Social Influence in Agent-Based Modelling

A Dynamic Network Model of Juvenile Delinquency

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Collaboration

- This model was developed in collaboration with

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&
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Outline

- Juvenile Delinquency Networks
- Agent-Based Modelling
- Opinion Dynamics Models
- Social Circles
- Leader of the Pack Model
- Validation
- Conclusions

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Juvenile Delinquency

- Sutherland's Differential Association
- Hirschi's Social Bond Theory
- Smångs 'Crucial Experiment'
- Sarnecki on Juvenile Delinquents
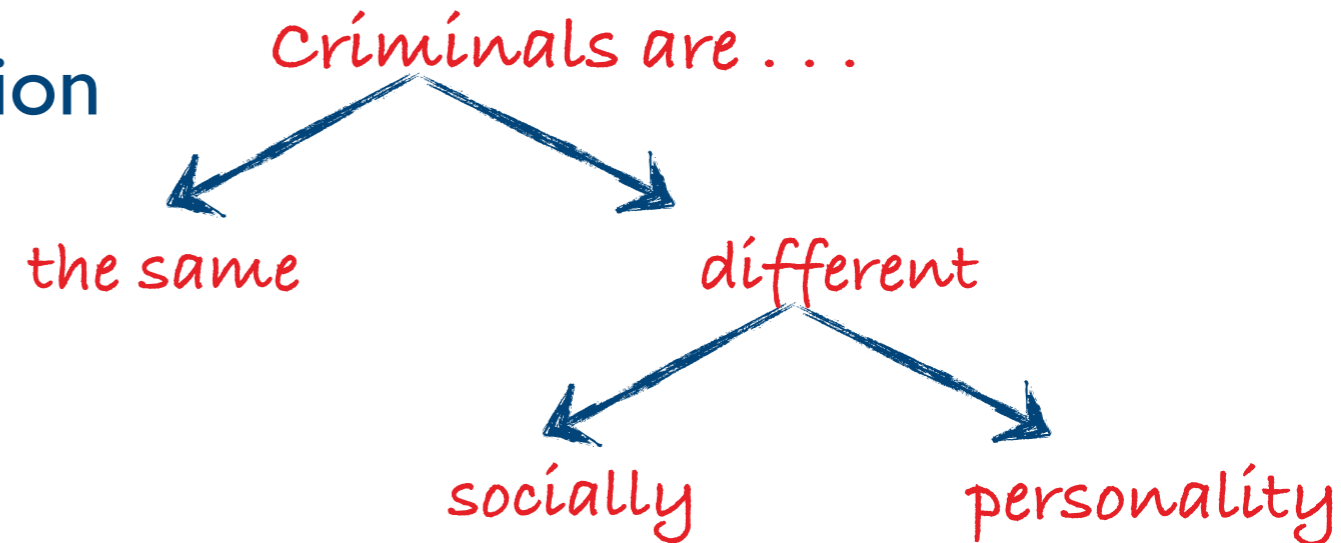
  - two studies Borlänge and Stockholm
  - networks of co-offending using police data
  - longitudinal study over 5 years

- Self report questionnaires: How delinquent are your friends?

Criminals are . . .

the same   different

socially   personality

Criminals cluster together:

Criminals have more criminal friends.

More friends of criminals are criminals.

Agent-Based Models

. . .are computer programs that create a world of heterogeneous agents, where the agent interacts with other agents and with the environment.

. . . permit simple, local interactions to generate complex, emergent behaviour, global patterns that can be compared with macro phenomena

. . . allow experimentation by varying parameters and comparing data obtained from the simulation with real world data.

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Opinion Dynamics in Agent-Based Models

Agent-based simulations of how opinions are spread through a population.

- Deffuant, et. al. (2002) *How can extremism prevail?* JASSS.
- social influence on 'worldview'
- agents: opinion & confidence (both continuous two-dimensional space)
- on an implementation they go to two extremes (or a consensus)
- these models are executed without a social structure.

Translate this directly into 'criminality' and 'susceptibility'.
Does not show the behaviour we want from Criminality.

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Social Networks in ABM

- preferential attachment, small world, random, regular.

- don't have properties real social networks have

- what we want is:

  - Personal networks

    Limited size of personal networks
    Allow some to have a very large networks
    Have high clustering

  - Social networks

    A low whole network density
    Assortativity by degree of connectivity
    Communities (low Grannis factor)
    Short path lengths
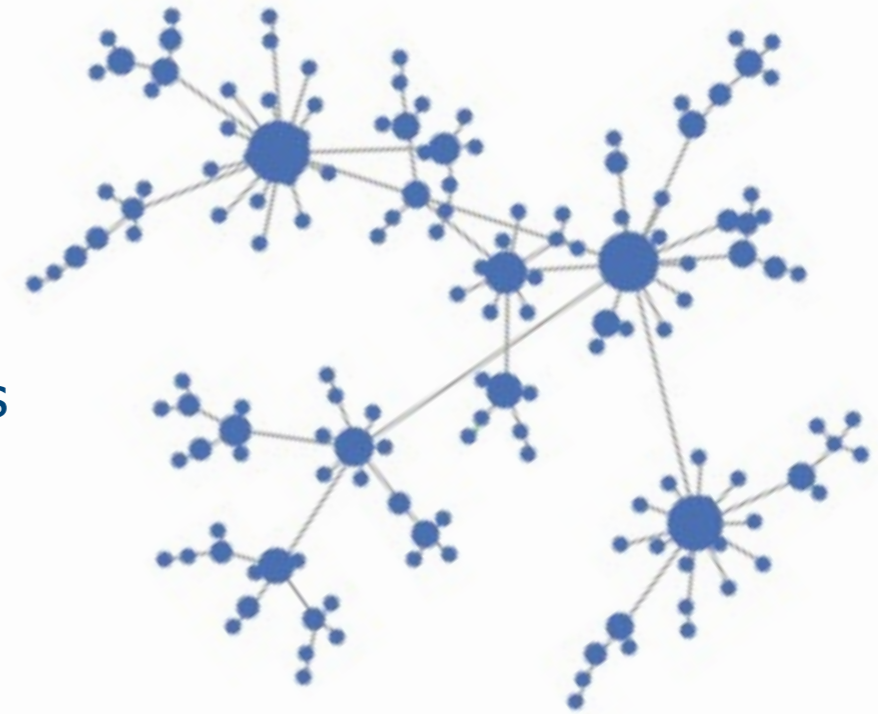
Properties of Implemented Networks

	Regular	Random	Small World	Scale-Free
Limited personal network	✓	✓	✓	✗
Fat-tail	✗	✗	✗	✓
High Clustering	✓	✗	✓	✗
Low Density	✓	✓	✓	✓
Short Path	✗	✓	✓	Possibly
Assortative	✗	✗	✗	✗
Communities	✗	✗	✗	✓

