A free, open, citizen science app to measure path quality

RAMBLERS

BLENHEIM ESTATE

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Background: Quality of paths in England

- There are tens of thousands of miles of public rights of way and other public paths across the UK that citizens can use.

- While most of these paths are legally recorded and mapped, their quality and ease of use is unknown, which means that users may not be fully aware of whether the paths are suitable for their intended use (e.g. manual or electric wheelchair, trail running, horse riding, family walks and rides etc.).

- Furthermore, if improvement works need to be done to make them more inclusive, safer (e.g. through the removal of challenging or hazardous obstacles) and more usable, there is no systematic way to capture and convey this information to the relevant authorities.

- To address some of the gaps and barriers, Natural England funded Systeme D, Oxfordshire County Council and the University of Oxford to undertake a proof of concept project to create a free, open, crowdsourced tool that any citizen can use to capture and share the quality of public rights of way and other public paths across England.

Background: Quality of paths in England

The first step in developing our tool was to identify the key quality metrics that define a good/bad path for different types of uses. We used two methods to collect this information: a survey and literature scan, the results of which are presented on the next two slides (full report here: https://www.greenspacehack.com/project/path.html).

	Summary of poor pathway characteristics	**Summary of good pathway characteristics**
Surface	uneven; muddy; slippery; broken; potholes; deep rut; sharp/lots of stone; boggy	appropriate (hard/firm/soft/smooth/natural) surface; good footing/walking surface; smooth; level; safe; good drainage;
Path	narrow; poor access; poor signage; obstructions/obstacles (barbed wire;); ploughed field; dangerous animals; steep slope; dog mess; poor quality furniture; shared use paths; problems with dogs (loose dogs, feces, etc.);	good signage; good/easy access; sufficient width; defined rights of way; nice view/varied surroundings; good state of repair (furniture, etc.); car parking; appropriate route (straight/circular);
Vegetation	overgrown; bramble; nettle; low branches; fallen trees	well maintained vegetation (nettle/bramble)
Gates/Stiles	broken/locked gates	good 'friendly' gate

Literature scan summary

General principles	***Safe***: Safety and a stress-free environment are core tenets of achieving a successful Local Path. Conflict points such as high vehicle numbers and high speeds should be minimised by providing a consistent level of experience across the Paths network. Crime prevention and enhanced social safety are also key outcomes of well-designed Local Paths. Crossing aids; crossings; verge width; surveillance; presence of hazards; feelings of reassurance; lighting (photopic illuminance; spectral power distribution; spatial distribution)
	Connected: Local Paths should connect destinations such as residential neighbourhoods, schools and universities, town centres, transit stations, and bicycle facilities. They should seamlessly connect to the wider transport network including Express Paths. Additionally, these connections should be designed to be easily navigated. Where intuitive design is unachievable, clear and consistent wayfinding signage should be employed. Car parking, bike parking.
	Accessible & Comfortable: Paths infrastructure should be accessible for all users, including children and people with disabilities. Considerations include ample width, gentle gradients, smooth transition in surfaces, and avoidance of high volumes of traffic that create fumes and noise. Accessible points are also important (e.g. car parks, bus stops and/or train stations); barriers: illegal obstructions such as fences, buildings and encroachments
	Enabling: Local community and stakeholders should be engaged early in the process to incorporate Te Aranga principles and community driven initiatives. Local Paths should integrate with the existing streetscape and celebrate Auckland's unique character by responding to and incorporating elements of the surrounding natural and built environment, heritage and culture. Opportunities to include ecological function through planting, water sensitive design, and low energy/low toxicity materials should be integral to each Local Path design
Signage	Entry/exit, services/facilities, route precautions/restrictions
Conflict points	High vehicle numbers/speed; bike speeds); level of shared use (are paths segregated for different uses?); avoid high levels of traffic
Aesthetic	Cleanliness (dog mess, litter, vandalism); sights; garden maintenance; parks; pollution/air quality; trees; architecture; street maintenance; noise levels; naturalness/greeness (plant cover, tree canopy, biodiversity, scenery, beauty, preservation)
Surfaces	Gentle gradients; pinch points; smooth transition in surfaces; tactile paving; general guidance in Section 2G: https://www.royalparks.org.uk/__data/assets/pdf_file/0005/85658/The-Royal-Parks-Walking-and-Cycling-Technical-Design-Guidance-2017.pdf); path width: p12 here: https://www.pathsforall.org.uk/mediaLibrary/other/english/outdoor-access-design-guide.pdf & Section 3a here: https://www.royalparks.org.uk/__data/assets/pdf_file/0005/85658/The-Royal-Parks-Walking-and-Cycling-Technical-Design-Guidance-2017.pdf
Built items	all integral mechanisms such as latches and handles, are accessible and easy to use; further guidance: https://www.pathsforall.org.uk/mediaLibrary/other/english/outdoor-access-design-guide.pdf

