



Mining process models and architectural components from test cases

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13th April, 2015 @ InSTA 2015

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- Summary

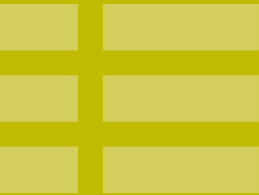
System Testing in the Industry

- Functional Testing of business applications carried out by independent teams
- Test Design
 - Usage Scenarios identified from Requirements
 - Test cases identified for each scenario
 - Test data identified using equivalence class partitioning (ad-hoc)
 - Test scripts generated manually
- Test Execution
 - Test scripts executed manually by system testers
 - Automation in single digits to low double digits
- Usage of test management tools much higher

Manual Test Script

Test		Test Step		
Case ID	Test Pre-Condition	Step Name	Description	Expected Result
Case_65937	1.The User should have access to the Flipkart site	1	Enter the URL "www.flipkart .com" in the browser.	The system should display the Homepage of Fipkart
		2	click the Register link present in the header section of the Home page.	The system should navigate the user to the Registration page
		3	Enter all the details in the mandatory fields.	The system should accept the details
		4	click "Sign Up" button.	The system should register the user with Fipkart after validating all the entered details
Case_65938	1.The User should have to access to the Fipkart site. 2.The user should have valid username and password.	1	Enter the URL "www.Fipkart .com" in the browser.	The system should display the Home page of Fipkart
		2	click on the Login button.	The system should navigate the user to the Login page
		3	Login to the system with valid login credentials.	The system should allow user to login
		4	Search and select product	The system should allow user to view and select search product
		5	Add product to the cart by the help of add To My cart button	The system should add the selected products to the cart
		6	click on "Buy Now" button	The system should navigate user to shipment page
		7	Click the Credit card link in the payment information section.	System should navigate user to the navigate page.
		8	Enter all the details in all the mandatory field and press pay button	System should process the payment after validating all the entered details
Case_65939	1.The User should have to access to the Fipkart site. 2.The user should have valid username and password.	1	Enter the URL "www.Fipkart .com" in the browser.	The system should display the Home page of Fipkart
		2	Search and select product	The system should allow user to view and select search product
		3	Add product to the cart by the help of add To My cart button	The system should add the selected products to the cart
		4	click on "Buy Now" button	The system should navigate user to the Guest sign up page
		5	Click the "SIGN UP" button in the guest sign up section.	The system should navigate user to shipment page
		6	Enter the shipment details.	The system should accept the details
		7	Click the Credit card link in the payment information section.	System should navigate user to the navigate page.
		8	Enter all the details in all the mandatory field and press pay button	System should process the payment after validating all the entered details

- Acquisition & Maintenance
 - Test Scripts manually generated: Over 80% scripts are inherited
 - Test architecture, documents: Not available or currency an issue
 - Test Scripts difficult to comprehend:
 - Change hands multiple times during lifetime
 - consistency an issue
 - local view v/s global view
 - Changes are difficult, no universal template
 - **Precise understanding essential: Gap Analysis**
 - Few tools
- Manpower turnover
 - 20% - 25% for IT services (Attrition & People Movement)

A decorative graphic in the top-left corner consisting of a 2x3 grid of six light blue squares.

System Testing – Sample Scenario

Motivating Example: An online retailer

The screenshot displays the Flipkart website interface. At the top, the Flipkart logo is on the left, and navigation links for 'Flipkart First', 'Download App', 'Sell', '24x7 Customer Care', 'Track Order', 'Signup', and 'Login' are on the right. A search bar is positioned below the logo. The main navigation menu includes categories like 'ELECTRONICS', 'HOME & KITCHEN', 'MEN', 'WOMEN', 'BABY & KIDS', 'BOOKS & MEDIA', 'MORE STORES', and 'OFFERS ZONE'. Below this, a secondary navigation bar lists various product types such as 'Mobiles', 'Tablets', 'Bedsheets', etc. The main content area features several promotional banners: a 'GHAR BAITHE GHAR SAJAO' banner for home decor, a '48 HOURS 48 DEALS' banner for furnishing, a large 'BEAUTY BONANZA' banner for beauty products, and a 'MOTO E (2ND GEN)' banner for mobile phones. On the right side, there are vertical banners for '#DO THUMB THING GET SOMETHING!', 'BEST TIME TO REFASHION YOUR HOME', and 'MICROMAX UHD SMART TV'. A sidebar on the far right promotes 'HP INK ADVANTAGE PRINTERS'. At the bottom, a 'DEALS of the DAY' banner shows a countdown timer.

System Testing: Sample scenario

Normal Flow	Enter URL	Alternate Flow	Enter URL
	Login with valid credentials		Browse products
	Browse products		Add item/ items to the cart
	Add item/ items to the cart		checkout
	checkout		Sign up to the system
	Enter shipment details		Enter shipment details
	Confirm order		Confirm order
	Make Payment		Make Payment
Alternate Flow	Enter URL	Variations :	
	Browse products		Select different payment mode...
	Add item/ items to the cart		
	checkout		Ex. : Make payment by using credit card /
	Login to the system		debit card / net banking or choose COD
	Select shipment details		option
	Confirm order		
	Make Payment		