Simmel's Model of Social Circles
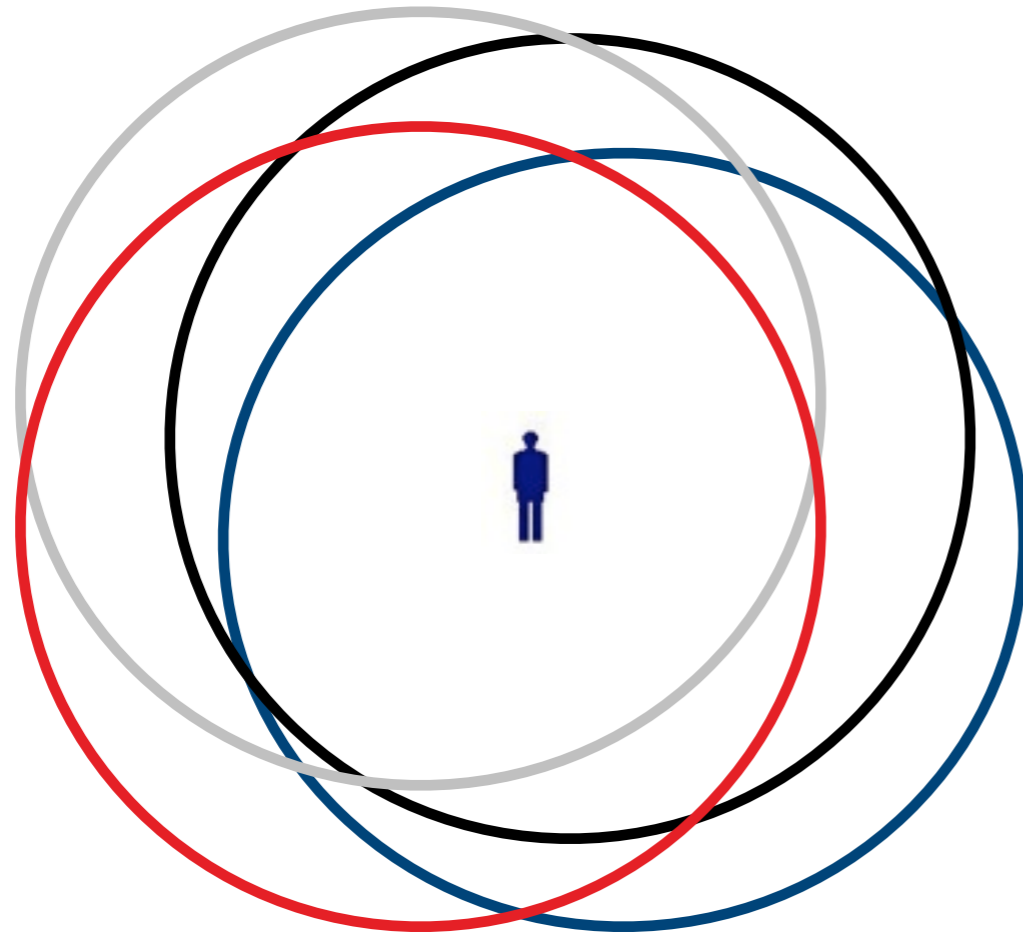
Circles intersect a lot