Key references: *https://content.aucklanddesignmanual.co.nz/streets-and-parks/Documents/Local_Path_Design_Guide_Rev_1.2.pdf; https://www.tandfonline.com/doi/full/10.1080/15502724.2016.1169931; https://discovery.ucl.ac.uk/id/eprint/10089037/7/Berent_10089037_thesis.pdf; https://www.hertfordshire.gov.uk/media-library/documents/environment-and-planning/countryside-access-and-management/rights-of-way/improvement-plans/rights-of-way-improvement-plan-201718-202728.pdf https://shop.bsigroup.com/products/gaps-gates-and-stiles-specification/standard http://publications.naturalengland.org.uk/publication/4580441024102400#:~:text=The%20BHS%20ran%20a%20trial%20of%20existing%20self-closing,recommendations%20including%20that%20a%20further%20trial%20be%20conducted*

Pathway App: Design

- Using the quality metrics identified from our survey and literature scan, we explored methods to capture these metrics using open and crowdsourced methods

- OpenStreetMap (the largest crowdsourced map in the world) was used for the base map

- The first app was created in iOS
    - *Subsequent apps will be created for both iOS and Android*

- Different methods were used to capture information on quality indicators that were integrated into a variety of functionalities in the first version of the app including:
    - Location tracking
    - Image capture and identification of different path elements
    - Mobile app sensing/measurements to determine surface quality
    - Smart, structured surveys to capture information on path quality

Pathway App: Build

- The app was built in Swift 5 using Apple's Xcode IDE
    - *Because of the close coupling with sensor hardware and OS-specific functionality (such as the Core ML framework for image recognition), using a cross-platform architecture such as Flutter was not practical*

- The survey forms were built using the open source Eureka library, extended with new row designs to minimise user friction; each form is a subclass of a CommonSurvey ancestor which provides common functionality such as upload

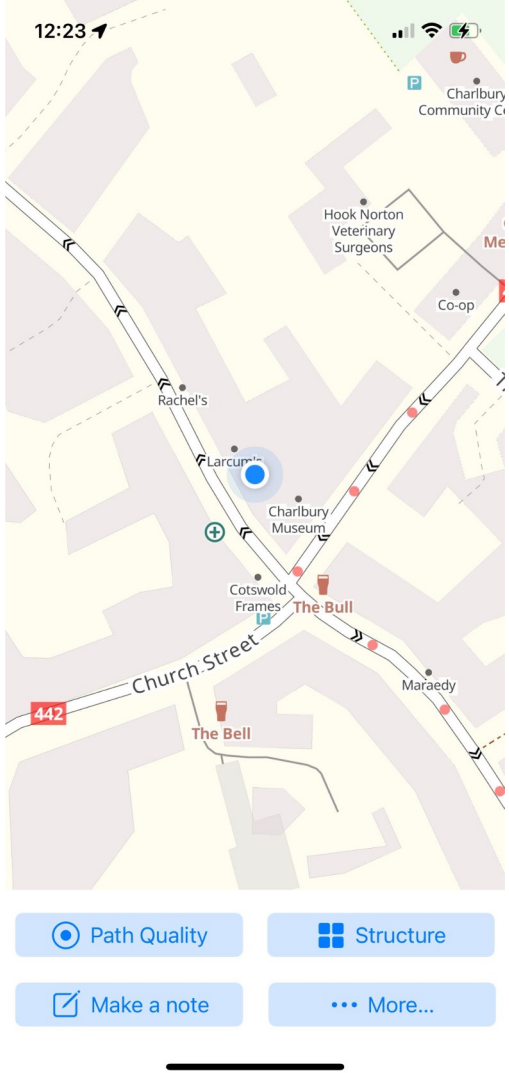
- The core sensor inputs each have their own ViewController:
    - ImageRecognitionVC for text (signs) and image (structure) detection
    - LidarScanVC for LIDAR surface analysis
    - MeasureVC for width/height measurement

