Applying Connectivity Tool

You may also find the user manual (/help/guidance) and guidance on Interpreting connectivity scores (/help/interpreting-connectivity-scores) or understanding the data (/help/understand-the-data) useful.

1. Who this guidance is for

This guidance is for all users of Connectivity Tool.

2. Mission statement

Connectivity Tool combines transport and land use data to generate a national measure of connectivity for any location in England and Wales. This connectivity score measures people's ability to get where they want to go.

The Connectivity Tool has been explicitly designed for professionals working in spatial and transport planning and the wider built environment. It assists plan-makers and decision-takers in locating development in the most sustainable locations and can help with planning for the transport infrastructure required to support it. It also indicates which new sustainable transport schemes could prove most useful in raising people's connectivity to vital jobs and services. To help broaden access and increase awareness, we're introducing Connectivity Tool, a free public accessible, scores-only platform, that allows everyone to access the tool and see the connectivity scores.

3. The architecture of the Tool

Connectivity Tool is designed to help its users understand the connectivity pattern of an area, both overall and by different destinations and modes of transport.

4. Practical application

The tool and the data underpinning it has been rigorously tested and is fit-for-purpose and ready to be applied in real world policy-making and decision-taking.

The tool has been extensively tested with over 40 local authorities as well as key stakeholders to ensure that it is fit-for-purpose and able to be applied in the way set out in the mission statement above. The tool has been launched jointly by the Department for Transport, Active Travel England and the Ministry of Housing, Communities and Local Government. The government is considering how the tool can be reflected in national planning policy and guidance.

The Department for Transport is continuing to develop the Connectivity Tool to make sure it meets its users' needs. To provide feedback, please contact the project team at connectivity@dft.gov.uk.

Updates to this guidance on the practical application of the tool will continue to be developed both on the basis of the feedback we receive, but also the evolution of our thinking on how the tool is best reflected in national planning policy and guidance.

5. Interpreting mode- and destination-specific scores

All connectivity scores (overall, and for each mode of transport and type of destination) are expressed as a percentage of the most connected location in the country. Because of this, scores cannot be compared either between modes or between destination types. In particular, you cannot use the connectivity score to compare how well a location is served by one mode versus another.

For example, a location scoring 60 for connectivity to education and 70 for health is not necessarily better connected to health than to education. Likewise, a site with a score of 60 for walking and 50 for public transport is not necessarily better connected by walking than by public transport.

The overall connectivity score is the primary guide to understanding how connected a particular place or development site is. This takes into account access to all destinations included in the connectivity score by public transport, walking and cycling. Scores for specific modes or destinations can assist in providing context or in specific cases where only access to some kinds of destination is relevant (for example non-residential land uses).

The overall score aims to appraise connectivity by more sustainable modes of transport. It therefore does not account for driving in the overall score and while the Tool is capable of calculating the connectivity of site by driving, this needs to

be specifically selected. Scores by driving should not be used as the basis for making policies and decisions

6. What Connectivity Tool does not do

Connectivity Tool does not currently take into account the quality of walking, cycling or public transport routes. This includes aspects such as footway presence, footway width, surface type, and lighting. The outputs of the score therefore should always be contextually appraised using local knowledge / evidence and having regard to other material considerations.

The score is worked out for people as a whole, not for individual users. It doesn't reflect how one specific person might use the transport network differently from most people (for example, if they can only walk a much shorter distance). It also doesn't take into account the particular mix of ages or other characteristics of people living in the area you're looking at.

Connectivity Tool does not measure the fares or cost of any mode of transport, as this varies between different locations, ages and other characteristics. Nor does it measure reliability and congestion of public transport services. It assumes a manually propelled bicycle so does not currently include or factor in the further distances that electric bikes facilitate by cycling.

7. Working in rural and urban areas

Connectivity Tool is designed to show variation in connectivity scores in places across England and Wales. Connectivity scores are highest in areas with easy access to jobs and facilities – either physically close or easily accessible by public transport. These will often be higher in town centres and around major transport interchanges and frequent public transport routes. The very highest scores are found in inner areas of large cities and the very lowest scores in remote countryside. However, between the extremes, the picture is more mixed: some suburbs of large cities score relatively low, while small towns and major transport nodes in predominantly rural areas often score relatively high.

Filtering the connectivity score by local authority (Figure 1; this can be accessed under the 'Filter map' menu on the map sidebar) can help to differentiate the scores at the local authority or combined authority level.

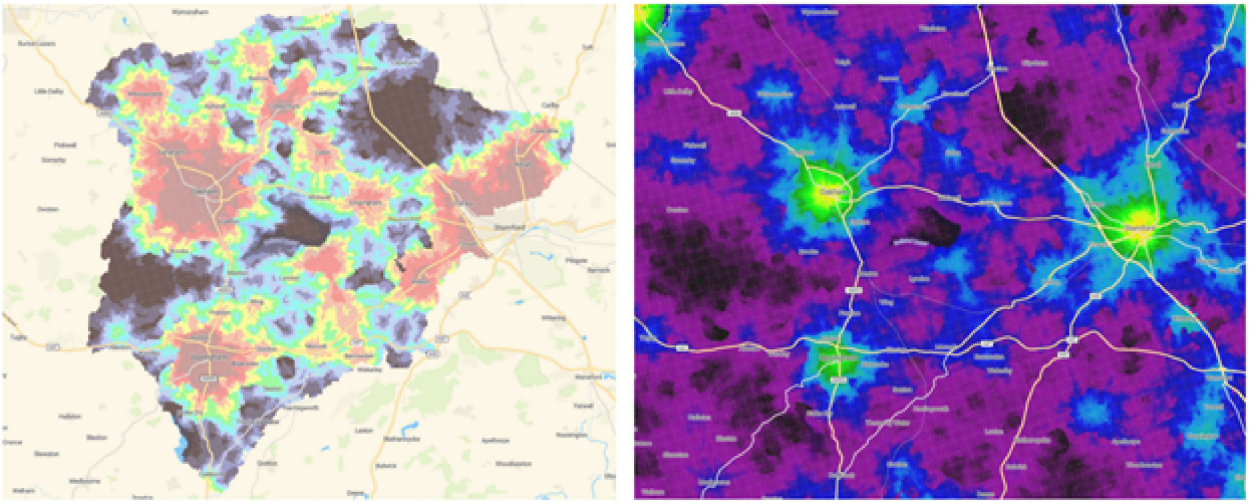

Figure 1: Local authority bands (left) vs the national score (right)

