We conducted a controlled user experiment to evaluate the effectiveness of our system in the democratization of factor investing. The RankFIRST (RF) visual analytics system was compared with the iQUANT (IQ) system. Users were required to construct their portfolio with the assist of the two systems. In order to reduce the influence of user fatigue on the results in the experiment, we selected 100 stocks from the stock market using specific criteria for the experiment.

A. The screenshot of IQ system

Figure 2 shows a screenshot of the iQUANT system. For a detailed introduction to the system, please refer to the published paper in EuroVis'21.

Figure 3 shows a screenshot of the RankFIRST system. We refer to the detailed introduction of RankFIRST in the main paper.

B. Stock Selection Criteria

The 100 stocks selected for the experiment meet the following condition: the factor exposure distribution of the selected stocks is consistent the factor distribution of the entire market during the chosen time period. Figure 1 shows the factor exposure distribution of the "skew" factor in the selected stocks (Figure 1(a)) and in all the stocks (Figure 1(b)), in a typical year of 2015. It can be observed that the two distributions are similar.
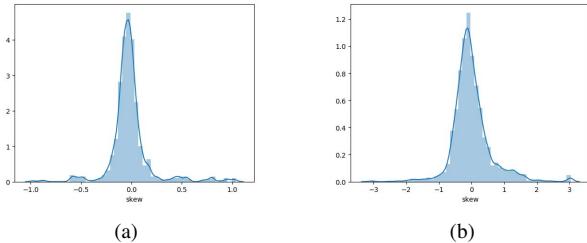

(a)   (b)

Fig. 1: Factor exposure distribution of the "skew" factor: (a) the selected stocks; (b) all stocks in the stock market of 2015.

C. User Study Process

All subjects need to read a latest white paper for the Chinese stock market before participating in the experiment, and have a preliminary understanding of factor investing.

The user study consists of five steps.

Step 1: Fill in the user registration form and determine the system that user will use first based on Table I. If the user uses the RF system first, perform Step 2, 3, 4, 5; Otherwise, perform Step 4, 5, 2, 3;

Step 2 (learning session of RF): Learn the functionality of each part of the RF system and the operating method of the RF system. The subject needs to use RF to select stocks in a period different from the test session, i.e. Jan to Dec in 2015;

User ID	Time Period	System	Time Period	System
1	T1	IQ	T2	RF
2	T1	IQ	T2	RF
3	T1	IQ	T2	RF
4	T1	RF	T2	IQ
5	T1	RF	T2	IQ
6	T1	RF	T2	IQ
7	T2	IQ	T1	RF
8	T2	IQ	T1	RF
9	T2	IQ	T1	RF
10	T2	RF	T1	IQ
11	T2	RF	T1	IQ
12	T2	RF	T1	IQ

TABLE I: The list of users and their setting in the study. (T1: Feb. to July, 2014; T2: Mar. to Aug., 2017)

Step 3 (test session of RF): The user uses the RF system to select 10 stocks from an initial pool of 100 stocks to construct the investment portfolio within the given period (T1 or T2).

Step 4 (learning session of IQ): Watch and learn the functionality of each part of the IQ system and the operating method of the IQ system. The subject needs to use IQ to select stocks in a period different from the test session, i.e. Jan to Dec in 2018;

Step 5 (test session of IQ): The user applies the IQ system to an initial pool of 100 stocks. They are required to select 10 stocks to construct the investment portfolio within the given period (T1 or T2).