- The basemap uses vector tiles created from OpenStreetMap data with tilemaker and displayed with the open source MapLibre GL library

- Several other open source libraries were used to provide common UI and on-boarding functions

Pathway App: Design - *User Interface*

- Our goal was to create a clear, comprehensible user interface suitable for use by different types of path user
- The opening map geolocates to the user's location
- On the bottom of the screen, there are five core functions the user can explore:
  - Capturing path quality
  - Capturing structure information
  - Capturing sign text and design
  - Recording points of interest with predefined categories
  - Making any notes on the path



Pathway App: Design - *Path Quality*

- There are several quality indicators incorporated into ‘Path Quality’ including:
  - Path width measurement (e.g. of how path width is measured is captured in the picture on the far right)
  - Surface roughness
  - Surface type
  - Surface quality
  - Obstructions (slide 9)

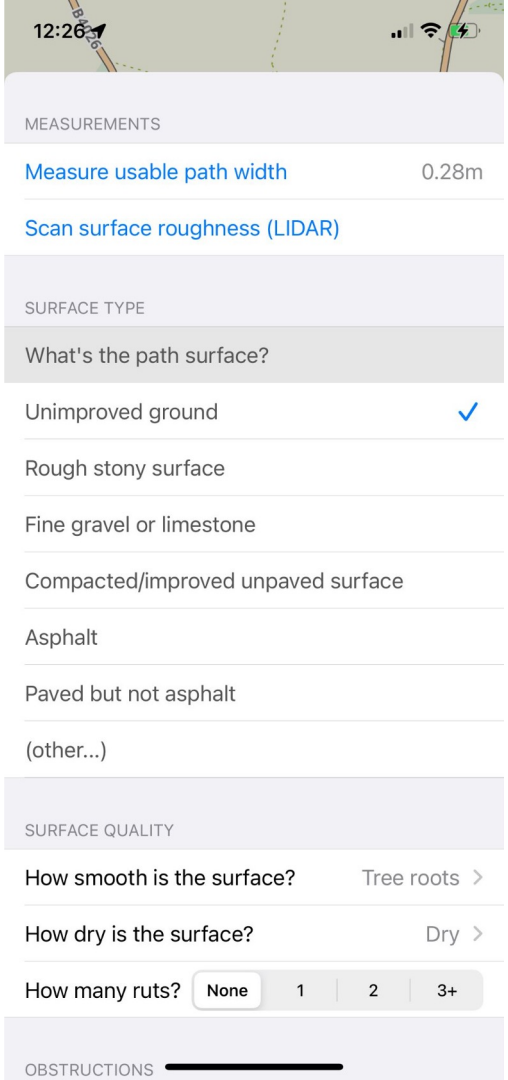
- Users also have an option to take a photo of the path (slide 9)