8. Next steps

The data underpinning the tool will be updated on at least a yearly basis. The Department for Transport, working with the Ministry for Housing, Communities and Local Government, Active Travel England and other key stakeholders will coordinate to explore future developments of the tool.

As new functionality or policy is developed for Connectivity Tool, we will update this suite of guidance.

Also See

- User manual (/help/guidance)
- Understanding the data (/help/understand-the-data)
- Interpreting connectivity scores (/help/interpreting-connectivity-scores)

Interpreting Connectivity Scores

You may also find user manual (/help/guidance), guidance on applying the Connectivity Tool (/help/applying-connectivity-tool) or understanding the data (/help/understand-the-data) useful.

Explanation

Each location has a connectivity score from 0 to 100. A location's Connectivity score is calculated as a percentage of the highest score in England and Wales, which is always 100.

To assist in interpreting the Connectivity score, the below tables aim to contextualise the numerical scores by comparison to the Connectivity scores of the population across England and Wales. It's critical to consider the wider context of locations when interpreting the scores. For example, though a score of 55 may appear relatively low, that could be high for a relatively rural settlement that is not in close proximity to economic centres. Also, given that scores are calculated based on the purpose of travel and by mode of transport, what constitutes a 'median' score can vary between the overall score and between the type of destination and mode. Importantly, a score of 50 does not represent a median or average score.

The below tables show the median and each 10th percentile for the overall score, and for each type of destination and mode of transport, across the population.

There are six types of destination, each listed in the first table below; education, leisure and community, health, shopping, residential and workplaces. There are four modes of transport, each listed in the second table below; walking, cycling, public transport and driving. Only the first three of those modes of transport are included in the overall Connectivity score. More information on how Connectivity scores are calculated is included in the methodology .

How to interpret the tables

A location which scores at the 10th percentile means that location is more connected than 10% of Output Areas across England and Wales. Given that Output Areas have similar populations to one another, this means that a score at the 10th percentile is (approximately) more connected than 10% of the (residential) population in England and Wales.

To illustrate: If an area has an overall score of 71, the location would score higher than at least 60% of the population in England and Wales. However, if it had a driving score of 71,

the area would be in the bottom 10% of the population in England and Wales for connectivity by driving. Meanwhile, a workplace score of 71 would mean that the location scores higher than at least 80% of the population in England and Wales for connectivity to workplaces. This demonstrates that scores across different types of destination and modes of travel are not comparable and therefore the percentiles should be taken into account when interpreting scores.

By destination

	Overall	Education	Leisure	Health	Shopping	Residential	Workplaces
10th percentile	**38.9**	**34.1**	**37.8**	**25.9**	**38.1**	**45.6**	**36.9**
20th percentile	**52.1**	**47.0**	**48.7**	**43.1**	**56.5**	**55.2**	**45.9**
30th percentile	**58.6**	**55.1**	**54.9**	**51.1**	**64.9**	**60.5**	**51.0**
40th percentile	**63.1**	**60.6**	**59.6**	**56.9**	**70.6**	**64.3**	**54.7**
Median	**66.8**	**65.0**	**63.6**	**61.7**	**75.2**	**67.3**	**58.0**
60th percentile	**70.2**	**68.9**	**67.5**	**66.1**	**79.3**	**70.2**	**61.1**
70th percentile	**73.7**	**72.8**	**71.7**	**70.3**	**83.4**	**73.5**	**64.4**
80th percentile	**77.8**	**77.1**	**76.8**	**74.9**	**87.4**	**77.4**	**69.1**
90th percentile	**83.2**	**82.7**	**83.3**	**80.6**	**91.6**	**84.6**	**78.8**

By mode of transport

	Overall	Walking	Cycling	Public transport	Driving
10th percentile	**38.9**	**33.7**	**48.4**	**40.7**	**74.6**
20th percentile	**52.1**	**48.0**	**58.1**	**53.5**	**79.8**
30th percentile	**58.6**	**55.5**	**63.1**	**59.7**	**82.6**

	Overall	Walking	Cycling	Public transport	Driving
40th percentile	**63.1**	**60.7**	**66.7**	**64.2**	**84.5**
Median	**66.8**	**64.8**	**69.7**	**67.8**	**86.2**
60th percentile	**70.2**	**68.5**	**72.5**	**71.2**	**87.6**
70th percentile	**73.7**	**72.1**	**75.5**	**74.7**	**89.0**
80th percentile	**77.8**	**76.3**	**78.7**	**79.0**	**90.6**
90th percentile	**83.2**	**81.6**	**83.6**	**85.3**	**92.5**

Also See

- User manual (/help/guidance)
- Applying the Connectivity Tool (/help/applying-connectivity-tool)
- Understanding the data (/help/understand-the-data)

Understand The Data

You may also find user manual (/help/guidance), guidance on applying the Connectivity Tool (/help/applying-connectivity-tool) or interpreting connectivity scores (/help/interpreting-connectivity-scores) useful.