System Testing: – An online retailer

The screenshot displays the Flipkart.com homepage. At the top, the Flipkart logo is on the left, and navigation links for 'Flipkart First', 'Download App', 'Sell', '24x7 Customer Care', 'Track Order', 'Signup', and 'Login' are on the right. A search bar is centered below the logo. Below the search bar is a horizontal menu with categories: ELECTRONICS, HOME & KITCHEN, MEN, WOMEN, BABY & KIDS, BOOKS & MEDIA, MORE STORES, and OFFERS ZONE. A secondary navigation bar lists various product types like Mobiles, Tablets, Bedsheets, etc. The main content area features a large blue banner for 'GHAR BAITHE GHAR SAJAO' with '48 HOURS | 48 DEALS' and a 'SHOP NOW' button. Below this is a large red and pink grid banner for 'BEAUTY BONANZA' with 'OFFERS LIKE NEVER BEFORE' and 'ON 60+ BEAUTY & GROOMING BRANDS'. To the right of the main banner are several promotional cards: '#DO THUMB THING GET SOMETHING!', 'BEST TIME TO REFASHION YOUR HOME', 'MOTO E (2ND GEN)', and 'MICROMAX UHD SMART TV'. A vertical sidebar on the right shows an HP logo and 'HP INK ADVANTAGE PRINTERS'. At the bottom, there are more promotional banners, including 'DEALS of the DAY' and a countdown timer.

Enter URL Flipkart.com

The system should display the Home page of Fipkart

System Testing: Example (Cont.)

The screenshot displays the Flipkart website interface. At the top, the Flipkart logo and navigation links (Flipkart First, Download App, Sell, 24x7 Customer Care, Track Order, Signin, Login) are visible. The search bar contains the text "moto e (2nd gen)". Below the search bar, a category menu lists various product categories. The main content area shows search results for "moto e (2nd gen)", displaying four product listings. Each listing includes a product image, a "6 OFFERS" badge, the product name, specifications, price, and ratings. The right sidebar features a promotion for the Flipkart Mobile App, stating it is "INDIA'S #1 SHOPPING APP" and includes a "GET THE APP >" button. The bottom of the page has a "flipkart first" logo.

Search Product

The system should display the searched products

System Testing: Example (Cont.)

The screenshot shows the Flipkart website interface. At the top, there is a navigation bar with the Flipkart logo, search bar, and various utility links like 'Flipkart First', 'Download App', '24x7 Customer Care', 'Track Order', 'Signup', and 'Login'. Below the navigation bar, there are category tabs: ELECTRONICS, HOME & KITCHEN, MEN, WOMEN, BABY & KIDS, BOOKS & MEDIA, MORE STORES, and OFFERS ZONE. The main content area displays the product page for the 'Moto E (2nd Gen) 3G (Black, with 8 GB)'. The product image shows a black smartphone with a yellow screen. To the right of the image, the product name is displayed, along with a star rating of 3.75 (375 reviews) and options to 'Write a REVIEW', 'Add to WISHLIST', and 'Add to COMPARE'. Below the product name, there are specifications: '0.3 MP Secondary Camera', 'Android v5.0 OS', 'Dual Sim (GSM + UMTS)', and '5 MP Primary Camera'. A 'WARRANTY' section states '1 year manufacturer warranty for Phone and for in the box accessories'. There is also a link to 'View Compatible Accessories'. A badge indicates 'Available with 1 Seller at 411013'. The price is listed as 'Rs. 6,999 MRP (Free delivery)'. Below the price, there are two buttons: 'ADD TO CART' (orange) and 'BUY NOW' (green). To the right, there is a 'SOLD BY' section for 'WS Retail' with a rating of 4.3/5 and an 'Advantage' badge. Below this, there are '6 OFFERS' with details: 'Introductory Offer Price of Rs.6,999. Offer till stocks last.', '6 months of unlimited music downloads with Saavn Pro (price shown is inclusive of this offer). View T&C', and 'EXTRA Rs.250 OFF on purchase of lifestyle products worth Rs 1,000 or more (price shown is...'. At the bottom of the product page, there are small thumbnail images of the phone from different angles.

Add product to Cart and click Buy now

The product should be added to cart

System Testing: Example (Cont.)



Need Help? call 1800 1080 1800

SECURE PAYMENTS

ORIGINAL PRODUCTS

FREE & EASY RETURNS

100% BUYER PROTECTION

1. BEFORE YOU PLACE YOUR ORDER! > Sign In

What is your Email Address?

john.peter@yahoo.com

CONTINUE

Sign in with your social account

No posts on your behalf, promise!

f Facebook

g Google

2. DELIVERY ADDRESS

3. ORDER SUMMARY 1 items Total: Rs.6999

4. PAYMENT METHOD

Signing in saves you time!

Provide Email

The system should navigate user to the Guest sign up page

System Testing: Example (Cont.)

flipkart.com Need Help? call 1800 1080 1800

SECURE PAYMENTS ORIGINAL PRODUCTS FREE & EASY RETURNS 100% BUYER PROTECTION

1. BEFORE YOU PLACE YOUR ORDER! > Sign Up

john.peter@yahoo.com [Change](#)

Set Password*

Confirm Password*

SIGN UP

Sign in with your social account

No posts on your behalf, promise!

Facebook

Google

2. DELIVERY ADDRESS

3. ORDER SUMMARY 1 items Total: Rs.6999

4. PAYMENT METHOD

Signing in saves you time!

Click Sign up

The system should navigate user to shipment page

System Testing: Example (Cont.)