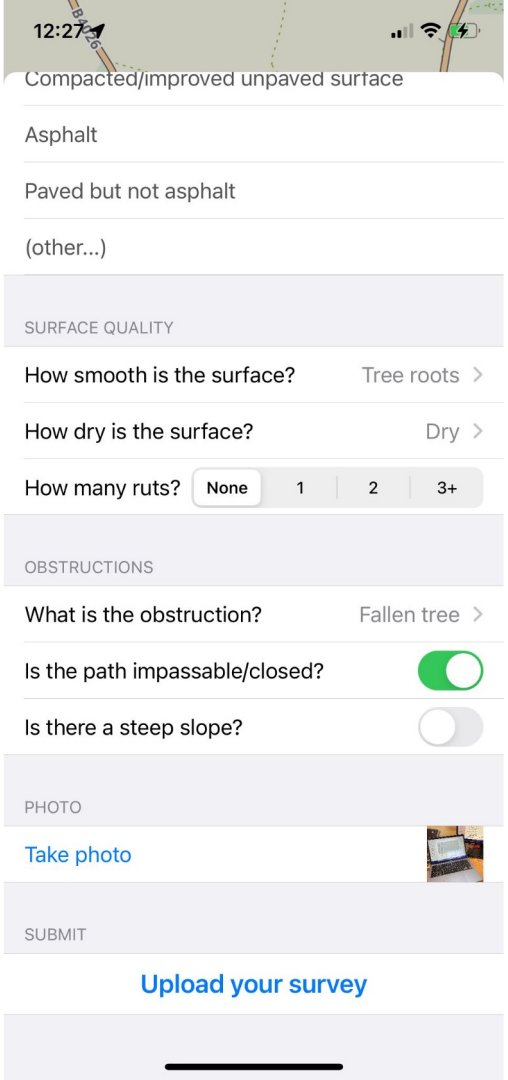
Pathway App: Design - *Path Quality*

- Obstructions:
  - There are several types of obstruction that can be selected from a list of options
  - Other characteristics of the obstruction (e.g. whether the path is impassable and if there is a steep slope) can also be indicated

- Users also have an option to take a photo of the path to highlight quality indicators

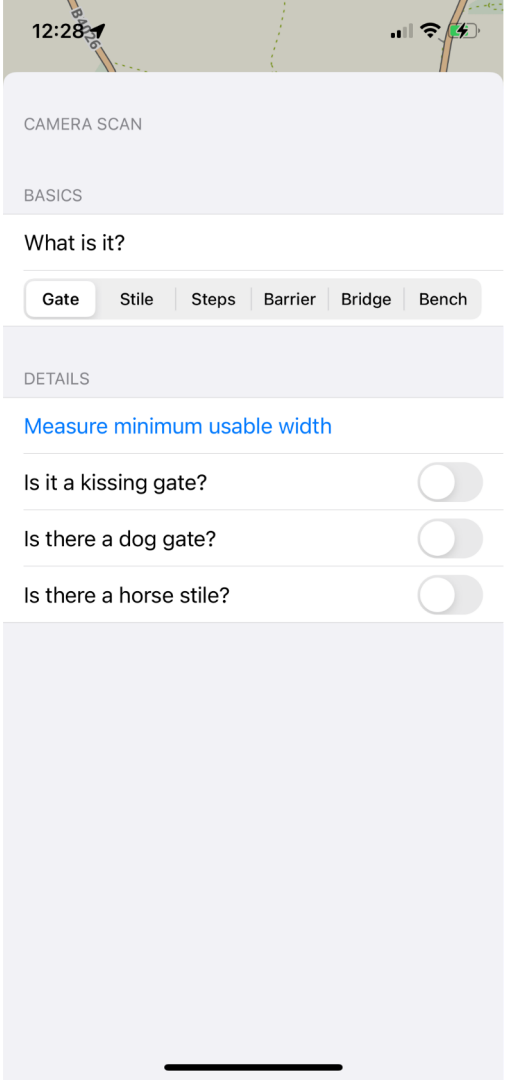
- Once the information has been completed, users can upload their survey