Main points

- The Connectivity Tool is based on the connectivity metric, which measures an individual's ability to reach employment, services, and social engagements.
- The metric evaluates the value of destinations and the opportunity to reach them using various modes of transport, including walking, cycling, driving, and public transport.
- Using this new method, we find that 1-hour connectivity metrics provide a good visual and numeric summary of the total value one can reach.
- Furthermore, the method captures that most value is located near urban centres, with origin points able to reach these centres benefiting from higher connectivity.
- The model shows that while active travel and public transport connectivity have clear "hot spots" located near the centres, travel using private vehicles can be seen as the "equaliser", bringing connectivity to rural areas.
- These are our first estimates of connectivity, and we welcome feedback to inform our future developments and refinements.

Introduction

The Connectivity metric measures someone’s ability to get where they want to go. It measures opportunity to travel to employment, services and for social reasons, weighted by people's overall proclivity to take those options. It aims to capture as the most common modes of travel and destination types, the time required to

reach these destinations, the value presented by the destinations, and people's travel preferences.

It doesn't show how many people take different routes: purely their opportunity to do so. Nor is it a transport model: there is no trip assignment or convergence processes.

Definitions and clarifications

In this guidance, "score" is used as shorthand for Connectivity score, or the Connectivity for one or more modes. "Starting location" refers to a selected grid square.

The metric is calculated only for starting locations in England and Wales. Trips that start in England and Wales and end in Scotland are included.

The default Connectivity metric (the 'overall' score in the Connectivity Tool) measures Connectivity by walking, cycling and public transport. Modes can also be considered on their own; the modes included in the Connectivity metric are:

1. walking,
2. cycling,
3. public transport, including walking to and from public transport stops
4. driving
5. overall - which excludes driving, to represent sustainable modes of transportation. It is a weighted average, with weights determined by number of trips as reported in the National Travel Survey (NTS), and which are approximately 52%/40%/8% public transport, walking, and cycling, respectively.

The purposes of travel considered are:

1. employment,
2. visiting friends in their homes (residential),
3. education,
4. shopping,
5. leisure and community,
6. healthcare.

Data sources

We combine data for destinations (data on shops, services, places of leisure, employment, student numbers, and population), network infrastructure between these locations (for driving, public transport, and active travel), and willingness to

travel (travel behaviour). We also use data obtained from user research sessions to inform the value of destinations and the diminishing returns of being able to access more of the same type.

Destinations

Data for all destination categories uses the best source of data based on quality assurance and exploratory analysis. The data has been procured at the address level, , with the exception of data on workplaces, which is available at the postcode level. The following sources were used for each destination category:

- **Education**: Department for Education official records
- **Leisure & Community**: Ordnance Survey AddressBase, Ordnance Survey Greenspaces, and OpenStreetMap data repositories
- **Healthcare**: NHS England
- **Shopping**: Ordnance Survey AddressBase supplemented by OpenStreetMap data
- **Residential Properties**: Ordnance Survey AddressBase
- **Workplaces**: Business Register and Employment Survey (BRES) dataset provided by the Office for National Statistics

All referenced datasets represent the most current available information (as a mix of Q4 2024 or Q1 2025 data), with the exception of the BRES dataset, which utilises 2023 provisional figures. This is due to the BRES dataset being released periodically, and the 2024 data not yet being available at the time of development, though this will be included in the next update.

Transport Networks

To determine which destinations are within reach of each origin, we need a graphical representation of the travel infrastructure, which represent the transport networks around Great Britain as millions of nodes and links (small sections of roads or pathways). Again, data sources were selected based on their quality and ease of use within the data pipeline. We use Ordnance Survey (OS) MasterMap network data for driving, OpenStreetMap for walking and cycling, and BaseMap for public transport.

Willingness to Travel

To determine willingness to travel, we use data from the National Travel Survey (NTS), years 2011-2020. This results in approximately 2.5 million unique trips. Data from all years are aggregated to obtain the total number of trips across all years for each combination of mode, purpose, and hour of the day, and length in

minutes. It is worth noting that because data up to 2020 is used, the data that feeds into the Connectivity model doesn't capture post-Covid changes in travel patterns.

The data sources are summarised in the table below.

High-level concept	Lower-level concept	Data provided	Data Source
Where do people want to go?	How, where, and when people travel	Self-reported number of trips by mode and purpose at different times of the day	DfT (National Travel Survey years 2011 – 2020)
	Destinations that people may want to travel to	Locations and types of buildings	Ordnance Survey, DfE, NHS, OpenStreetMap
Where can people go?	Value of reaching destinations	Input on diminishing returns parameters, relative importance of types, etc	Stakeholder engagement sessions
	Employment opportunities	Number of jobs in each postcode for all sectors	Office for National Statistics
	People living within the area for social visits	Population estimates at the Output Area level (England & Wales) and Small Area Data Zones (Scotland)	Office for National Statistics, National Records of Scotland
How can people get there?	Travel infrastructure: public transport	Public transport locations and travel timetables	BaseMap
	Travel infrastructure: active travel & driving	Road and walking networks, including restricted access to certain paths	Ordnance Survey, OpenStreetMap
	Efficiency of travel by road for private drivers	Congestion data for road links in England, Scotland and Wales	DfT (Congestion Statistics)

Methodology

The metric is calculated for each of approximately 15 million 100-metre square areas in England and Wales. Trips that start in England and Wales and end in Scotland are included, meaning that destinations in Scotland can contribute to Connectivity in locations outside of Scotland. The model calculates a connectivity score for each combination of purpose of travel, mode of travel, and time of day. The modes considered are walking, cycling, and driving. In addition, the public transport mode includes trips that involve combinations of walking, bus, rail, light rail, underground and ferry, such that all forms are considered as one joint network.

From here, the scores can be aggregated to an overall connectivity score. The overall score excludes driving, to represent sustainable modes of transportation. It is a weighted average, with weights determined by number of trips as reported in the National Travel Survey (NTS) for each combination of purpose and mode of transport. These are approximately 52%/40%/8% public transport, walking, and cycling, respectively.