Characteristic of smaller, more homogeneous societies. (In Spencer's functionalism, a society at an early stage of development.) Social groups overlap/intersect a lot, so most people are in the same group with lots of the same people. A person's various social roles or personality aspects tend to reinforce each other. There may be pressure to conform, and the individual may feel strongly embedded in society.
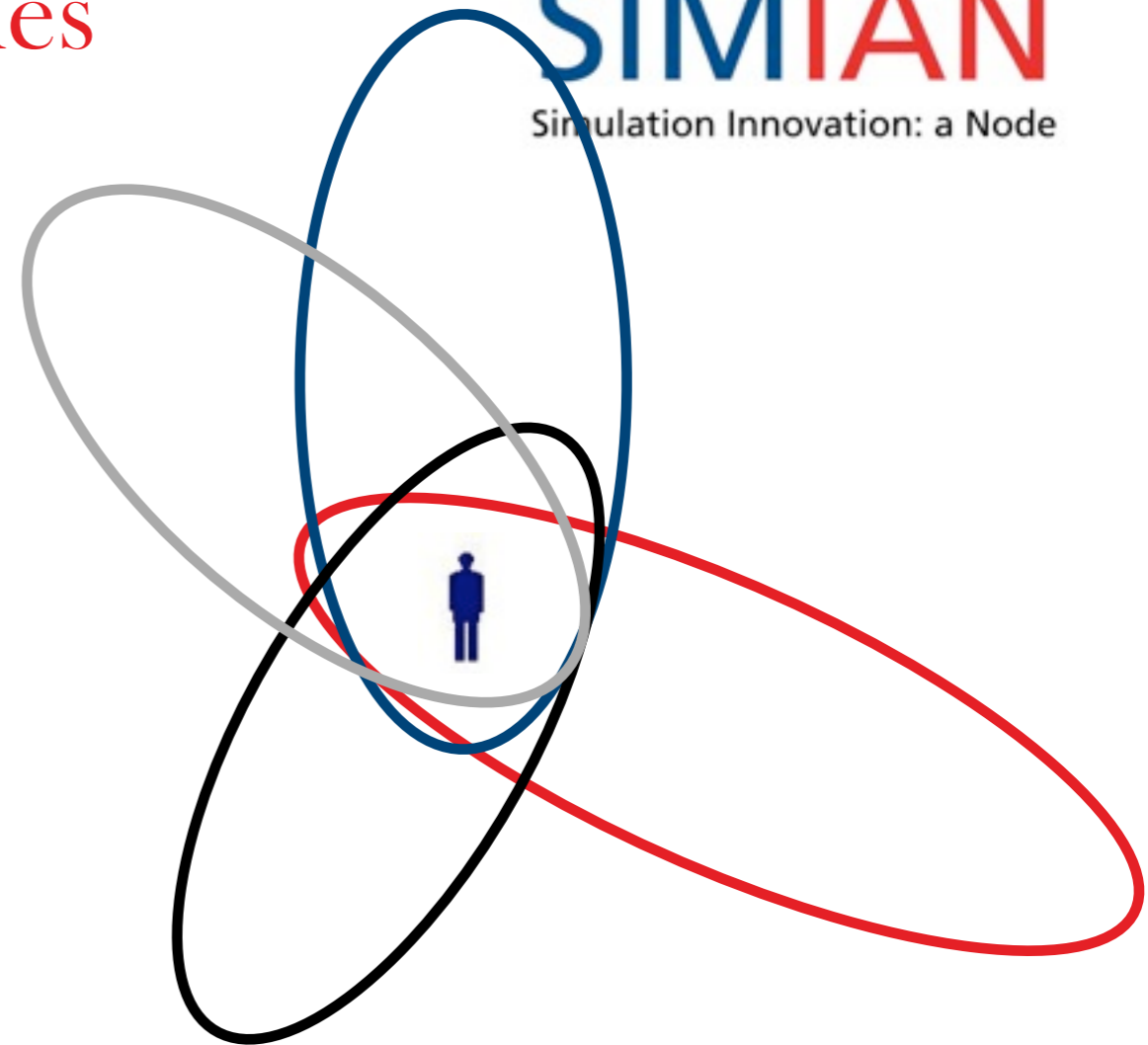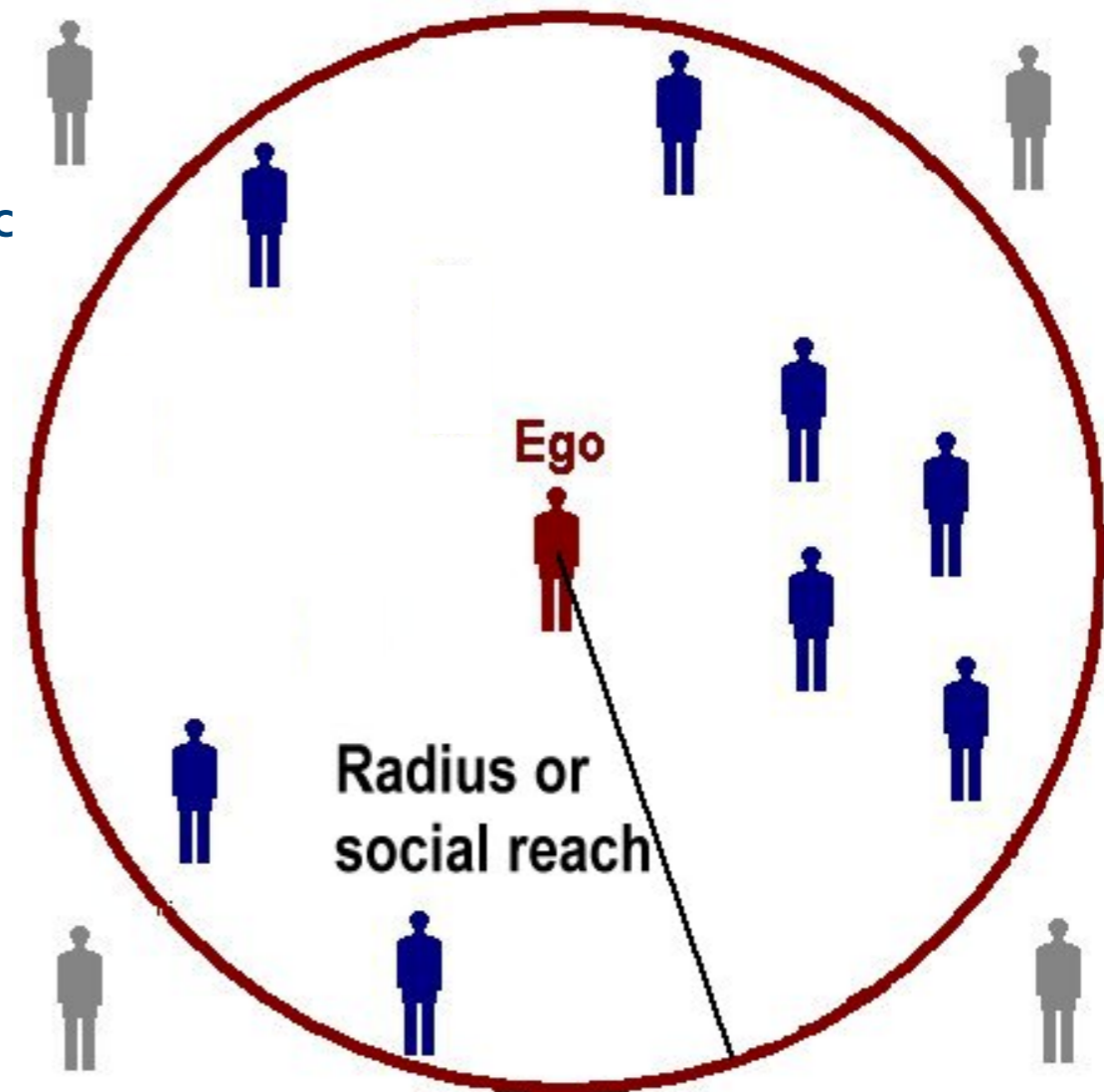
Circles intersect only a little

Characteristic of larger, more diverse societies with much specialization or division of labor. (In Spencer's functionalism, a society at an later stage of development.) Social groups overlap/intersect only a little, so few people are in the same groups with each other. A person's various social roles or personality aspects tend to diverge from each other. The individual may feel free but isolated.

http://www.lsu.edu/faculty/fweil/SimmelCircles.htm

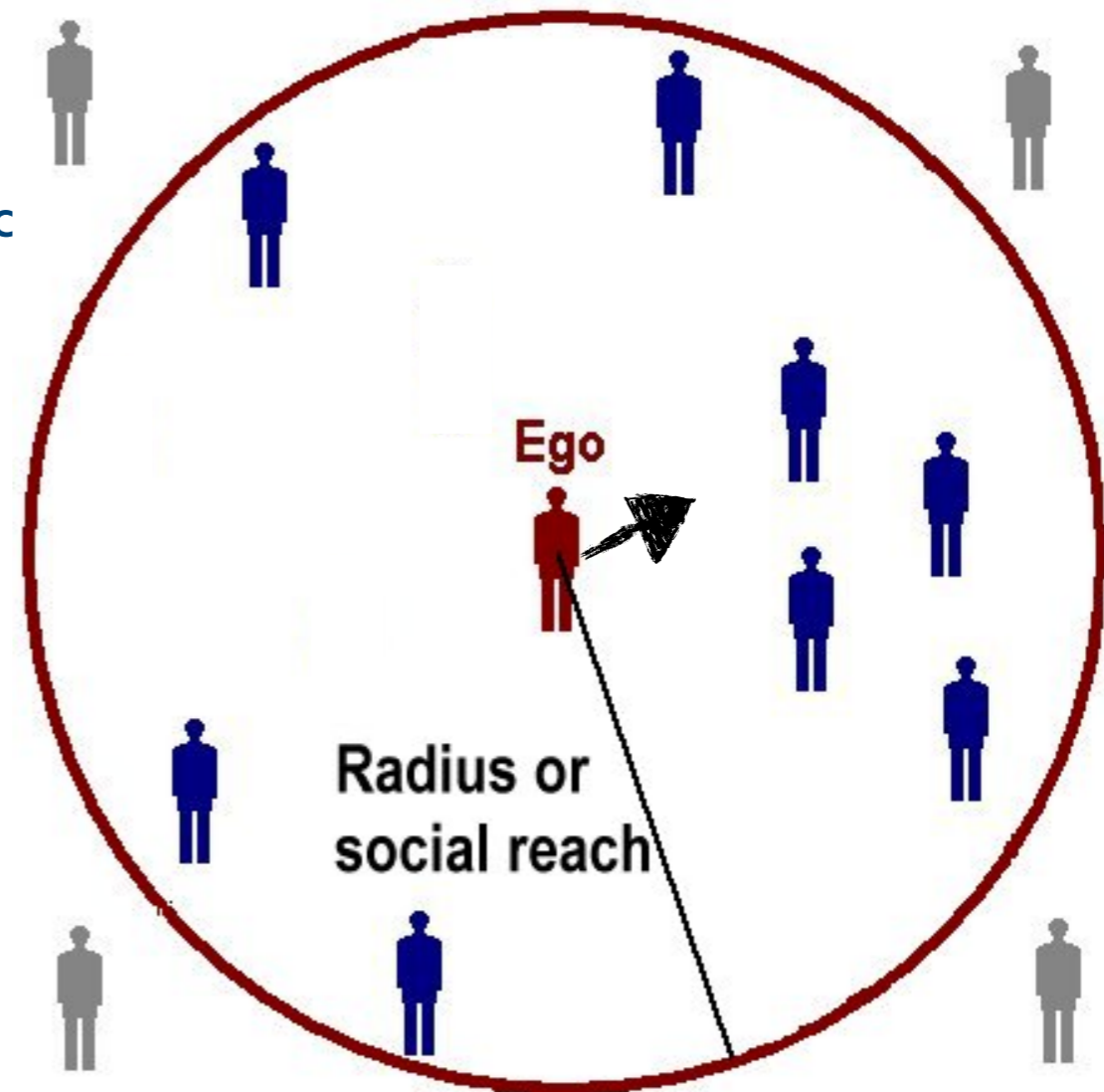http://www.lsu.edu/faculty/fweil/SimmelCircles.htm