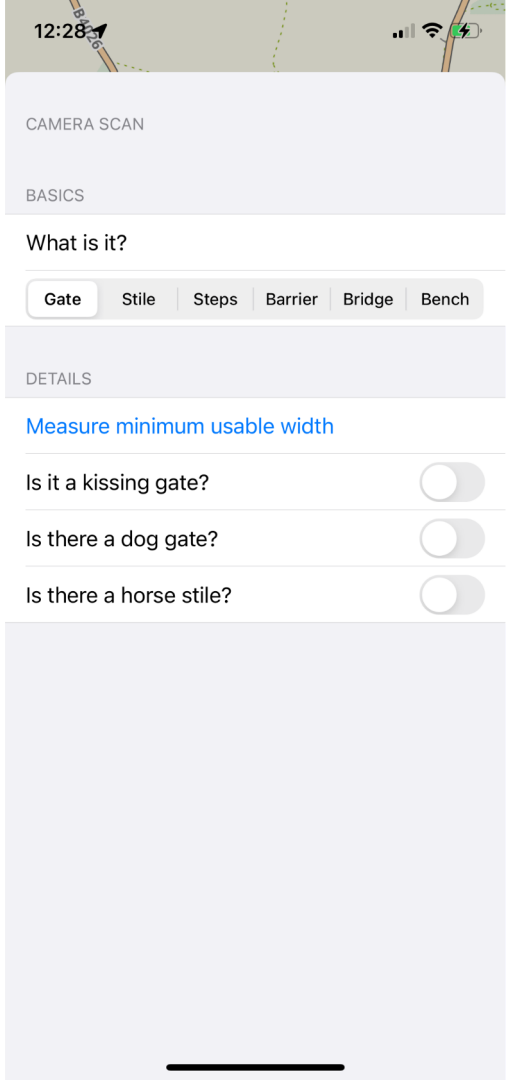
Pathway App: Design - *Structures*

- Structures can be captured through a combination of survey instruments and image recognition
- The survey instrument allows users to indicate the type of structure (e.g. gates, stiles, steps, barriers, bridges, benches) on the path as well as the different characteristics of the structure (e.g. for ‘Gate’ users can indicate whether it is a ‘kissing gate’)
- To minimise the number of options presented to the user, the survey reacts to earlier inputs – for example, “Is it a kissing gate?” is only shown when the user has already selected “Gate”



Pathway App: Design - *Structures*

- Users can also take a picture of the structure, which can be classified using the app's image recognition software
- Where the app recognises a structure from the image, the survey elements are automatically populated with the recognised features (for example, "Gate" and "Wooden")



Pathway App: Data Capture

- When the user completes a survey and clicks “Upload my survey”, the data is transmitted to a backend server
    - The backend is written in Ruby and stores survey data as JSON in a PostgreSQL database

- To minimise the personal information surface, no user account functionality is currently offered. Instead, each session has a unique identifier (UUID) which is associated with the survey uploads. Users can download “their” data in machine-readable format by opening a page on the server keyed to that UUID

- The data is intended as input to OpenStreetMap (OSM) editor software, rather than a direct upload to OSM itself (which would require extensive conflation logic). Recorded tracks are in GPX format which all OSM software supports; surveys are in JSON format which can be processed into OSM tags, and survey categories are broadly aligned with OSM tagging. Future work will build this processing pipeline including automatic tag transformations, and provide a conflation UI based on previous work carried out for Oxfordshire County Council’s Cycling Infrastructure Evaluation project

- Data will also be made available for bulk download by area, such as local authority boundaries

Pathway App: Testing

- Once the app was designed, several methods were used to test it and collect feedback including:
    - Working with West Berkshire Council and Exegesis to test and validate the app on a dense network of public rights of way in West Berkshire (March 22, 2022)
    - Engaging with a select group of volunteers, including in Oxfordshire, through our partners
- During the internal testing period, 75 surveys were received from users

Testing with colleagues from West Berkshire, Exegesis, Natural England, Oxfordshire County Council, Systeme D, University of Oxford

Pathway App: Testing –
Feedback for revised version

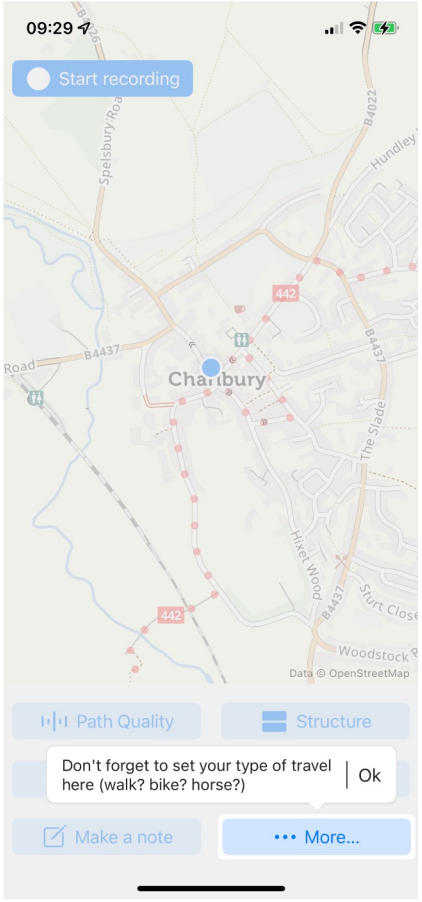
- User Feedback was collected in field testing in West Berkshire and subsequently by user reports to the developers (slide 15)