Pathfinding algorithm

For each mode of travel, the transport system is stored as a network. This network is made up of nodes and links (sections of road, path, etc. which connect two or more nodes together). The networks vary in size, for example the Great Britain cycling network has 8.5 million nodes. Figure 2 illustrates such a network.

We compute the set of accessible destinations for each origin location using a custom implementation of Dijkstra's shortest path algorithm. The algorithm is developed in Rust, a programming language selected for its superior computational performance compared to Python. Unlike traditional point-to-point shortest path algorithms, our implementation explores all nodes in the network, systematically tracking their associated destinations and travel times.

To account for variability in travel time due to traffic congestion and variations in public transport timetables we have calculated the destinations within reach and their associated travel times for multiple times of day for the modes of driving and public transport. The connectivity scores for these two modes are then the weighted average across all times, with the weights being the volume of mode-purpose specific journeys as apparent from the NTS. For walking and cycling, we assume that there is no variability in travel time, so only one set of scores is calculated.

A cut-off point has been set for a maximum travel time of 60 minutes. This is done to limit the number of calculations, as well as to match the empirical observation of most trips in the NTS taking less than an hour.

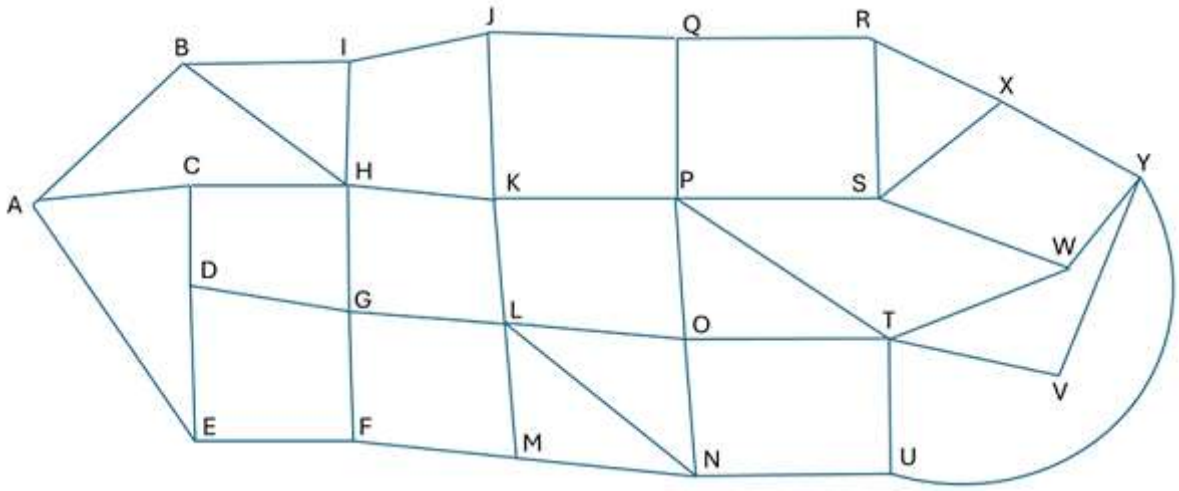

Figure 2 An example network of links (the lines) and nodes (labelled with letters)

Travel Times

Travel time between network nodes are determined by the time required to traverse the link between the nodes, and the turns that need to be made along the route (if any). Furthermore, for walking and cycling, gradients in terrain are taken into account using Tobler's hiker's function. The time on the link itself is determined by its length and the speed of travel, which differs by mode. All links in the graph include coordinate information in the form of polylines that we can use to obtain the angle of the turn as measured in degrees clockwise. In line with Open Trip Planner (OTP), turns between 45 and 135 degrees are classed as right turns, turns between 135 to 225 degrees as U turns, and turns between 225 to 315 degrees as left turns. The quality, comfort, or safety a route is not factored in. For example, if you can cycle somewhere in less time, cycling connectivity increases, but if you make a route safer or more pleasant, connectivity is not impacted.

Limitations

Users should bear in mind the following provisos when looking at public transport routes:

- The Connectivity model assumes that all timetables are adhered to, i.e. there are no delays or cancellation in services. This will make areas with unreliable services appear more connected than they are in reality.
- The model does not include congestion of public transport, that is, the travel times and metric for public transport assumes there is space on every service.

- The monetary cost of travel is not included due to a lack of fares data.
- No park and ride options are currently included. We don't plan to implement this due to lack of data.
- People are not assumed to have planned their journey. They are modelled as leaving their homes at a given point in time regardless of whether this corresponds to available public transport services. This doesn't reflect expected behaviour, where people are expected to plan so they minimise long waits. However, the model works this way as it reflects the added utility of more frequent public transport service.

Destination Values

The centroid of each starting square area was mapped to its nearest node on the transportation network for each mode of transport. Each destination node in a network that is within reach of a starting location and while using a certain mode of transport, can be thought of as providing Connectivity value V to that starting location, for each travel purpose. For example, a large employer besides a destination node that connects to a train station means that node will have a high value for the purpose of employment and the public transport mode. For each transport mode, each node in a network has 33 value scores: one for each type of destination. Each type of destination is linked to a travel purpose, to which it contributes connectivity. Each subtype maps to one of six destination types, and has a different diminishing returns parameter, which is used to calculate how much additional value a destination provides to a starting location, depending on how many other destinations of the same type are already within reach of that starting location. The diminishing returns parameter is used to calculate the value of each destination node. Higher values indicate that the diminishing returns of additional destionations of the same type is less strict. These were chosen based on stakeholder engagement sessions and extensive exploratory analysis of the data. The number of destinations also feed in on this - very common destination types tend to be accessible in high numbers, which result in a lower diminishing returns parameter, while rarer destination types are less likely to be reached in high numbers, which results in a higher diminishing returns parameter. The table below shows the purpose, destination type, source of data, and diminishing returns parameter for each type of destination.