The Social Circles Model

- model of the uptake of the telephone on historic data (Hamill 2010)
- friends are those inside the circle
- all agents have the same radius
- 'moment in time' influence
- movement towards the centroid of the social circ
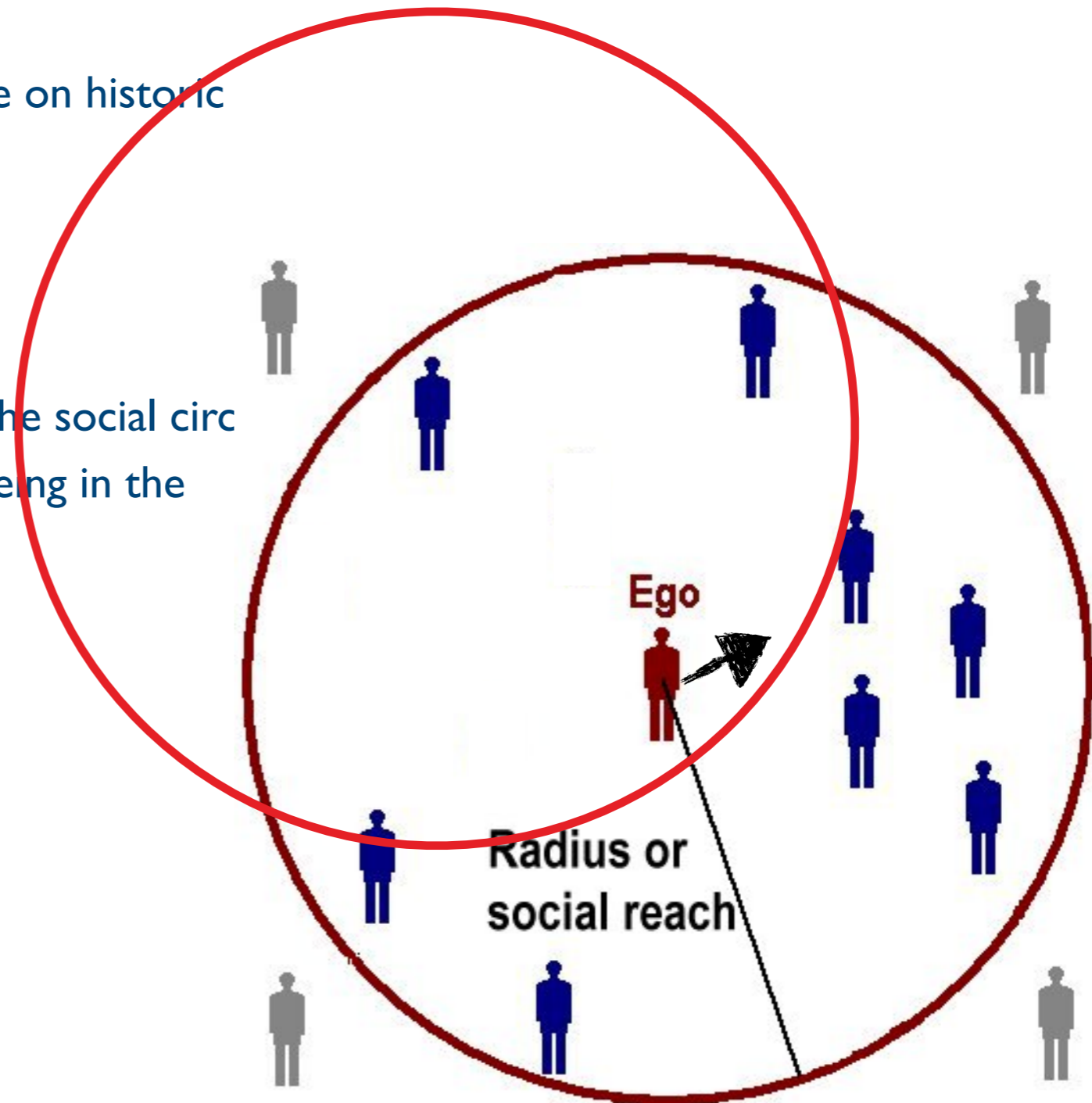- personal social circle equivalent to being in the intersection