The screenshot shows the Flipkart checkout process. At the top, there is a navigation bar with the Flipkart logo, a help number (1800 1080 1800), and four service icons: SECURE PAYMENTS, ORIGINAL PRODUCTS, FREE & EASY RETURNS, and 100% BUYER PROTECTION. Below this, the checkout steps are listed: 1. EMAIL ID (checked), 2. DELIVERY ADDRESS (highlighted in green), and 3. ORDER SUMMARY. The delivery address form contains the following fields: Name (John Peter), Pincode (411013), Address (54 B TRDDC, Hadapsar, Industrial estate, Industrial estate, Pune, Maharashtra - 411013), Landmark (Honeywe11), Country (India (Service available only in India)), and Phone (+91 8460015684). A 'CHANGE EMAIL' button is located next to the email ID field. A 'SAVE & CONTINUE' button is at the bottom of the form. The order summary at the bottom shows 1 item for a total of Rs. 6999.

flipkart.com Need Help? call 1800 1080 1800

SECURE PAYMENTS ORIGINAL PRODUCTS FREE & EASY RETURNS 100% BUYER PROTECTION

✓ 1. EMAIL ID john.peter@yahoo.com CHANGE EMAIL

2. DELIVERY ADDRESS

Name John Peter

Pincode 411013

Address 54 B TRDDC, Hadapsar, Industrial estate , Industrial estate , Pune, Maharashtra - 411013

Landmark Honeywe11

Country India (Service available only in India)

Phone +91 8460015684


SAVE & CONTINUE


3. ORDER SUMMARY 1 items Total: Rs.6999


Enter shipment details


System should accept details


System Testing: Example (Cont.)

 Need Help? call 1800 1080 1800

 SECURE PAYMENTS

 ORIGINAL PRODUCTS

 FREE & EASY RETURNS

 100% BUYER PROTECTION

✓ 1. EMAIL ID john.peter@yahoo.com [CHANGE EMAIL](#)

✓ 2. DELIVERY ADDRESS John Peter 8460015684
54 B TRDDC, Hadapsar, Industrial estate , Pune, Maharashtra - 411013 [CHANGE ADDRESS](#)

3. ORDER SUMMARY 1 items

 ADD GIFT WRAP for Rs.30Send Order Confirmation SMS alert to +91 [CONTINUE](#) Amount Payable: Rs.6999

Click Continue

System should display order summary

System Testing: Example (Cont.)

The screenshot displays the Flipkart checkout process. At the top, the Flipkart logo and contact information are visible. Below the header, there are four steps: 1. EMAIL ID (john.peter@yahoo.com), 2. DELIVERY ADDRESS (John Peter, 8460015684, 54 B TRDDC, Hadapsar, Industrial estate, Pune, Maharashtra - 411013), and 3. ORDER SUMMARY (1 items, Total Rs.6999). Step 4, PAYMENT METHOD, is highlighted in green. On the left, a sidebar lists payment options: Credit Card, Net Banking, EMI, Debit Card, COD, and EGV. The main area shows the 'Pay using Credit Card' section with logos for VISA, MasterCard, AMERICAN EXPRESS, Diners Club, and DISCOVER. A form for entering card details is shown, including a masked card number, expiry date (01/17), cardholder name (John Peter), and a 'Save this card for faster payments' checkbox. A large orange 'Pay' button is at the bottom. On the right, a summary box shows 'Total Rs.6999' and 'Amount Payable Rs. 6999'.

Click the Credit card link, Enter details and Pay

The system should validate details and process payment

Test Scripts: Observations

- Test Procedures
 - Sequence of user actions – data entry, navigations, V&V ...
 - Describing a usage scenario
- Test scripts
 - Manual scripts are fewer – 100s to 1000s (unlike automatically generated test cases)
 - They however attempt to cover all edges

1	Enter the URL “www.Fipkart .com” in the browser.
2	Search and select product
3	Add product to the cart by the help of add To My cart button
4	click on “Buy Now“ button
5	Click the “SIGN UP” button in the guest sign up section.
6	Enter the shipment details.
7	Click the Credit card link in the payment information section.
8	Enter all the details in all the mandatory field and press pay button

A decorative graphic in the top-left corner consisting of a 2x3 grid of six light blue squares.

Can we mine Workflows from Test Scripts?

Can we use process mining techniques?

- Several mining techniques [2-5,8,14] to mine process models, FSMs from event logs
- Few applications by IT service providers
- Usage of test scripts for mining novel
- Experimented with several techniques: α -miner, heuristic miner, multi-phase miner, from the ProM toolset developed at TU/e and Synoptic[14]
 - Precision defined as the degree to which the model reflects the behavior in the log
 - Precision of the mined model between 14% and 100%
 - None of the algorithms handled **duplicates**
 - **Algorithms developed to handle large logs and unseen behavior – hence tend to generalize**
 - α -miner the most simplistic, mined models with precision 99%, heuristic miner – 30%, multi-phase miner – 14% and Synoptic – 100%

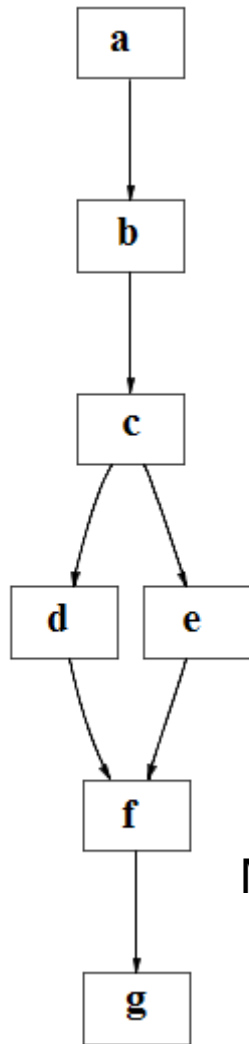
For comprehension: Models should be precise during acquisition and maintenance