For places of employment, the number of jobs at the postcode level was obtained from the Business Register and Employment Survey (BRES) dataset from the Office for National Statistics. Jobs then count towards the employment value at the destination node closest to the centroid of each postcode.

For the travel purpose "visiting friends in their home", the number of people to visit in their private homes is estimated by taking the number of people living in an Output Area (OA) and dividing it by the total dwellings in that OA. We then assume

each dwelling in that OA has that many people living in each residence (at the address level) that lies within that OA.

Purpose	Destination type	Source	Diminishing returns parameter
Education	Primary	DfE	0.5
	Secondary	DfE	0.5
	Further (16-18)	DfE	0.5
	SEND	DfE	0.5
	Private education	DfE	1.0
Healthcare	Pharmacy	NHS	0.25
	GP	NHS	0.5
	Opticians	NHS	0.5
	Dentist	NHS	0.5
	Hospitals	NHS	5.0
	Private health	NHS	0.5
	Emergency	NHS	0.25
Leisure & Community	Pub/bar/nightclub	OSM	3.0
	Sports facility	OSM	3.0
	Green spaces	OS Green Spaces	0.5
	Cinema/theatre	OS AddressBase	0.5
	Culture	OSM	1.0
	Hall/social club	OS AddressBase	1.0

Purpose	Destination type	Source	Diminishing returns parameter
	Job centre	OS AddressBase	0.25
	Recycling centre	OSM	0.25
	Place of worship	OS AddressBase	0.5
	Post office	OSM	0.25
	Post box	OSM	0.25
	Library	OS AddressBase	0.25
	Bank/financial service	OS AddressBase	1.0
Shopping	Restaurant/takeaway	OS AddressBase	7.0
	General retail shop	OS AddressBase	7.0
	Supermarket	OS AddressBase	0.5
	Convenience	OSM	0.25
Employment	Job	ONS - BRES	N/A
Residential	Residence	OS AddressBase	N/A

Willingness to travel

While two destinations may provide the same inherent value, in practice they will not be equally desirable destinations if one takes longer to reach than the other. We would expect the closer location to contribute more to the starting location's connectivity, with the value of thid trip time depending on how willing the average transport network user is to spend that long travelling to that type of destination. In

order to account for this, the Connectivity metric uses National Travel Survey (NTS) data to estimate willingness to travel given distances. Figure 3 illustrates the distribution of how far people travel to work when leaving between 8 am and 9 am, via various modes, based on the NTS. From the data it becomes clear that respondents are willing to use different modes of transport for different amounts of time to reach work at that particular moment in time. In practice, these data patterns will also depend on the purpose of travel.

To reflect the travel preferences of people as recorded in the NTS, we model the relationship between the value of locations at a particular node and the time it takes to reach that node using an impedance function. The function takes the time to get to a destination's node and outputs a multiplier. It takes the form of a curve, such as the example pictured in 4. In the example function, a travel time of 300 seconds returns a multiplier of 0.9, whereas a travel time of 1400 seconds returns a multiplier of 0.3, meaning that the same node would have triple the value if it were 300 seconds rather than 1400 seconds away. To reflect people's traveling preferences more accurately, the function will be different for each mode, purpose, and time of day. To account for variation in travel preferences at different times of day, we fit impedance functions separately for morning rush hour (07:00-10:00), mid-day (10:00-16:00), evening rush hour (16:00-19:00) and nighttime (19:00-07:00).

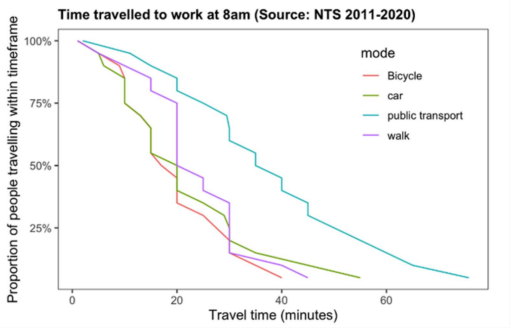

Figure 3 Time travelled to work at 8 am, NTS

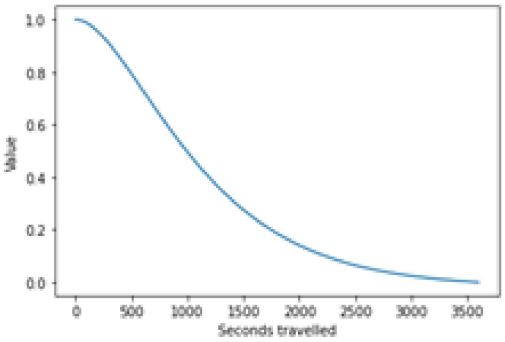

Figure 4 An impedance function, giving Impedance value as a function of seconds travelled

The Connectivity model calculates travel routes for all destinations that can be reached in up to an hour, to reflect the empirical data of very few respondents reporting travel beyond that time.

In the Connectivity model, an impedance function is fitted for each combination of purpose, time of day and mode of travel. Each function covers all starting locations and destinations: these impedance functions are assumed to be the willingness to travel of the average person across England and Wales. The contribution of a single destination node to the Connectivity score for a single origin using a given mode of transportfor a given purpose and time period is

calculated by multiplying the destination node's value by the multiplier given by the impedance function.

The model does not try to account for regional variation in willingness to travel as this would lead to feedback loops. For example, starting locations where many people are using public transport would have a Connectivity score which is disproportionally sensitive to the impact of improvements of the public transport network, thus undervaluing improvements in cycling infrastructure and underestimating how much people's behaviour would change on being offered a much-improved service. This means that the Connectivity model assumes the preferences of individuals and willingness to travel various distances are identical in all of England and Wales.