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Radius or social reach

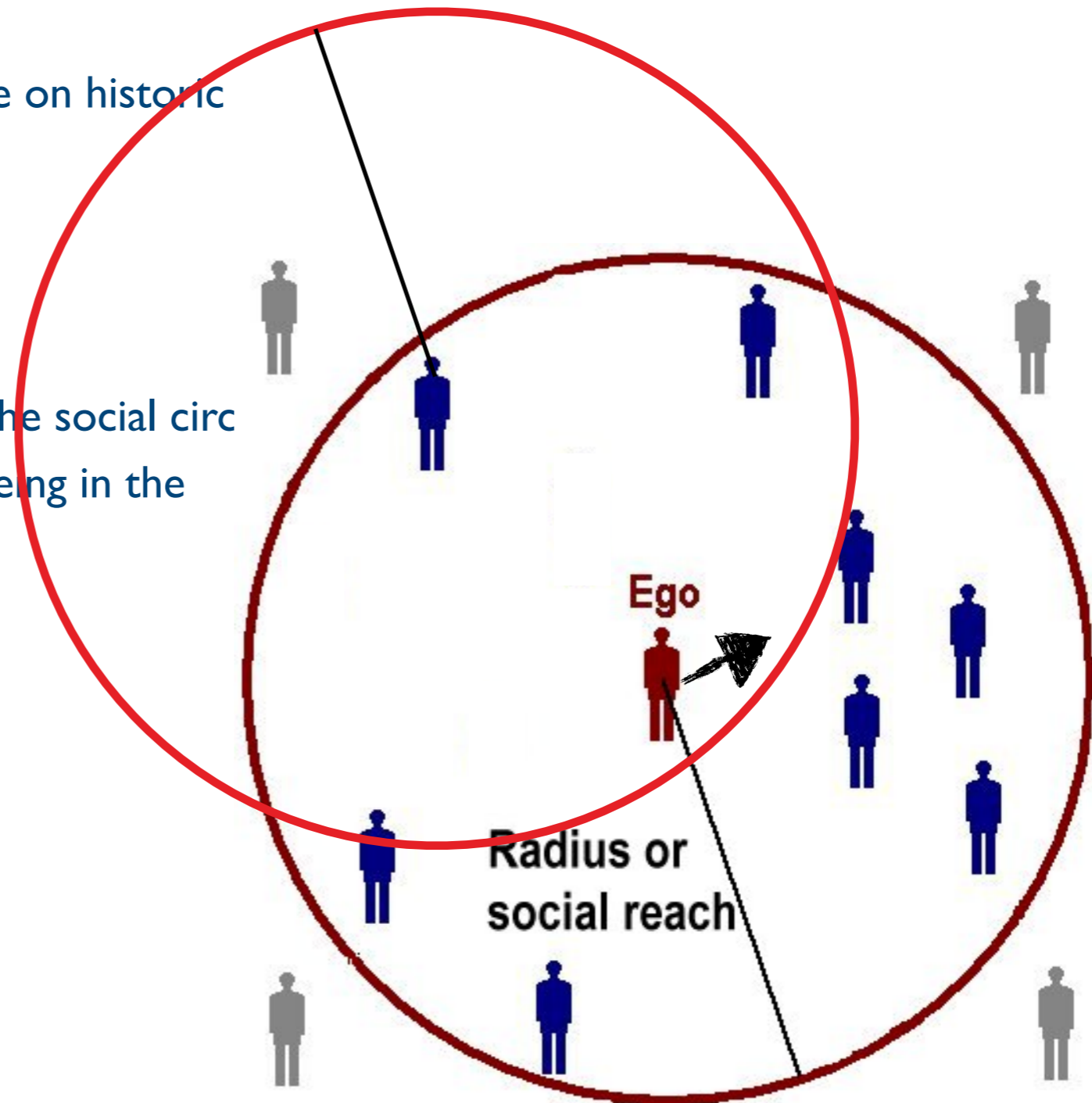ESRC National Centre for

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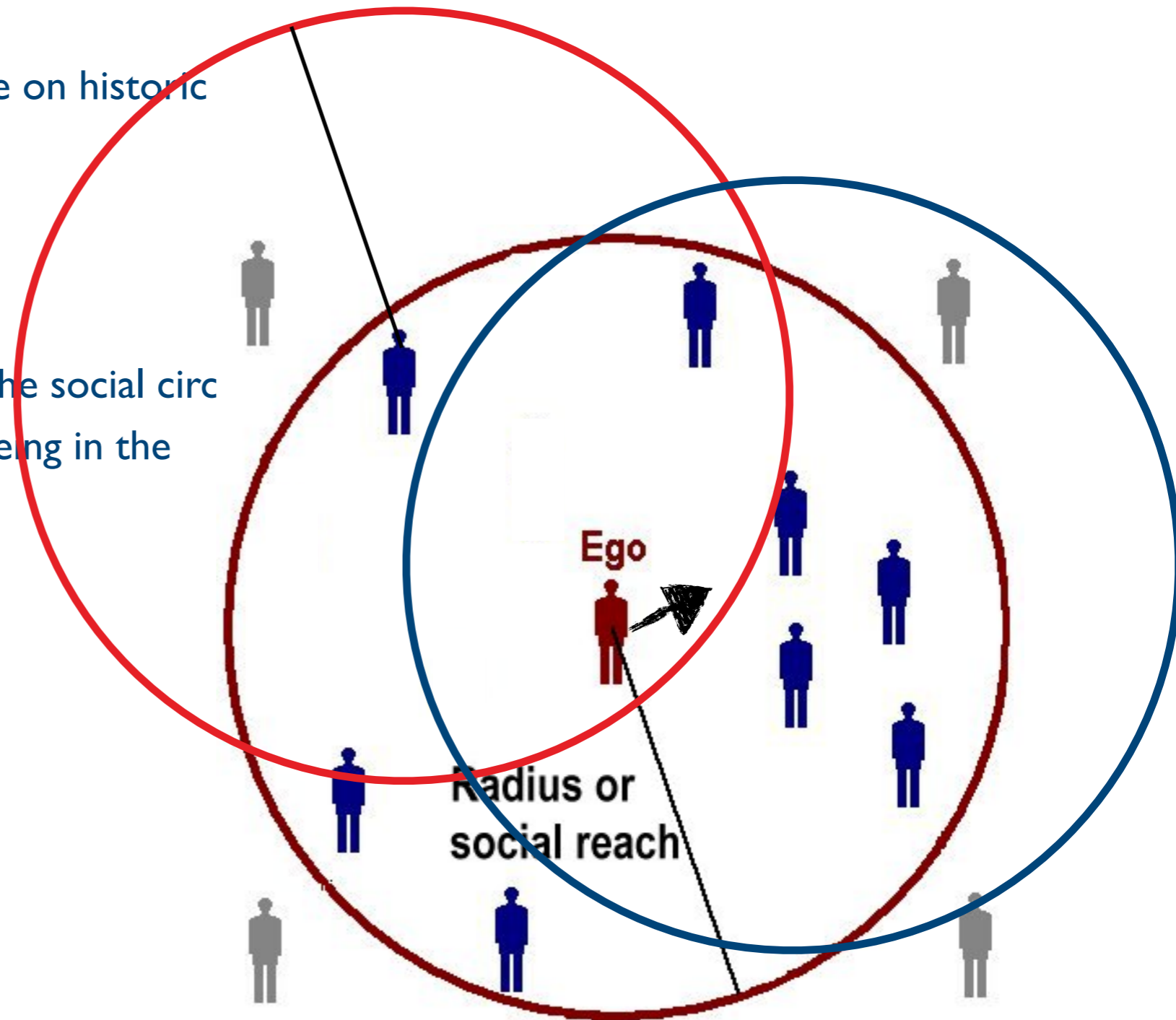ESRC National Centre for
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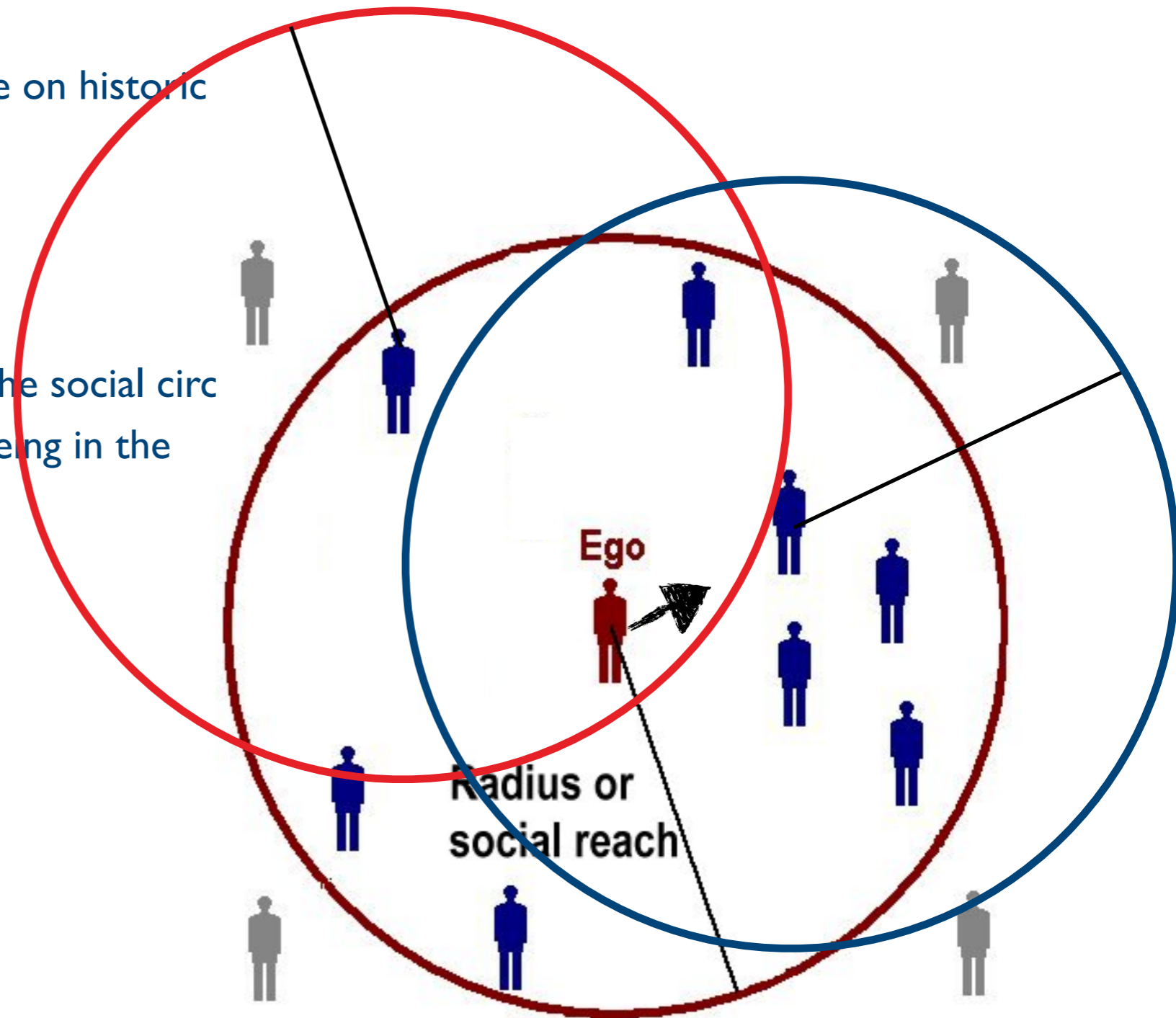- personal social circle equivalent to being in the intersection