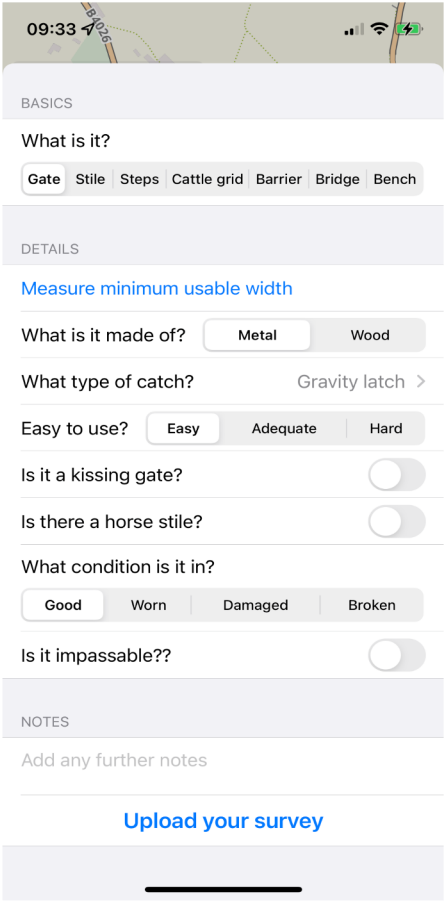
    - Key technical elements to modify included:
        - Filtering out GPS traces in areas of poor reception
        - Recording the heading of the user when taking a photo
        - Allowing the user to manually modify the survey location

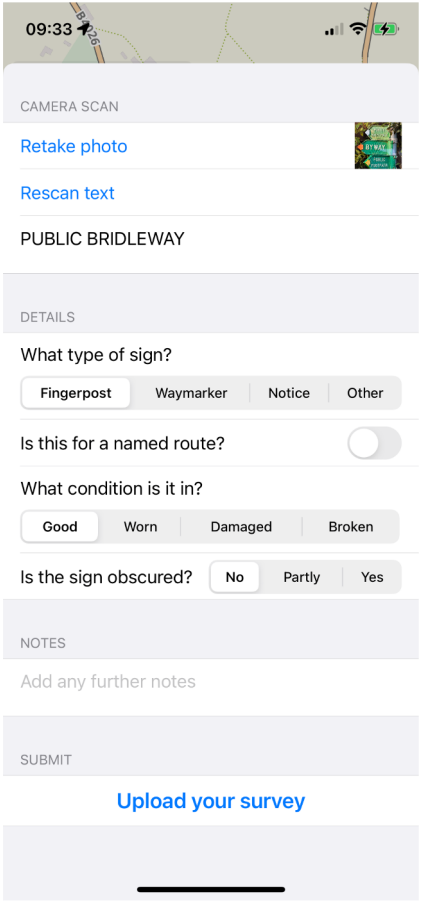
    - Key design elements to modify included:
        - Making the ‘user type’ preference more prominent
        - Adding a manual entry field for path width

    - Key content to modify included:
        - Adding horse & carriage users to the ‘user type’
        - Adding a catch field to gate surveys
        - Adding an ‘obscured?’ field to sign surveys

Pathway App: Revised version







Pathway App: Planning for version 2

- Other potential improvements were beyond the scope of the initial project, but could be addressed in version 2 of the app:
  - Identify the path to which the survey relates (by local authority ID and/or OpenStreetMap way ID)
  - Use the phone accelerometer to measure path roughness when cycling/using a wheelchair
  - Refine vector tile styling to give more prominence to rights of way
  - Continue recording the user's track when the app is running in the background
  - Allow surveys to have line geometries as well as just points
  - Batch up surveys for later upload in case of poor connectivity

Next steps

- The next steps for the project will include:
  - Expanded usability testing with interested user groups
  - Incorporation of further refinements to the app based on feedback collected
  - Official launch of the iOS version of the app in the Apple Store to further explore the proof of concept
  - Exploring how to incorporate feedback from the app directly to those responsible for path maintenance (e.g. councils, landowners, etc.)
  - Working with interested groups to develop a backend facilitate outputs to different user groups
  - Exploring a long-term “home” for the app, including the Creation of an Android version of the app

If you have any questions or would like any further information, please reach out to anant.r.jani@gmail.com

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BLENHEIM PALACE

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