Finally, it is important to note that NTS data from 2011-2020 is used in the current version of the Connectivity model. As such, the data that feeds into the model doesn't capture post-Covid changes in travel patterns.

Diminishing returns

The method of diminishing returns is used to reflect the reality that the contribution to connectivity provided by each additional opportunity, service, or facility becomes smaller as more are available. For example, gaining access to the first few hospitals, shops, or parks in an area brings significant benefits to local connectivity, as these initial options greatly increase choice and convenience. However, once several such facilities are already present, the extra value of adding yet another is less pronounced. By applying diminishing returns, analyses can more accurately represent that early increases in access have the greatest influence on connectivity, while further additions provide progressively smaller improvements.

The connectivity scores

Each destination node in a network that is within reach of a starting location using a certain mode of transport, can be thought of as providing Connectivity value to that starting location for that type of destination. For example, a large employer besides a destination node that connects to a train station means that node will have a high value for Employment and the public transport mode.

The various datasets on destinations gives us access to quite granular destination subtypes which we have grouped into the more manageable six types of destination. Apart from for trips to education, each subtype is assumed equally important within a type of destination. We assume this as we have no information on the number of trips made at the subtype level from the NTS, only the type of destination level. For education destinations, we assume the purpose for each subtype of destination is proportional to the number of pupils attending that type of

destination (e.g.: if twice as many people nationally attend primary school than university, then across the country primary schools will get double the weight when calculating the score for education).

The Connectivity model uses stakeholder engagement feedback to determine weights for each of the healthcare subtypes (e.g.: hospitals, GPs, other health facilities). This approach ensures that the relative importance of different healthcare destinations is better reflected in the model.

For each mode of transport, each node has 33 values – one for each subtype of destination.

Being able to access more locations results in a higher value for that destination type. This depends on the type of destination, as follows:

- For **employment**, value is determined by the number of jobs
- For **social visits/residential**, value is determined by the number of residents
- For **education**, value is determined by the number of pupils.
- For **all other sub-purposes**, value is determined by the number of destinations in reach.

The number of residents is estimated by taking the number of people living in an Output Area and dividing it by the total dwellings in that Output Area. We then assume each dwelling in that Output Area has that many people living there.

Opening times or quality of destinations are not accounted for: all destinations in a category are treated as equal in this regard. This is due to a lack of data on opening hours and how to relate opening hours to utility.

The overall score

To calculate the total Connectivity for an origin point for a given combination of mode and purpose, the relevant contributions of all destinations within reach are run through an additive function.

There are several possible choices for which form the total score function may take. In the current version of the model, we use the log-sum of scores contributed for jobs and visiting residences, and a weighted sum for all other destinations. We use this form because the expected maximum utility of the destination nodes scales logarithmically with the number of nodes. There is a range of literature setting a precedent for and supporting this in the transport space[2]. Alternative

options for can also be considered and form part of current ongoing development of the Connectivity metric.

An overall Connectivity score can be obtained for each starting location by taking a weighted average of the mode- and purpose-specific total scores. These weights would be chosen by the user of the Connectivity model. By default, the Connectivity Tool uses weights that reflect overall travel proclivity from the NTS.

Finally, to compare the scores across different starting locations, they are scaled to the score of starting location with the highest Connectivity score, such that the starting location with the best score receives a scaled score of 100, and all other areas receive a score which is relative to that. As such, a starting location with a score of 50 can be considered to be half as 'connected' as the best location in England and Wales.

The calculation method

The model works in several stages for a given network and starting location:

1. Find the node in the network closest to the centre point of the starting location: this is the 'start node'.
2. Calculate travel times between the start node and every other node in the network which is reachable in an hour.
3. Find the node in the network which is closest to each destination: each of these is a 'destination node'.
4. Use the shortest travel times from the starting node to every destination node to estimate the travel times to every destination.

Each destination reachable in an hour contributes to the Connectivity score for that destination with adjustments for the trip time and the 'value' of the destination.

5. To adjust for the trip time, the time to get to each destination node is put through an impedance function. Lower travel times give a higher output.
6. To adjust for the 'value' of the destination, the output of stage 5 is multiplied by a value that depends on the diminishing returns parameter and the number of destinations of the same type that were already considered to be in reach. More details of this method will be published in the near future. This gives the contribution of that destination to the starting location's Connectivity score.
7. The contribution of each destination is and summed over all destinations that could be reached to get the given starting location's Connectivity score for each

combination of a type of destination, mode of transport and time of day.

8. The Connectivity score for a given mode of transport at a given starting location is the weighted sum of all Connectivity scores for each time of day and destination for that starting location. Weights are the proportion of total trips made at each time of day and to each destination as recorded in the National Travel Survey (NTS) between 2011 and 2020 inclusive.
9. Breakdowns are also available by time of day, purpose of travel and mode of travel.

In practice this means that a starting node with lots of destinations (for example lots of jobs), which are quick to reach, gets a high connectivity score.

[1] The sample size requirements and imputation methods are in line with the Travel and Environment Data and Statistics (TRENDS) team (link (https://www.gov.uk/government/publications/journey-time-statistics-guidance/journey-time-statistics-notes-and-definitions-2019)).

[2] For example:
https://www.sciencedirect.com/science/article/abs/pii/S0965856407000316 (https://www.sciencedirect.com/science/article/abs/pii/S0965856407000316)

And for a more in-depth discussion of the use of logsums:
https://www.rand.org/pubs/working_papers/WR275.html (https://www.rand.org/pubs/working_papers/WR275.html)

Also See

- User manual (/help/guidance)
- Applying the Connectivity Tool (/help/applying-connectivity-tool)
- Interpreting connectivity scores (/help/interpreting-connectivity-scores)

Connectivity Tool User Manual

Contents

You may also find, guidance on applying the Connectivity Tool (/help/applying-connectivity-tool), Interpreting connectivity scores (/help/interpreting-connectivity-scores) or understanding the data (/help/understand-the-data) useful.