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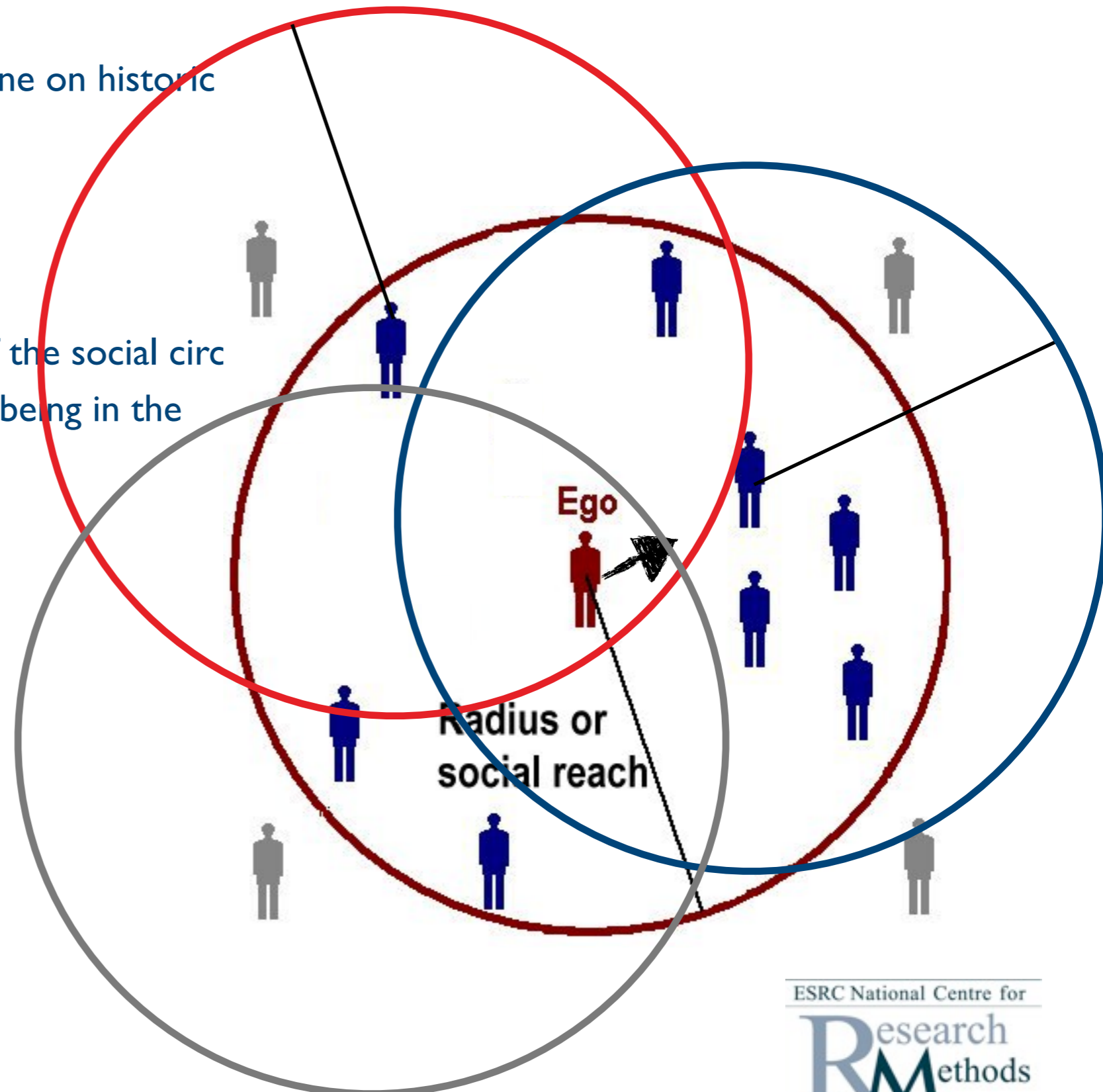- personal social circle equivalent to being in the intersection