D. User Evaluation Result

User ID	System	1st month	2nd month	3rd month
1	IQ	5.97%	17.46%	14.68%
2	IQ	5.93%	23.67%	21.27%
3	IQ	11.63%	24.56%	23.14%
10	IQ	6.16%	25.28%	28.05%
11	IQ	4.43%	20.27%	25.86%
12	IQ	5.72%	20.13%	24.18%
4	RF	4.98%	19.24%	29.07%
5	RF	3.83%	26.13%	39.84%
6	RF	7.02%	30.17%	35.36%
7	RF	11.01%	36.64%	43.51%
8	RF	5.75%	31.86%	42.61%
9	RF	6.68%	26.92%	33.08%
4	IQ	1.44%	3.28%	-2.20%
5	IQ	0.21%	-0.25%	-6.08%
6	IQ	0.46%	-2.89%	-8.75%
7	IQ	-0.19%	1.91%	-6.65%
8	IQ	0.23%	1.45%	-5.23%
9	IQ	1.48%	0.16%	-6.96%
1	RF	0.41%	-1.09%	-6.28%
2	RF	1.74%	-2.34%	-11.16%
3	RF	4.03%	4.37%	-2.11%
10	RF	-0.45%	0.39%	-5.96%
11	RF	0.43%	0.30%	-3.40%
12	RF	3.55%	2.76%	-0.41%

TABLE II: Returns of all testers-constructed portfolios over time.

The portfolio selected by each subject during the testing phase was used to calculate returns for the next 3 months. Table II shows the returns of testers-constructed portfolios in the next 1 month, 2 months and 3 months, respectively. Each group of experiments was carried out individually.
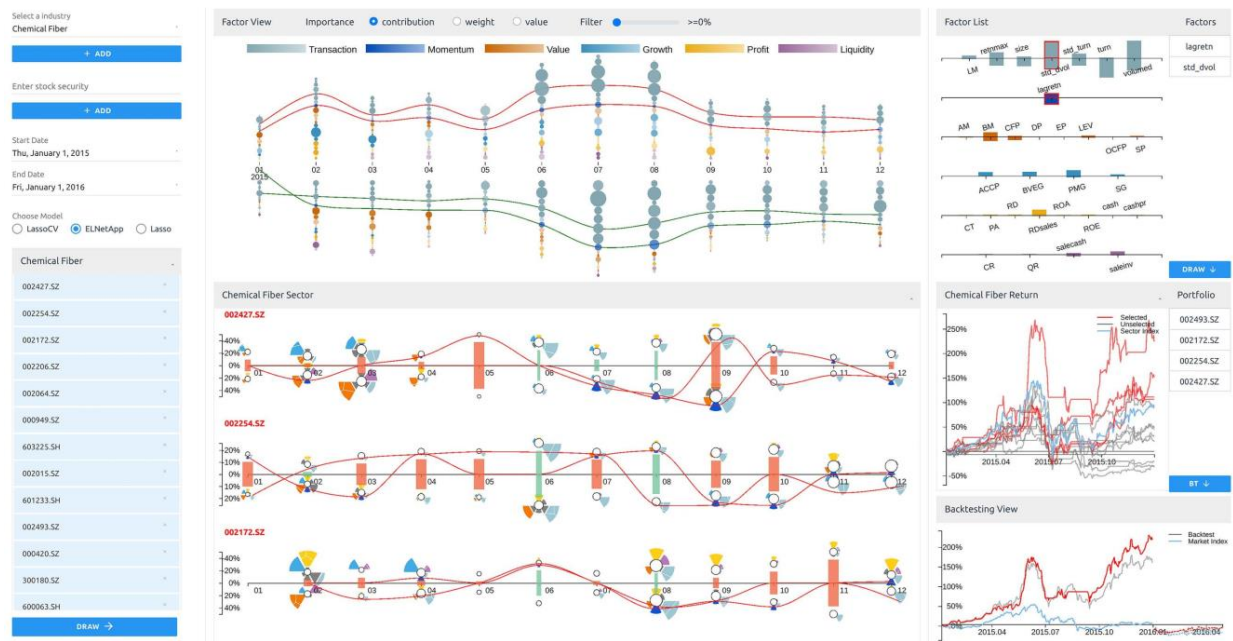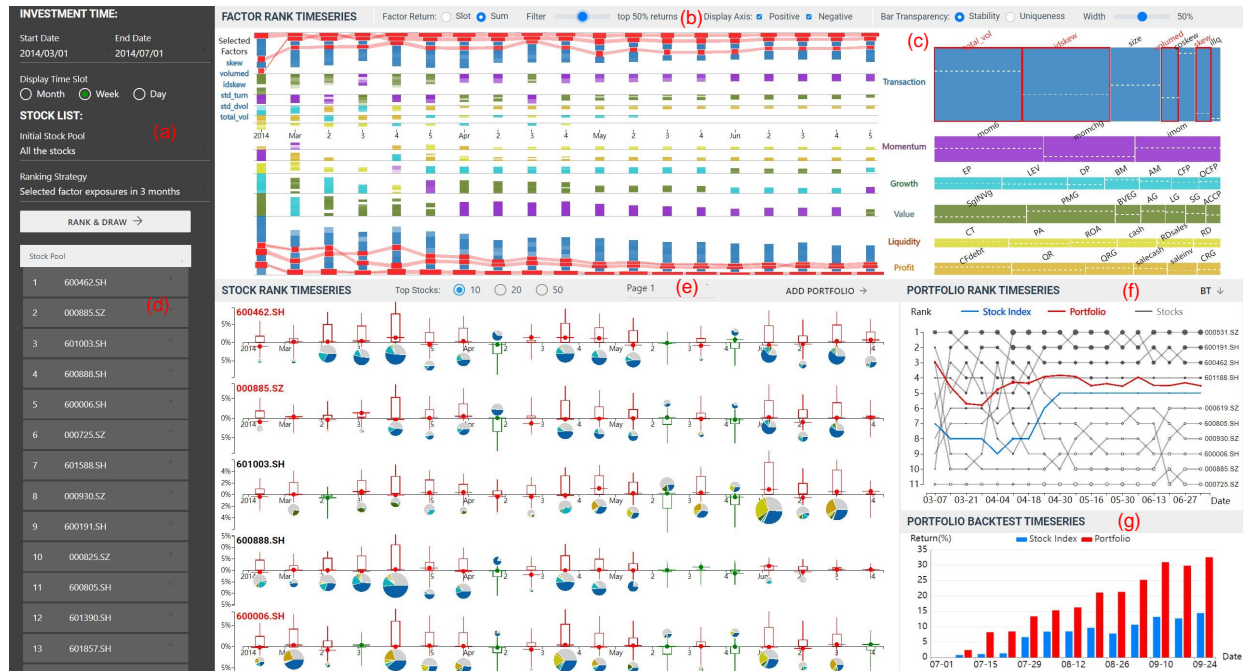
Fig. 2: The screenshot of the iQUANT system.