Introduction

All terms in **bold** are defined in the glossary at the bottom of this page.

Connectivity Tool is the publicly accessible, scores-only view of the Department for Transport's national connectivity metric. It shows how well places are connected to everyday destinations by walking, cycling and public transport.

For further queries on how to use the Connectivity Tool, please contact connectivity@dft.gov.uk.

Using the map

The map is Connectivity Tool's main interface.

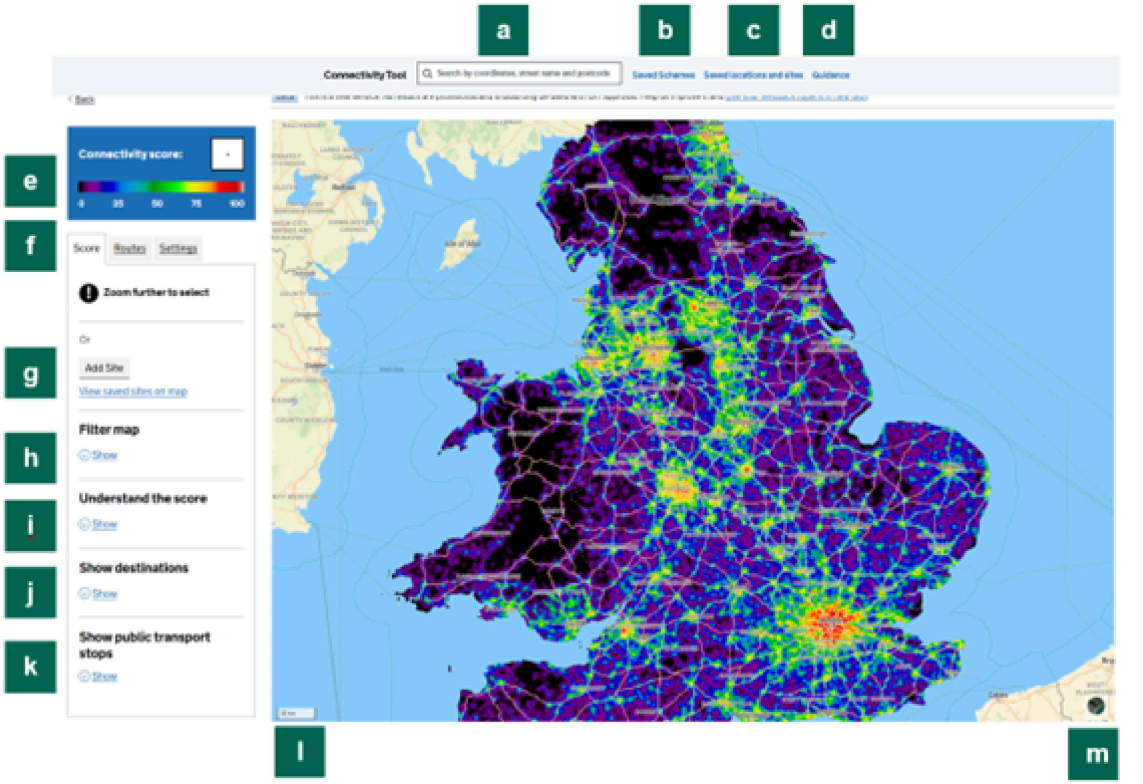

Figure 1: The main map view

Navigating Around

When you enter connectivity Tool for the first time, the map will display the national overall heat map for England and Wales.

The guidance can be accessed directly from the map view by clicking ‘Guidance’ on the top bar of the screen (Figure 1, **b**).

To search for a **location** (grid reference, place name, street name or postcode), type the location in the search box (Figure 1, **a**). Alternatively, zoom in by scrolling on your trackpad or mouse. The scale bar (Figure 1, **e**) at the bottom left corner of the map displays how far you have zoomed in.

Alternatively, you can pan/zoom; + / – controls are top-right (Figure 1, **c**).

Once you have zoomed in far enough, you will be able to move your cursor across the map and read the scores for each 100m x 100m **grid square** in the top left corner of the screen (Figure 1, **i**). Click anywhere on the map to select that location **tile**.

Additional Functions (Figure 1, d):

- The Info (bottom, “i” icon): opens attributions/data-source info.

- To use the measuring tool, select the icon to start; click along a path to measure distance; double-click to finish.

Customising the map

To view a satellite map, press the satellite view icon (Figure 1, **d**). The satellite view does not currently allow you to overlay or select a location. To view connectivity scores or select a location, switch back to the **score** view by pressing the same icon (Figure 1, **d**) again.

To change the transparency/opacity of the scores on the map, click the 'Settings' tab (Figure 1, **h**). This will take you to the 'Settings' **sidebar** (Figure 2). You can then enter an opacity value by entering a specific number in the box or by moving the slider (Figure 2, **a**). 0% is fully transparent (only the background map is visible; no scores are visible) while 100% is fully opaque (no background map is visible; only scores are visible).

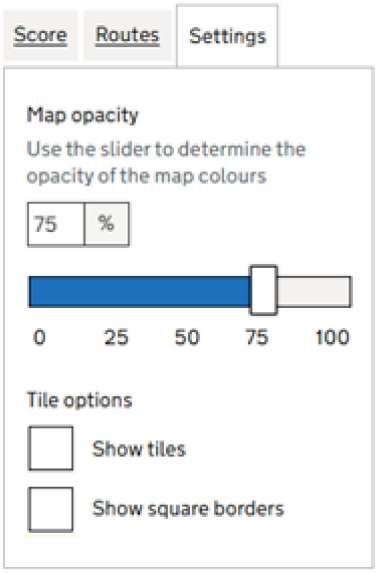

Figure 2: The 'Settings' sidebar

To add or remove tile colour fills or borders, click the 'Settings' tab (Figure 1, **h**) to open the Settings sidebar (Figure 2). To control the fills, tick or untick the 'Show tiles' box; when unticked, only the tile borders are shown. To control the borders, tick or untick the 'Show square borders' box; when unticked, only the tile colours are shown.