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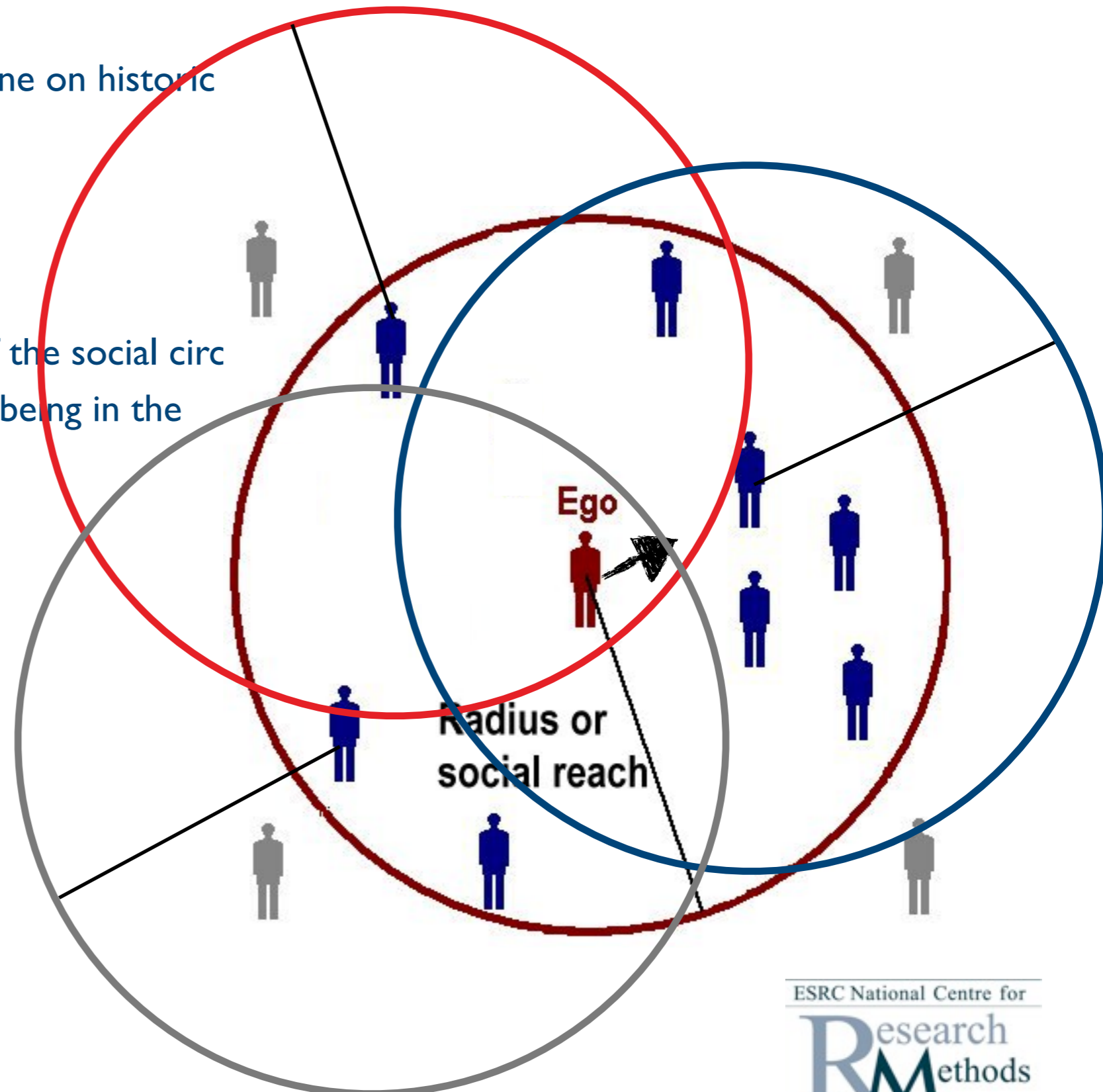ESRC National Centre for
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Opinion Dynamics and Social Circles

Agents:
- have criminality & susceptibility
- are influenced in their criminality by their 'friends'
- agents move towards their social circle centroid

Network:
- high clustering
- low Grannis factor (communities)
- high assortativity

Behaviour:
- opinions do not get extreme anymore
- static equilibrium
- no criminality correlation

Does not show the behaviour we want from criminality either.

"Leader of the Pack" Model

- Social interaction is constituted by the push towards imitating others and distinguishing oneself.
- Implement two movements

  - If maximally criminal in social circle, move away from centroid.
  - Otherwise, move towards the centroid.

- Some evidence that criminals are more extrovert (Eysenk 1979) and change friends more swiftly than others (Sarnecki 1978, 1983).

Does show some of the behaviour we want from criminality.

A Snapshot
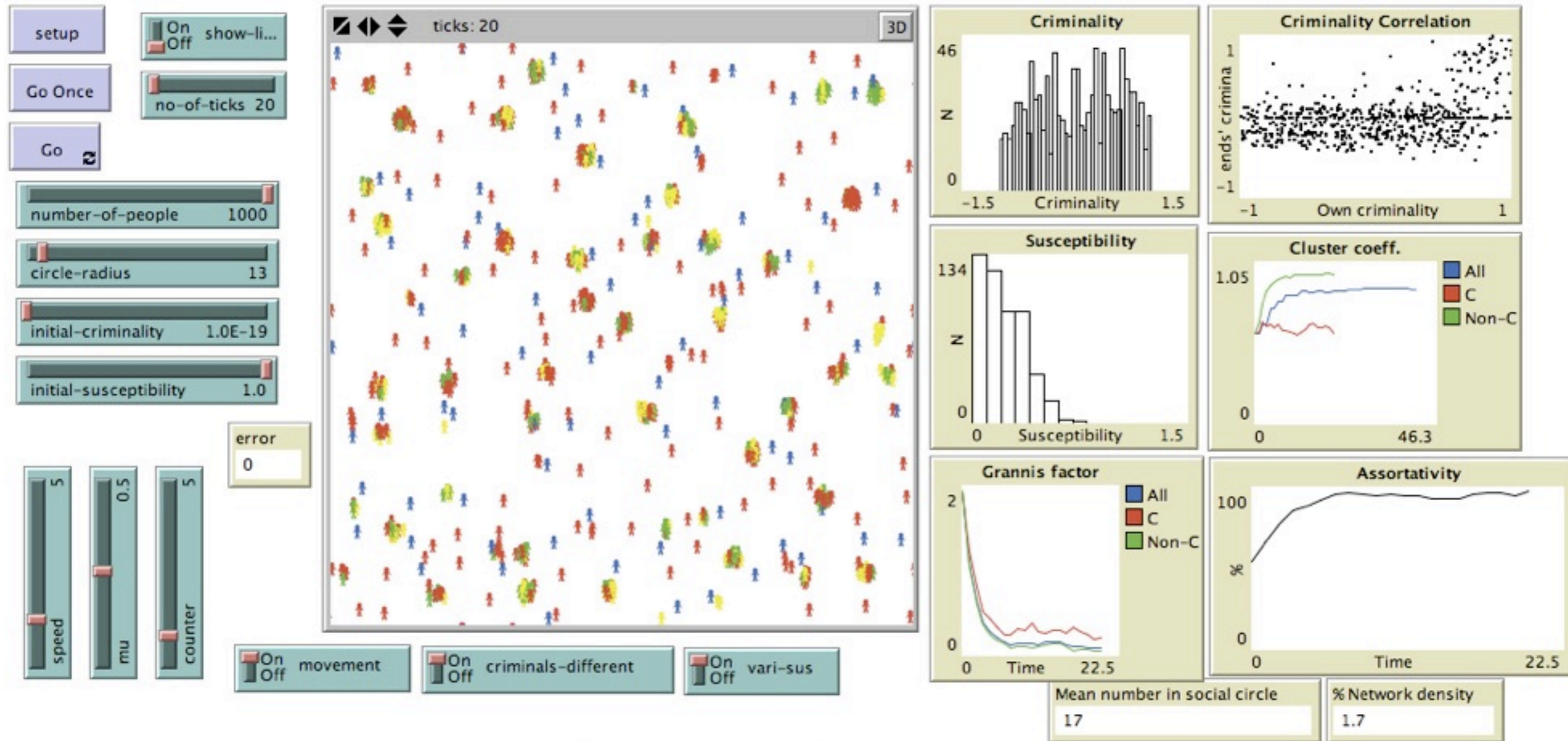
Green: law-abiders; Yellow: Normal; Red: Criminals; Blue: Gang leaders

