns

- accounts
- cards
- clients
- disp
- loans
- orders
- transactions

Column	Type
trans_id	integer
account_id	integer
trans_date	text
trans_type	text
operation	text
amount	real
balance	real
k_symbol	text

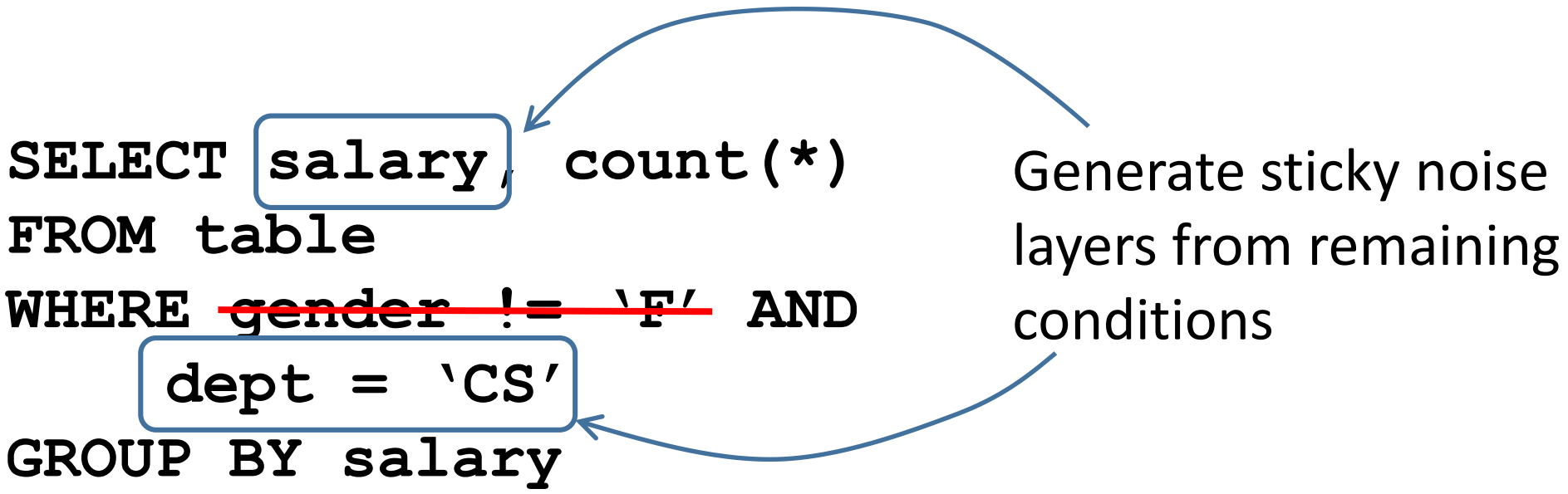
Diffix anonymization mechanisms

- Adds noise to answers
- Uses “sticky noise”
  - Prevents averaging attacks
  - No “budget” as with differential privacy
- Adds sticky noise for each data filter
- Filters answers with too few users
  - Noisy threshold
- Removes “low-effect” data filters

```
SELECT salary, count(*)
FROM table
WHERE gender != ‘F’ AND
     dept = ‘CS’
GROUP BY salary
```

```
SELECT salary, count(*)
FROM table
WHERE gender != 'F' AND
      dept = 'CS'
GROUP BY salary
```

Remove condition with minimal effect


SELECT salary, count(*)
FROM table
WHERE gender != 'F' AND
dept = 'CS'
GROUP BY salary
Generate sticky noise layers from remaining conditions

Building confidence

- Diffix is complex, not formally proven
- Positive evaluation for anonymity from CNIL
  - French national data protection authority
  - But this cannot be considered definitive
- Plan “bug bounty” type evaluation
  - Cash prizes for breaking anonymity
  - First anonymity bug bounty
  - Release in September

Thanks!

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