If you untick both the 'Show tiles' (Figure 2, **b**) and 'Show square borders' (Figure 2, **c**), no scores will be displayed on the map. However, you can still hover over grid squares, see the changes in **score** (Figure 1, **i**), and select a location.

Filtering the map

To change the view on the map (e.g. to select specific modes of transport, types of **destination**, or **local authority** areas), click ‘Show’ under the ‘Filter map’ heading (Figure 1, **g**). This will open the ‘Filter map’ menu (Figure 3).

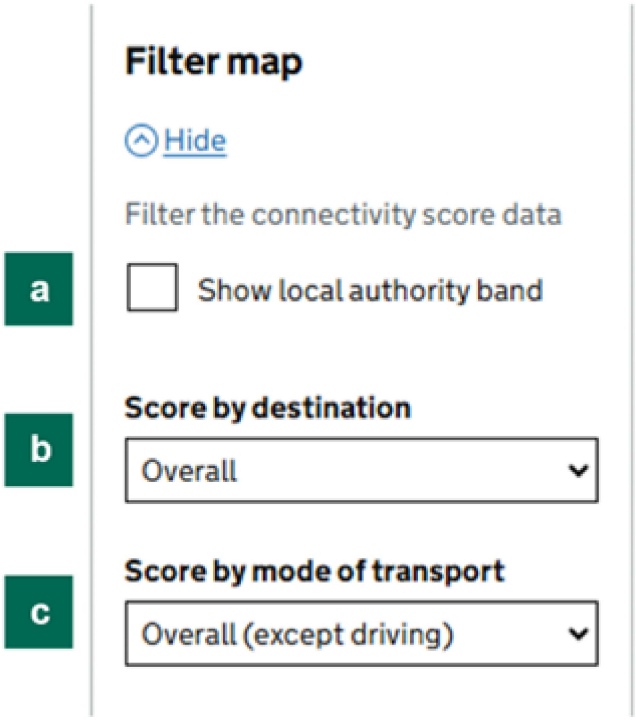

Figure 3: The ‘Filter map’ menu

To select a local authority or combined authority area, click ‘Show local authority view’ (Figure 3, **a**) and use the drop-down menu to search for the local authority you wish to view. You can also search by typing the name of the authority in the field. Once selected the map will centre on the local authority area and show connectivity scores for that area only.

To understand relative connectivity within the local authority area select ‘Show authority band’ (Figure 3, **b**). This will show a **‘Local authority band’** from A to J underneath the **overall** connectivity score. This ranks all grid squares in the local authority area into ten bands. These ten bands are also shown on the map in ten colours. In some instances, especially in smaller local authorities, not all bands will show on the map. This is because the range of scores within that local authority is too narrow to divide into ten roughly even bands.

To view scores for just one type of destination (i.e. shopping, education, employment, residential, healthcare, leisure), select the ‘Score by destination’ dropdown menu (Figure 3, **c**). Then select your desired type of destination.

To view scores for just one **mode of transport** (i.e. public transport, walk, cycling or driving), select the ‘Score by mode of transport’ dropdown menu (Figure 3, **d**). Then select your desired mode of transport.

You can also combine each mode of transport with each type of destination and view the score for that combination of mode and destination on that map.

Viewing public transport stops

To view the destinations on which a location's connectivity score is based, click 'Show' under the 'Show destinations' heading (Figure 1, **b**).

This allows you to view destinations for education, leisure and community, health, and shopping facilities. It is not possible to view workplaces or dwellings in this view as these are calculated differently.

Click on any destination to view its name (for schools and shops) and subtype of destination. Examples of subtypes of destination include primary (for schools) and supermarket (for shops).

To view **public transport** stops on the map, click 'Show' under the 'Show public transport stops' heading (Figure 1, **f**).

Glossary

More information on how Connectivity scores are calculated is included in the methodology (/help/understand-the-data).

- Local authority band: A method of better understanding score differences across a local or combined authority area, by dividing each local authority into ten bands from A (high scoring) to J (low scoring). One or more scores is grouped into each band. Each band represents approximately one-tenth of that local authority or combined authority's area.
- Destination: A destination is a place which counts for the calculation of connectivity scores, such as a shop, a primary school or a dwelling. Destinations fall into one of six categories: education, health, leisure, residential, shopping, and workplaces. More information on what each category is made up of is included in the methodology (/help/understand-the-data).
- Grid square: The 100m x 100m squares which are shown on the Connectivity Tool map. Each is assigned a 'tile', which overlays a colour onto the square.
- Location: Any single point (one-dimensional) on the map. Each location falls within a grid square.
- Mode of transport: Connectivity scores are calculated for four modes of transport: walking, cycling, public transport, and driving.
- Overall: The overall score is the standard connectivity score. The overall score includes all destinations, and all modes of transport except driving.

- Public transport: All forms of public transport are grouped into one mode for the purposes of the Connectivity Tool. This includes buses (including some demand-responsive services), coaches, trains, ferries, light rail, trams and metro systems.
- Score: A number from 0 to 100, reflecting the proportion of the highest-scoring location in England and Wales.
- Sidebar: The options menu to the left of the map.
- Stop: The existing network of public transport stops.
- Tile: The coloured overlay on top of a grid square.

Also See

- Understanding the data (/help/understand-the-data)
- Applying the Connectivity Tool (/help/applying-connectivity-tool)
- Interpreting connectivity scores (/help/interpreting-connectivity-scores)