Our Model

- Consisting of three other models

  - Opinion Dynamics

  - Social Circles

  - 'Leader of the Pack' (non-cumulative change)

- Displaying some features we want of criminal influence and behaviour

  - a range of criminality rather than extremes

  - Grannis factor low but not too low

  - criminals clustering together

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However we have **no validation** yet.

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Data We Have

- Sarnecki (2001) *Delinquent Networks: Youth Co-Offending in Stockholm.*

  - generic findings

    - age transition
    - age dependency of offending
    - clustering according to geography (and corresponding ethnicity)
    - a lot of co-offending, few single offenders

  - specific findings

    - overall durability of structure whilst transient relationships. (The same individuals over the five years but in different relationships.)
    - central network much more coherent but still transient
    - variance in size of social circles (23-151 in a network of 451 agents)
    - 3.7 cooffenders on average

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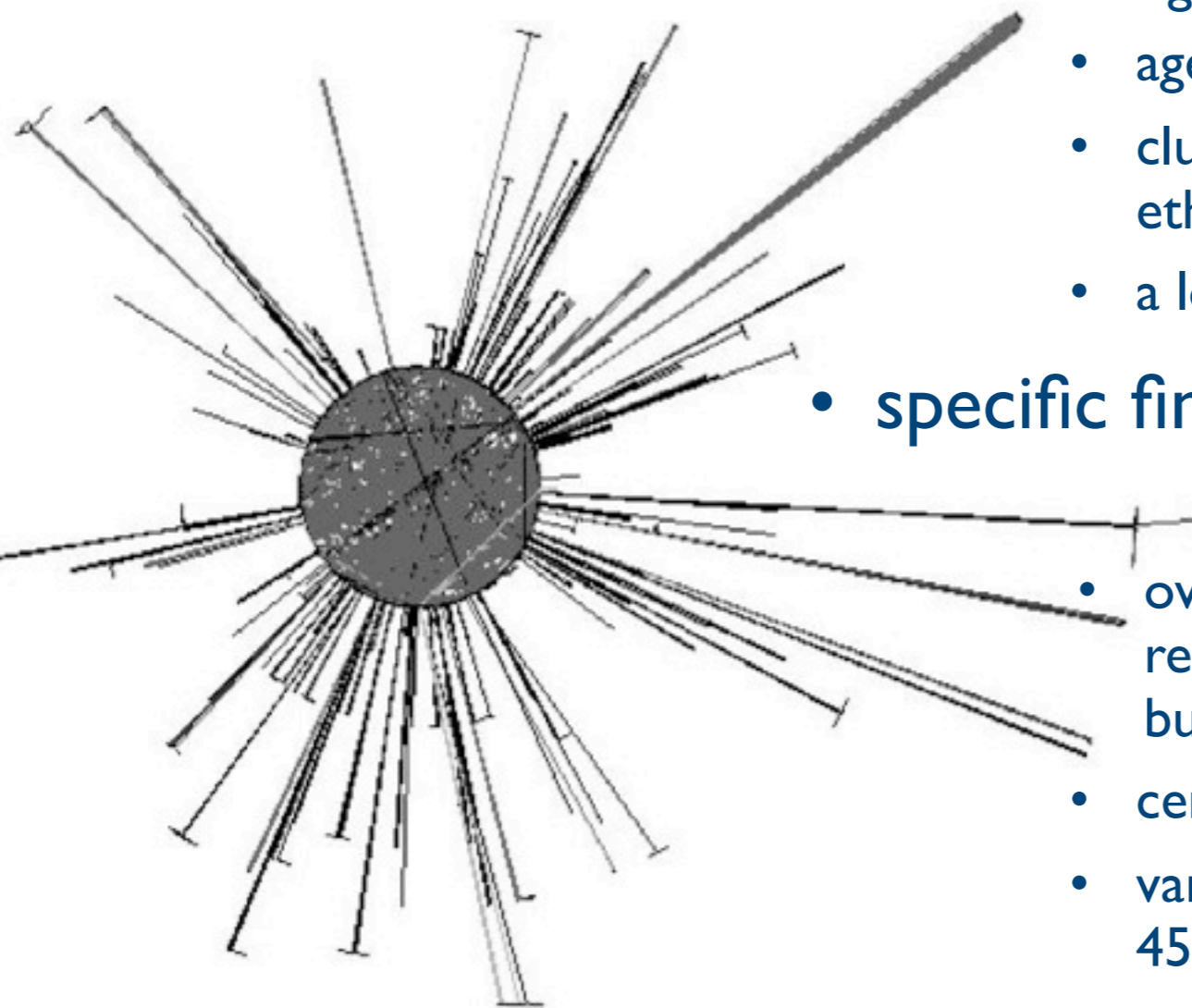
What data do we need?

- Corroboration on micro-behaviour
- Criminal network data (not only co-offending)
- Criminal networks within non-criminal networks.

ABM and patchy data?

- We need some micro-data but from there we can generate macro-phenomena to compare to some existing data.
- We do not need data on huge networks as agent-based models can scale up.
- We can 'test' claims like Smångs 'crucial experiment'.
    - e.g we might get the same network structure from different micro-behaviour.

Conclusions

- Opinion dynamics models are a good heuristic for criminal behaviour
- But we need a social structure as a playing field

  Social Circles Model

  - static equilibrium
  - Grannis factor too low

- 'Leader of the Pack' model is a step in the right direction
- No validation
- SNA and ABM should work closer together

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