Let A and B be events in a log

- $A > B$, if activity A is followed by B
- $A \rightarrow B$, If activity A is followed by B but B is never followed by A
i.e. if and only if $A > B$ and $B \not> A$
- $A \# B$, if and only if, $A \not> B$ and $B \not> A$
- $A \parallel B$, if and only if $A > B$ and $B > A$

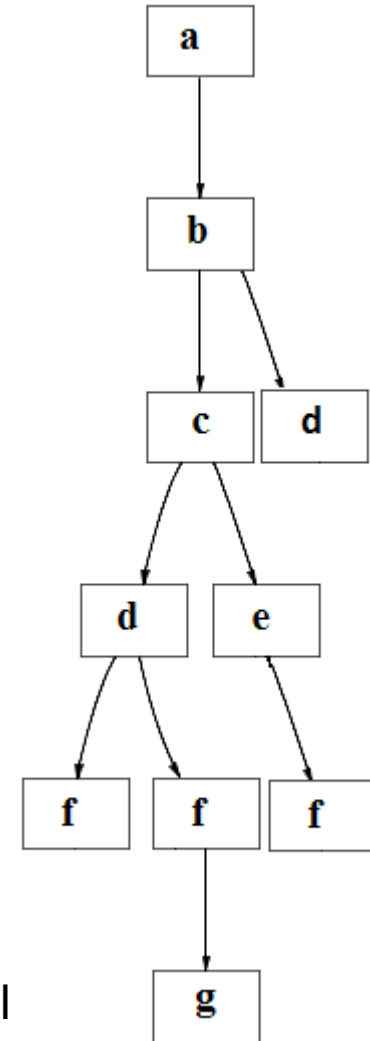
- Frequency of events is denoted as #A
- Number of times A is directly followed by B $\#A > B$
- metric $\$A \xrightarrow{L} B$ is used to measure the strength of the relationship between A and B depending on frequencies
- metric $\$A \rightarrow B$ is used to measure the strength of the relationship depending on the distance

Heuristic Miner: Mined Model



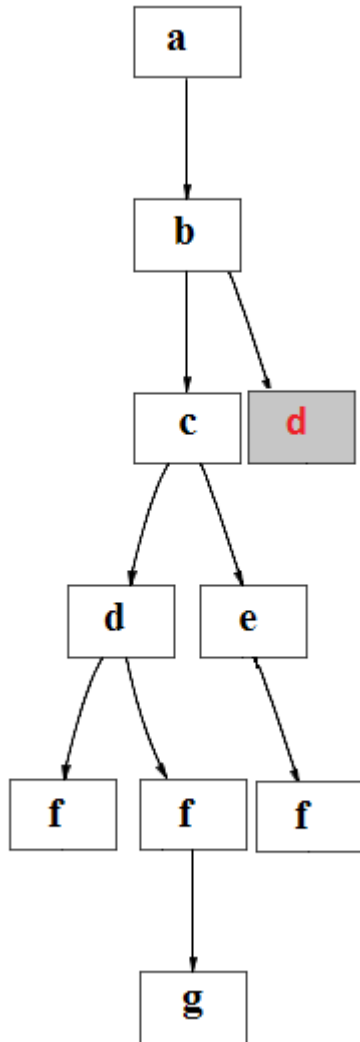
Mined Model

abcef
abcdf
abcdfg
abd



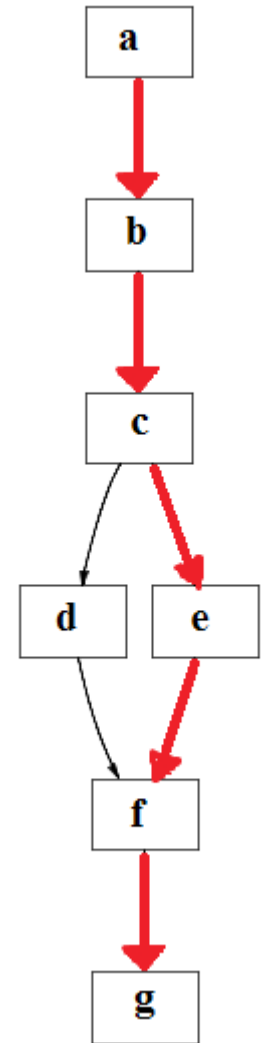
Precise Model

Heuristic Miner: Analysis



Noise: The edge between b and d dropped from model

Generalization: New path in the model from e to g not in the log



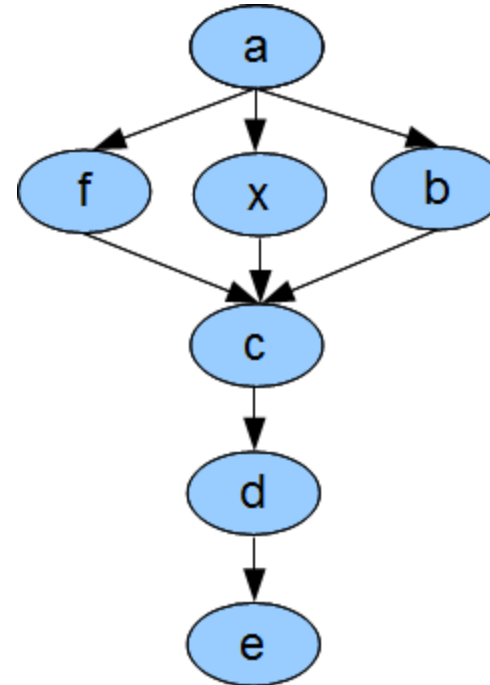
Synoptic: Studying Logged Behavior with Inferred Models