Fig. 3: The screenshot of the RankFIRST system.

APPENDIX B
FACTOR LIST

56 factors involved in this article are derived from white paper on quantitative factors in China's A-share market, published in 2018, which can be categorized into 6 classes: 1) *Transaction factors* representing the overall status of a company and its transaction statistics; 2) *Momentum factors* including daily stock returns in recent 6~12 months, change and characteristic momentum; 3) *Value factors* including book-to-market ratio, asset-to-market ratio, and other performance related ratios; 4) *Growth factors* portraying the growth of a company in assets, profit, etc; 5) *Profitability factors* quantifying stock returns on equity and other company profit related factors; 6) *Liquidity factors* characterizing the liquidity of a company. Table III shows all the factors and their definitions. The calculation method of the factor can refer to in the detailed report.

Factor	Full Name	Definition
A: Transaction friction:		
size	Firm size	Close price times shares outstanding
beta	Market beta	Covariance of daily stock return and Wind A return divided by variance of market return
betad	Downside betad	Covariance of daily stock return and Wind A return under market return level divided by variance of market return (rm¡0)
idvol	Idiosyncratic idvol	The standard deviation of the residuals from regression of daily return on market return over one month
vol	Total vol	The standard deviation of stock returns over one year
idskew	Idiosyncratic idskew	The skewness of the residuals from regression of daily return on market return
skew	Total skew	The skewness of intraday stock returns
coskew	Co coskew	The coskewness of stock return and market return
turn	Trading turn	The average daily volume turnover over one year
std_turn	Volatility std_turn	Monthly standard deviation of daily share turnover
volumed	Volume volumed	Trading volume * price
std_dvol	Volatility std_dvol	Monthly standard deviation of daily dollar trading volume
retnmax	Maximum retnmax	The maximum daily return in month t
illq	Illiquidity illq	The average of the ratio of the absolute stock return to its dollar volume over one year
LM	Zero LM	Turnover weighted number of zero trading days for most recent one month
sharechg	Anuual sharechg	Annual percentage change in shares outstanding
age	Firm age	Number of years since first Compustat coverage.
B: Momentum:		
mom12	12-month mom12	The 11-month cumulative of daily returns from month t-11 to month t-1
mom6	6-month mom6	5-month cumulative returns from month t-5 to month t-1.
momchg	Momentum momchg	Cumulative returns from month t-6 to t-1 minus months t-12 to t-7
imom	Idiosyncratic imom	The cumulative residuals from regression of stock returns on market index returns from month t-11 to month t-1
lagretn	Lagged lagretn	The monthly return in month t
C: Value:		
BM	Book BM	Book value of equity divided by end of fiscal-year-end market capitalization
AM	Asset AM	Total Assets divided by fiscal-year-end market capitalization
LEV	Leverage LEV	Total liability divided by fiscal-year-end market capitalization.
EP	Earnings EP	Annual income before extraordinary items divided by end of fiscal year market capitalization.
CFP	Cash CFP	cash flows divided by fiscal-year-end market capitalization
OCFP	Operating OCFP	Operating cash flows divided by fiscal-year-end market capitalization
DP	Dividend DP	Annual revenuedivided by market capitalization
SP	Sales SP	Total dividend divided by market capitalization
D: Growth:		
AG	Asset AG	Annual percent change in total asset.
LG	Liabilities LG	Annual percent change in total liabilities.
BVEG	Book BVEG	Annual percent change in book value of equity.
SG	Sales SG	Gross profit margin is operating profit divided by operating sales. Changes in gross proft margin is the annual percentage change in gross profit margin from month t-12 to t.
PMG	Profit PMG	Annual percent change in sales from month t-12 to t
INVG	Inventory INVG	Percentage change in total taxes from quarter t-4 to t.
INVchg	Inventory INVchg	Change in inventory divided by average total assets.
SgINVg	Sales SgINVg	Percentage change in inventory from month t-12 to t.
TAXchg	Tax TAXchg	Annual percentage change in sales minus annual percent change in inventory
ACC	Accruals ACC	Annual income before extraordinary items minus operating cash flow divided by average total assets
ACCP	Percent ACCP	Gross profit minus operating cash flow and then divided by absolute value of (net profit)
E: Profitability:		
ROE	Return ROE	Earnings before extraordinary items divided by lagged common shareholders' equity
ROA	Return ROA	Earnings before extraordinary items divided by one quarter lagged total assets
CT	Capital CT	Sales divided by lagged assets.
PA	Profit PA	Gross profit divided by total assets.
cashpr	Cash cashpr	Cash and cash equivalents divided by average total assets.
cash	Cash cash	Fiscal year end market cap plus long-term debt minus total assets divided by cash and cash-equivalents
RD	Research RD	R&D expense divided by end-of-fiscal-year market capitalization
RDsale	R&D RDsale	R&D expense divided by sales
F: Liquidity:		
CR	Current CR	Current assets divided by current liabilities
QR	Quick QR	(current assets – inventory) divided by current liabilities
CFdebt	Cash CFdebt	Earnings before depreciation and extraordinary items divided by average total liabilities
salecash	Sales salecash	Annual sales divided by cash and cash equivalents
saleinv	Sales saleinv	Annual sales divided by total inventory
CRG	Current CRG	Annual growth in current ratio
QRG	Quick QRG	Annual growth in quick ratio

TABLE III: List of 56 factors involved in this paper. All data sourced from White paper for the list of quantitative factors in a major stock market(http://mscf.pbcsf.tsinghua.edu.cn/uploadfile/2018/0316/20180316025702935.pdf).