- Synoptic constructs a system model from a set of observed system execution traces
- Synoptic mines three kinds of invariants relating events from the trace graph
 - $a \rightarrow b$: Event a is always followed by event b
 - $a \nrightarrow b$: Event a is never followed by event b
 - $a \leftarrow b$: Event a always precedes event b
 - For given examples traces, 57 such invariants mined from the traces: abcd, axcde, afcd

AlwaysFollowedBy (\rightarrow)	NeverFollowedBy (\nrightarrow)	AlwaysPrecedes (\leftarrow)
$a \rightarrow c$	$a \nrightarrow a$	$a \leftarrow b$
$f \rightarrow c$	$b \nrightarrow a$	$a \leftarrow c$
$x \rightarrow c$	$c \nrightarrow f$	$c \leftarrow d$

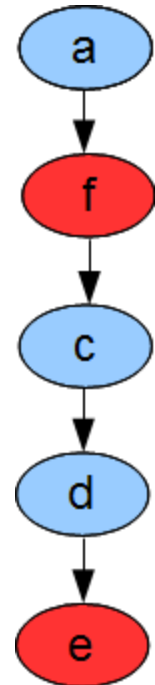
Initial Model, Refinement & Coarsening

- Initial Model: Contains only one occurrence of each event
 - If an event a is immediately followed by an event b in the trace, then there must be an edge from a to b
 - If an event a is never immediately followed by an event b in the trace, then there is no edge from a to b
- Refinement: Model is split
 - Model checker generated counter examples are used as guide to split the model
 - Such that all mined invariants are satisfied
- Coarsening: Nodes in the models are merged
 - K-Tails algorithm used to make the model compact



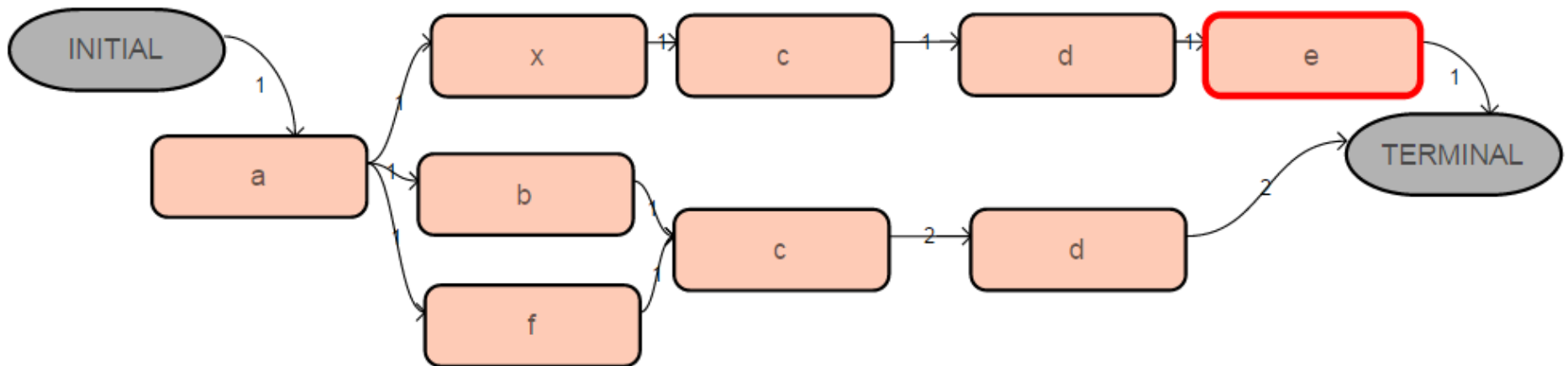
Initial Model

Counter Example



Synoptic: Final Model

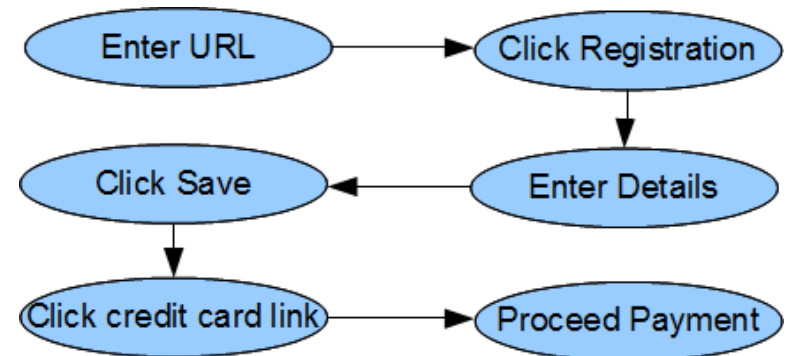
abcd
axcde
afcd



Challenge: Duplicates

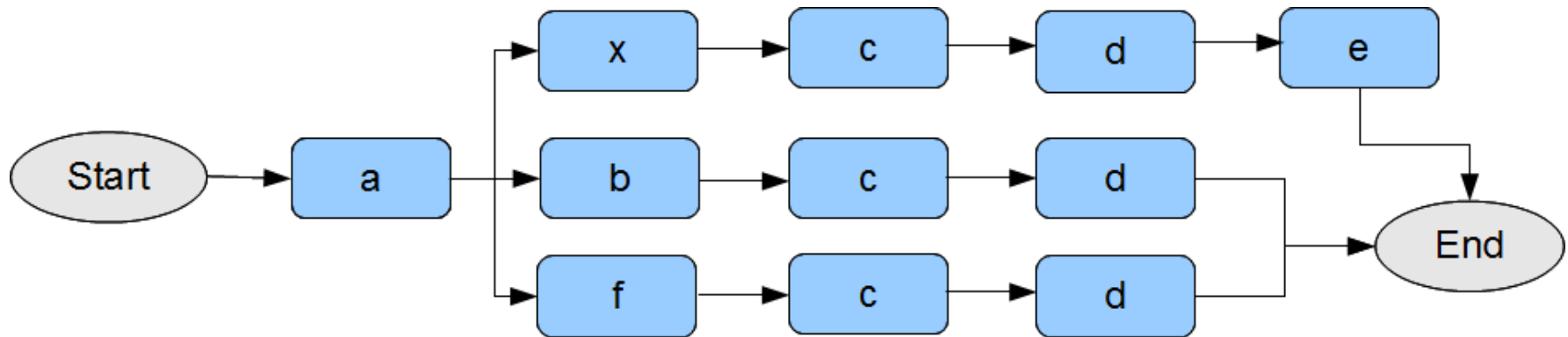
Case ID	Step Name	Description
Case_65934	1	Enter the URL "www.flipkart .com" in the browser.
	2	click the Register link present in the header section of the Home page.
	3	Enter all the details in the mandatory fields.
	4	click save button.
Case_65935	1	Enter the URL "www.Fipkart .com" in the browser.
	2	click on the Login button.
	3	Login to the system with valid login credentials.
	4	Search and select product
	5	Add product to the cart by the help of add To My cart button
	6	click on "Buy Now" button
	7	Enter the shipment details
	8	click save button.
	9	Click the Credit card link in the payment information section.
	10	Enter all the details in all the mandatory field and press pay button

- Both occurrence of "click save button" are in different context.
- Each such occurrence should be treated as unique action
- Incorrect handling of duplicates could lead to infeasible paths in the model



Synoptic: Analysis

- Though Synoptic tool creates precise models, it does not handle duplicates
 - Ex: In trace 1 and 3 events C and D node occur in different context, however, Synoptic tool merges them



- For the experimental subject, about 30% duplicates were accidentally handled correctly
 - K-Tails does not merge nodes that do not have common parent

Challenge: Similar Test Steps

Case ID	Step Name	Description
Case_65934	1	Enter the URL "www.flipkart .com" in the browser.
	2	click the Register link present in the header section of the Home page.
	3	Enter all the details in the mandatory fields.
	4	click save button.
Case_65936	1	Enter the URL "www.Fipkart .com" in the browser.
	2	Click on the login button.
	3	Enter valid username and password.
	4	Press save button

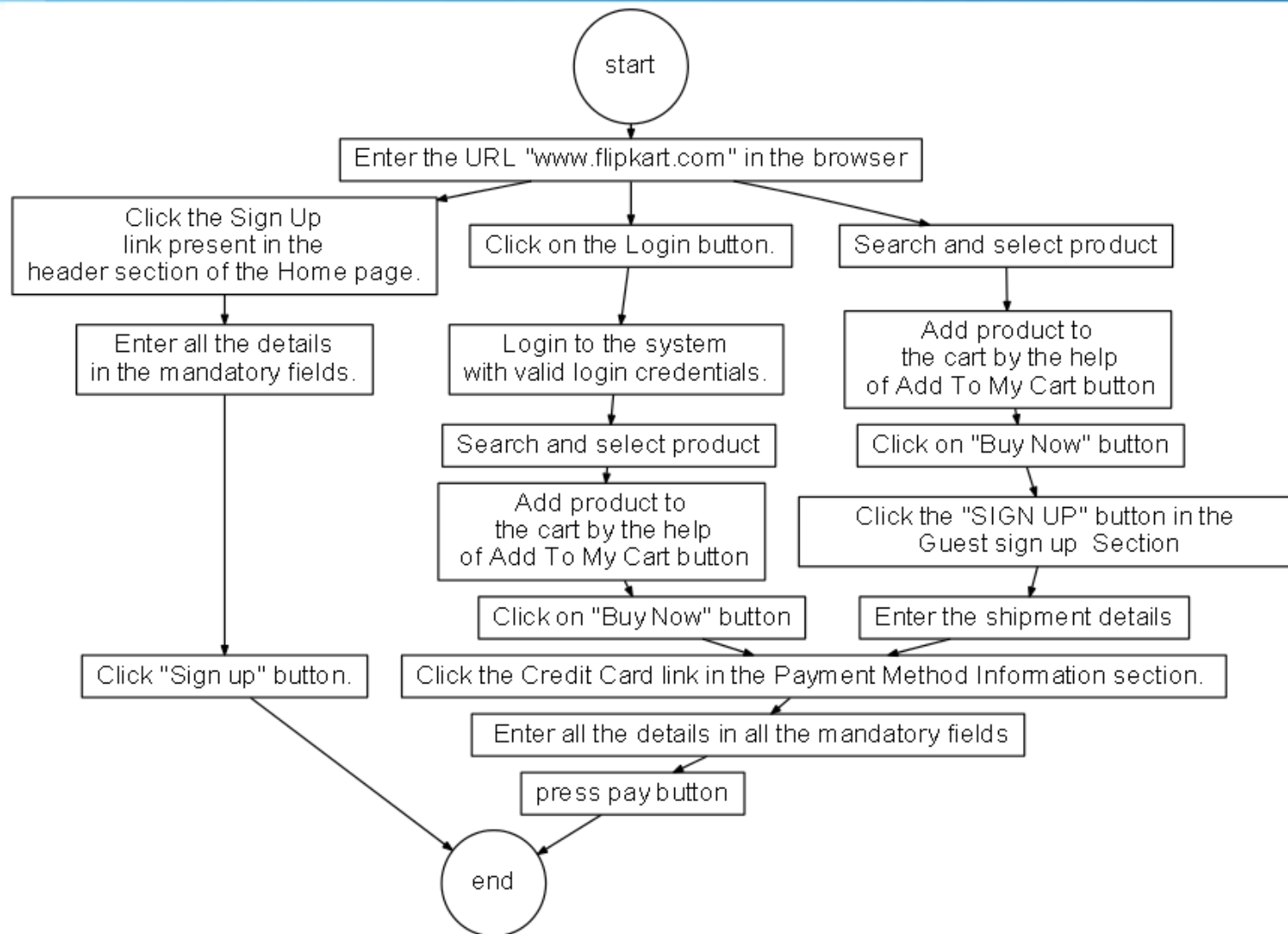
Example:

click save Button

Press save button

Click the save button

Sample scenario: Workflow model




Mining Test Scripts: Research Challenges

- How do I mine models from test scripts that are precise?
 - Duplicates?
 - Similar steps?
- Test steps are low level user actions. What kind of abstractions can we identify in the model?

A decorative graphic in the top-left corner consisting of a 2x3 grid of six light gray squares.

Patterns: Architectural Components

Platform Specific Pattern: Payment

 **Indian Railway Catering and Tourism Corporation Limited**
A Government of India Enterprise

Payment Option

Payment Mode : Net Banking Payment Gateway / Credit Card Debit Card Cash Card EMI

Select a Payment gateway :

Transaction Charge : 1.8%+Service Tax as applicable

Please Provide Credit Card Information

Card Type* :

Card Number* :

Card Expiry Date* : Month : Year(yyyy) :

CVV Number* : [What is CVV?](#)

Name on Card* :

Captcha* :

Captcha letters are case sensitive

9GKEXb [Refresh](#)



Payment Details

Credit Card




Debit Card

Net Banking

Cash on Delivery

PayU Money

Amount Payable : Rs.600.00 [Fare details here →](#)

Select card type:   

Name on the card

Card no.

Expiry Date

CVV [what is this?](#)

Save my card for express check out (100% secure)

Sample Scenarios for Payment







Normal Flow	Select Credit card as payment mode	Alternate Flow	Select Debit Card as payment mode
	Select card type		Select card type
	Enter valid card details in appropriate field		Enter valid card details in appropriate field
	Click pay button		Click pay button
Alternate Flow	Select Credit card as payment mode	Alternate Flow	Select Net Banking as payment mode
	Select card type		Enter valid username and password for net banking
	Select card from save cards by which you want to make payment		Enter payment details
	Click pay button		Make Payment

Domain Specific Pattern: Funds Transfer

NetBanking **HDFC BANK** Change Password Update Contact Details Logout

Accounts **Funds Transfer** BillPay & Recharge Cards Demat

Select Transaction Type

 Transfer within the bank (Re.1 to Rs.10 Lac per day) Go	 Instant Transfer to other bank (IMPS- Account No.) Go	 Transfer to other bank (NEFT) (Also for Credit Cards Payment) (Re.1 to Rs.10 Lac per day) Go
 Transfer to other bank (RTGS) (Rs.2 Lac to Rs.10 Lac per day) Go	 Instant Transfer to other bank (IMPS- Mobile No.) Go	 Transfer to eCMS Account (Virtual Account) (Re.1 to Rs.10 Lac per day) Go



Transfer Funds to

Your linked ICICI Bank account TRANSFER NOW LINK MY ACCOUNT Know More	Any other ICICI Bank account TRANSFER NOW Know More
An account in other bank through NEFT, RTGS or IMPS with IFSC code TRANSFER NOW Know More	Any mobile number through IMPS using MMID TRANSFER NOW Know More
Any mobile number using cardless cash withdrawal TRANSFER NOW Know More	

Domain Specific Pattern: Funds Transfer (Cont.)



DETAILS > CONFIRMATION

Transfer Funds to an account in other bank through NEFT

Payment mode

NEFT RTGS IMPS-IFSC (24x7 Instant Transfer)

From which of your accounts*

Select

Total available amount

INR of 20/03/2015 15:09

To which payee account*

Select

Amount (INR)*

1000

Remarks

Installment

Payment date

20/03/2015

Payment type*

One Time

*mandatory

NEXT ADD PAYEE

NetBanking
HDFC BANK Change Password Update Contact Details Logout

Accounts **Funds Transfer** BillPay & Recharge Cards Demat

From Account	- Select An Account -	▼
Beneficiary	- Select A Beneficiary -	▼
Beneficiary IFSC Code		
Beneficiary Account Number / Credit Card Number		
Transfer Amount	1000	
Transfer Description	Installment	
Funds Transfer Status to be sent to	Mobile	▼
	8460015684	

I accept Terms & Conditions and have read the Note below

Back Continue

Sample Scenarios: Funds Transfer

Normal Flow	Select Fund transfer option
	Select transaction type as your linked account
	Enter all the details in the mandatory fields
	Click continue
Alternate Flow	Select fund transfer option
	Select transaction type as other bank account
	Select to which beneficiary account you want to transfer fund
	Enter all other details
	Click continue

- Alternate scenario for fund transfer:
 - After selecting the transaction type, you will select Beneficiary from the existing list or you add new beneficiary.

- Platform Patterns
 - Login
 - Registration, Lazy Registration
 - Payment

- Domain Patterns
 - Fund Transfer
 - Placing an order
 - Claim Processing

- Can we use patterns to mine behavioral components?
- How do I describe a pattern? – Specification Language?
- What machinery do I need to match patterns to identify concrete components?
- How do I distinguish user actions?
 - Model comprehensibility
 - Identifying V&V v/s navigation
 - Structural abstractions
 - Heuristics

A decorative graphic consisting of six light gray rectangles arranged in a 2x3 grid on the left side of the slide.

Test Step Classification

Classification Scheme

- Data Entry
 - Form field entry, selecting radio buttons or from drop down lists
 - Examples:
 - Enter the same user name and password provided at the time of registration
 - Enter the valid Order number and email address

- Verification
 - Verification of on screen results or database
 - Examples:
 - Check if the correct amount has been deducted from account
 - Verify that the Order history Page contains details of all the orders

- Navigation
 - UI Action that navigates user to a different form or a web page
 - Examples:
 - Click the Sign Up link
 - Click the Login link present in the header section of the Home page

Classification Scheme

- Form Submission
 - Specialized UI Action culminating a set of actions
 - Examples:
 - Click Save button
 - Click OK button
- UI Action
 - All other UI actions
 - Examples:
 - Click the delete button present besides each contact

Validated with SMEs

Specializations – Heuristics, Model Comprehensibility

Experimental Setup

- Subjects
 - 232 Test scripts for 5 sub-modules of an e-commerce application
- Automatic Classification using supervised learning
 - Mallet [10] tool developed at Umass, Amherst
 - Naïve Bayes, Maximum Entropy, Decision Tree
- Training Set
 - Created from the subject having largest # test scripts
- Objective: Determine if supervised learning techniques can be used to automatically classify test steps

Subjects

- **E-Commerce:** E-Commerce is an online e-commerce application. Users of the application can browse products listed on the website. Registered users can view and add products to a cart and checkout the products. Guest users need to register or sign in during the check out process
- **Basket Management:** Basket Management is a sub module of an e-commerce application. Shopping cart management related functionality like adding items, creating lists, deleting items etc.
- **Content Management System(CMS):** CMS is a sub system that enables the user to create content. It also enables the approver to view verify and approve the content
- **Order Management:** Order Management is a sub module of an e-commerce application. It supports order related processes like, checking status of order, changing order, viewing an order based on some criteria etc.
- **Customer Notification:** Customer Notification is another sub module of e-commerce application. Processes like conformation of order, change in order status, etc. where end-users receive notification from the system

Subject Details

Case Study	# test cases	# total events	#Unique events before dis-conjugation	#Unique events after dis-conjugation	#Unique events after similarity analysis
E – Commerce	119	483	140	161	141
Basket Management	41	289	100	107	103
CMS	42	396	64	76	62
Order management	16	178	53	58	58
Customer Notification	14	108	60	70	66
Total	232	1454	417	472	430

Results: Naïve Bayes

Case study	No. of events correctly classify in each category					Precision	Recall
	Navigation	UI Action	Data Entry	Form Submission	Verification		
E-Commerce	36	33	41	0	21	0.75	0.75
Basket Management	17	41	11	2	13	0.84	0.75
CMS	5	31	12	1	9	0.94	0.84
Order Management	14	12	7	0	18	0.67	0.71
Customer Notification	17	18	7	0	14	0.71	0.75

Precision between 67%-94% and Recall between 71%-84%

Results: Max Entropy

Case study	No. of events correctly classify in each category					Precision	Recall
	Navigation	UI Action	Data Entry	Form Submission	Verification		
E-Commerce	34	33	40	2	23	0.95	0.89
Basket Management	17	46	13	4	16	0.87	0.91
CMS	5	26	12	3	10	0.89	0.96
Order Management	14	13	5	1	19	0.94	0.93
Customer Notification	15	18	7	3	14	0.92	0.92

Precision between 87%-95% and recall between 89%-96%

Results: Decision Tree

Case study	No. of events correctly classify in each category					Precision	Recall
	Navigation	UI Action	Data Entry	Form Submission	Verification		
E-Commerce	22	37	38	0	22	0.70	0.68
Basket Management	7	45	10	0	17	0.66	0.61
CMS	0	31	9	0	10	0.55	0.54
Order Management	1	17	6	0	18	0.65	0.60
Customer Notification	0	22	6	0	14	0.50	0.56

Precision between 50%-70% and recall between 54%-68%

- Maximum Entropy performs much better
 - Precision between 87%-95% and recall between 89%-96%
- Specializations a problem
 - Naïve Bayes: The action “click submit button” is classified as UI action as “click” and “button” occur more frequently in UI action
 - Maximum Entropy: The action “click submit button” is classified as Form Submission action as "submit button" and "click submit" occurs more frequently in Form submission
 - Decision Tree: "click submit button" is classified as UI action. Whenever "click" occurred, it checks for other higher probability words in the tree

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Summary

- Test scripts in the enterprise for business applications largely
 - Creation as well as during maintenance
- Comprehension of the manually written test scripts is a challenge
- Present the novel idea of mining workflow models
 - Similar / Duplicate test steps key challenges
- Suggest that test scripts have architectural components
 - Mining may be possible
- Present a test step classification scheme
 - Experimental results of automatic classifier using supervised learning

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